CHPRC-03407
Revision 1

Performance Assessment Closure Plan for the Integrated Disposal Facility

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

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Performance Assessment Closure Plan for the Integrated Disposal Facility

Document Type: RPT Program/Project: Integrated Disposal Facility (IDF)

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APPROVED
By Lynn M. Ayers at 7:46 am, Nov 04, 2019

Release Approval Date

Executive Summary

This report documents the closure plan for the Integrated Disposal Facility (IDF) performance assessment (PA). The IDF closure plan is one of several supporting documents that are compendiums to the IDF PA as required in DOE O 435.1[1] (Figure ES-1). The IDF PA is documented in RPP-RPT-59958.[2] This closure plan follows the requirements and outline specified in the applicable the U.S. Department of Energy standard used for developing documents supporting DOE-STD-5002-2017.[3]

The IDF is a *Resource Conservation and Recovery Act of 1976*[4]-compliant landfill (i.e., double-lined trench with leachate drainage system) that is designed and constructed to receive immobilized low-activity waste glass and associated secondary solid waste produced by the Hanford Tank Waste Treatment and Immobilization Plant, as well as liquid secondary waste that has been treated at the Effluent Treatment Facility. In addition, other Hanford Site wastes, including wastes that result from the decommissioning of the Fast Flux Test Facility as well as other onsite, non-*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*[5], nontank wastes and solid wastes, are planned for disposal at IDF. Following the completion of all disposal activities, an engineered barrier will be installed as a closure cap over IDF. The final IDF closure cap shall be designed to minimize maintenance and ensure long-term stability to isolate the disposed waste.

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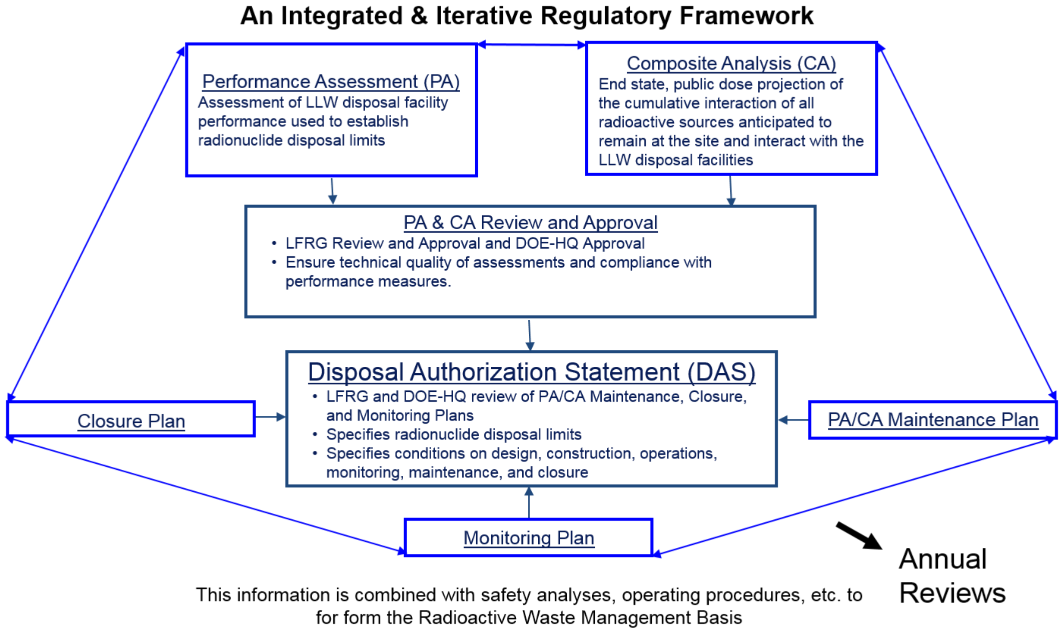
[1] DOE O 435.1, Chg 1 (PgChg), 2017, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives-documents/400-series/0435.1-BOrder-chg1.

[2] RPP-RPT-59958, *Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington,* Rev. 1A, Washington River Protection Solutions, LLC, Richland, Washington.

[3] DOE-STD-5002-2017, 2017, *Disposal Authorization Statement and Tank Closure Documentation*, U.S. Department of Energy, Washington, D.C. Available at https://www.standards.doe.gov/standards-documents/5000/5002-astd-2017/@@images/file.

[4] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: https://www.gpo.gov/fdsys/pkg/STATUTE-90/pdf/STATUTE-90-Pg2795.pdf.

[5] *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, Pub. L. 107-377 as amended, 42 USC 9601 et seq., December 31, 2002. Available at: https://www.csu.edu/cerc/researchreports/documents/CERCLASummary1980.pdf.



Reference: RPP-PLAN-60324.[6]

Note: The IDF PA is documented in RPP-RPT-59958[2]. The IDF PA Monitoring Plan is documented in CHPRC-03347.[7] The IDF PA Maintenance Plan is documented in CHPRC-03348.[8] A revision of the Hanford Site Composite Analysis is in progress and expected to be completed in 2019. Both the IDF PA and the Hanford Site Composite Analysis are subject to LFRG review and approval.

DOE-HQ	=	U.S. Department of Energy, Headquarters
LFRG	=	Low-Level Waste Disposal Facility Federal Review Group
LLW	=	low-level waste

Figure ES-1. Documents Required for a Disposal Authorization Statement

The closure plan provides a summary of the facility and key assumptions affecting the PA and the closure of the facility. The closure plan provides a summary description of the site, facility, and the waste planned for disposal as well as the approach and schedule for the planned closure of the facility.

A preliminary closure plan for the IDF was produced prior to completing the initial phase of construction of the facility (RPP-21633[9]). This preliminary closure plan has been

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[6] RPP-PLAN-60324, *Integrated Disposal Facility (IDF) Performance Assessment Project Execution Plan*, Rev. 0, AREVA Federal Services, LLC, Richland, Washington.

[7] CHPRC-03347, 2019, *Performance Assessment Monitoring Plan for the Integrated Disposal Facility,* Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington.

[8] CHPRC-03348, 2019, *Performance Assessment Maintenance Plan for the Integrated Disposal Facility,* Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington.

[9] RPP-21633, *Preliminary Closure Plan for the Integrated Disposal Facility,* Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

updated to account for different waste streams and PA key assumptions and therefore will be superseded by the present document.

This closure plan is a living document that will be updated throughout the operational life of the disposal site with specific information about the disposal of mixed low-level waste and low-level waste, and partial closure of cells (e.g., covering waste packages with fill material) within the disposal unit, and other activities necessary to achieve the facility's final closed state.

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Terms

AEA	*Atomic Energy Act of 1954*
BBI	best-basis inventory
CDN	composite drainage net
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ETF	Effluent Treatment Facility
FFS	focused feasibility study
FFTF	Fast Flux Treatment Facility
HEPA	high-efficiency particulate air (filter)
HFSUWG	Hanford Future Site Uses Working Group
HMS	Hanford Meteorological Station
IDF	Integrated Disposal Facility
ILAW	immobilized low-activity waste
LAW	low-activity waste
LCRS	leachate collection and recovery system
LDS	leak detection system
LLW	low-level waste
LSW	liquid secondary waste
MLLW	mixed low-level waste
NEPA	*National Environmental Policy Act of 1969*
NRC	Nuclear Regulatory Commission
PA	performance assessment
RCRA	*Resource Conservation and Recovery Act of 1976*
ROD	record of decision
SLDS	secondary leak detection system

SSW	secondary solid waste
TC&WM EIS	*Tank Closure and Waste Management Environmental Impact Statement (TC & WM EIS)*
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WTP	Hanford Tank Waste Treatment and Immobilization Plant

1 Introduction

The Hanford Site consists of 1,450 km^2 (900 mi^2) of shrub steppe, sand, and sagebrush located near the Columbia River in southeastern Washington State (Figure 1-1). The Hanford Site is managed by the U.S. Department of Energy (DOE), the successor agency to the U.S. Atomic Energy Commission. As a plutonium production complex, the Hanford Site played a pivotal role in the nation's defense for more than 50 years, beginning in the 1940s with the construction of the Site as part of the Manhattan Project. Much of the byproduct nuclear materials created by the operations at the Hanford Site have been contained in underground waste storage tanks.

The DOE, through the Office of River Protection, created the River Protection Project (formerly the Tank Waste Remediation System Project) as part of the program for environmental remediation of the Hanford Site. The River Protection Project's mission (HNF-SD-WM-MAR-008, *Tank Waste Remediation System Mission Analysis Report*) is retrieval, pretreatment, immobilization, interim storage, and disposal of the high-level radioactive tank waste and associated incidental low-activity waste (LAW) disposal at the Hanford Site, followed by tank closure.

Some treatment of tank waste will be performed by the Hanford Tank Waste Treatment and Immobilization Plant (WTP) or supplemental technology such as bulk vitrification. The Tank Farm contractor will be responsible for work scope that includes receipt of immobilized low-activity waste (ILAW) from the WTP, safe transportation of the waste to the onsite disposal facility, and final disposal and closure monitoring. Other low-level waste (LLW) and mixed low-level waste (MLLW) generated as part of DOE cleanup activities at the Hanford Site and possibly from other sites will be disposed of in the Integrated Disposal Facility (IDF).

The IDF is located in the southern part of the 200 East Area of the Central Plateau on the Hanford Site. An aerial photograph of the current construction of IDF and other relevant Hanford-related facilities is presented in Figure 1-2. The IDF is similar in concept to the existing Hanford Site Radioactive Mixed Waste Burial Trench and the Environmental Restoration Disposal Facility. The disposal site is projected to consist of one expandable trench that is divided into separate cells. The IDF consists of a lined landfill, approximately 442 m (1,450 ft) wide (from west to east), with a total planned buildout of approximately 555 m (1,820 ft) in length (from north to south) and 13.2 m (43.3 ft) in depth. For the waste inventory and volume assumptions analyzed in the IDF performance assessment (PA) (RPP-RPT-59958, *Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington*), there was sufficient capacity in four cells to accommodate the waste. The IDF will contain four layers (or lifts) of waste packages separated vertically by 1 m (3 ft) of soil. Other waste types may have different layering strategies to accommodate varying sizes, but, in general, there are four lifts planned for the IDF, with a 1 m (3 ft) thick operational layer between each lift.

Construction activities of the IDF began in September 2004 with the completion of the Phase 1 construction (consisting of Cells 1 and 2) in October 2006. The IDF trench will be expanded as additional disposal capacity is needed. Each expansion will be filled with waste and an interim cover installed. The IDF final closure cap will be installed after the end of waste disposal in the IDF. The last IDF expansion is expected to be closed in 2051.

Post-closure monitoring of the IDF will continue to ensure that the waste is isolated and contamination is prevented from reaching the public and the environment in excess of limits. The duration of monitoring will be assessed at each permit review and renewal. Post-closure monitoring of the IDF will continue for at least 30 years, as required by both state and federal regulation. The duration of post-closure monitoring could be shortened or extended as appropriate based on the adequacy of the closure process (WAC 173-303-610(7), "Dangerous Waste Regulations," "Closure and Post-Closure," and

40 CFR 264.310, “Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,” “Closure and Post-Closure Care”).

The purpose of this document is to provide the technical basis for defining critical closure design features and future conditions needed to conduct the PA. This document also satisfies the DOE M 435.1-1, *Radioactive Waste Management Manual,* requirement that a preliminary closure plan shall be submitted to the Low-Level Waste Disposal Facility Federal Review Group for review. The PA provides DOE with a reasonable expectation that the waste disposal will meet the radiological performance objectives established in DOE M 435.1-1.

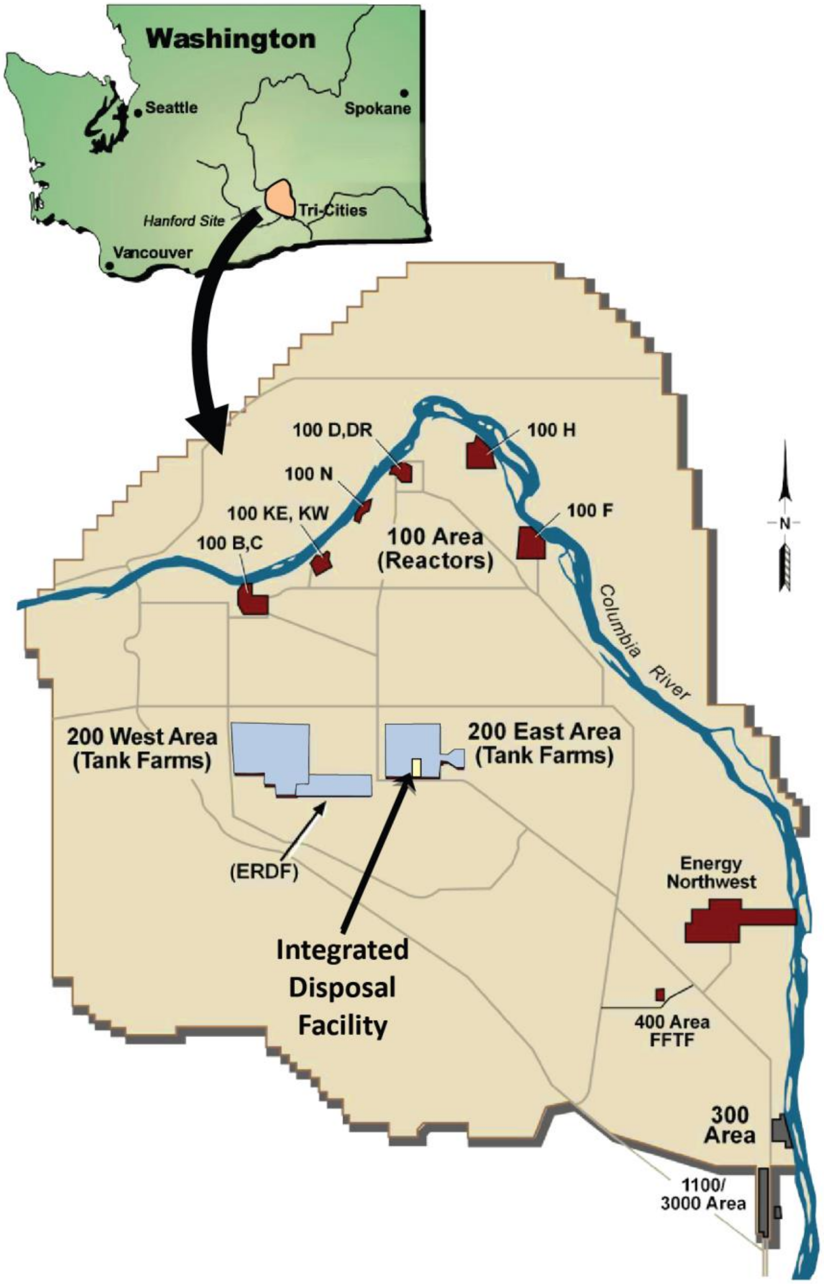

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Figure 1-1. Location of the Integrated Disposal Facility and Surrounding Area

Note: View is looking approximately due west. The IDF open trench, with a west-to-east width of 330 m (360 yd) along the floor of the trench, is visible in the lower third of the photograph. To the west of the IDF is the Route 4 access road and 1st Street, which forms the southern boundary of the 200 East Area. The west-east oriented structure to the northeast of the IDF is the Plutonium Uranium Extraction Plant canyon, which processed more than 63,500 metric tons (70,000 tons) of uranium fuel rods during its operations from 1956 to 1972 and again from 1983 to 1988. To the southwest of the IDF are the BC cribs and trenches, and immediately to the west of the BC cribs and trenches is the U.S. Ecology site. Further to the west of U.S. Ecology, the Environmental Restoration Disposal Facility is visible, as are the operational areas in the 200 West Area. Between the U.S. Ecology site and Environmental Restoration Disposal Facility there is a marked change in vegetation caused by the June 2000 24 Command Fire. To the west of the 200 West Area the basalt highlands, from south to north Rattlesnake Hills, Yakima Ridge and Umtanum Ridge are faintly visible at the top of the photo.

Figure 1-2. Aerial View of the Integrated Disposal Facility and Nearby Hanford Facilities

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2 Summary of Facility Description

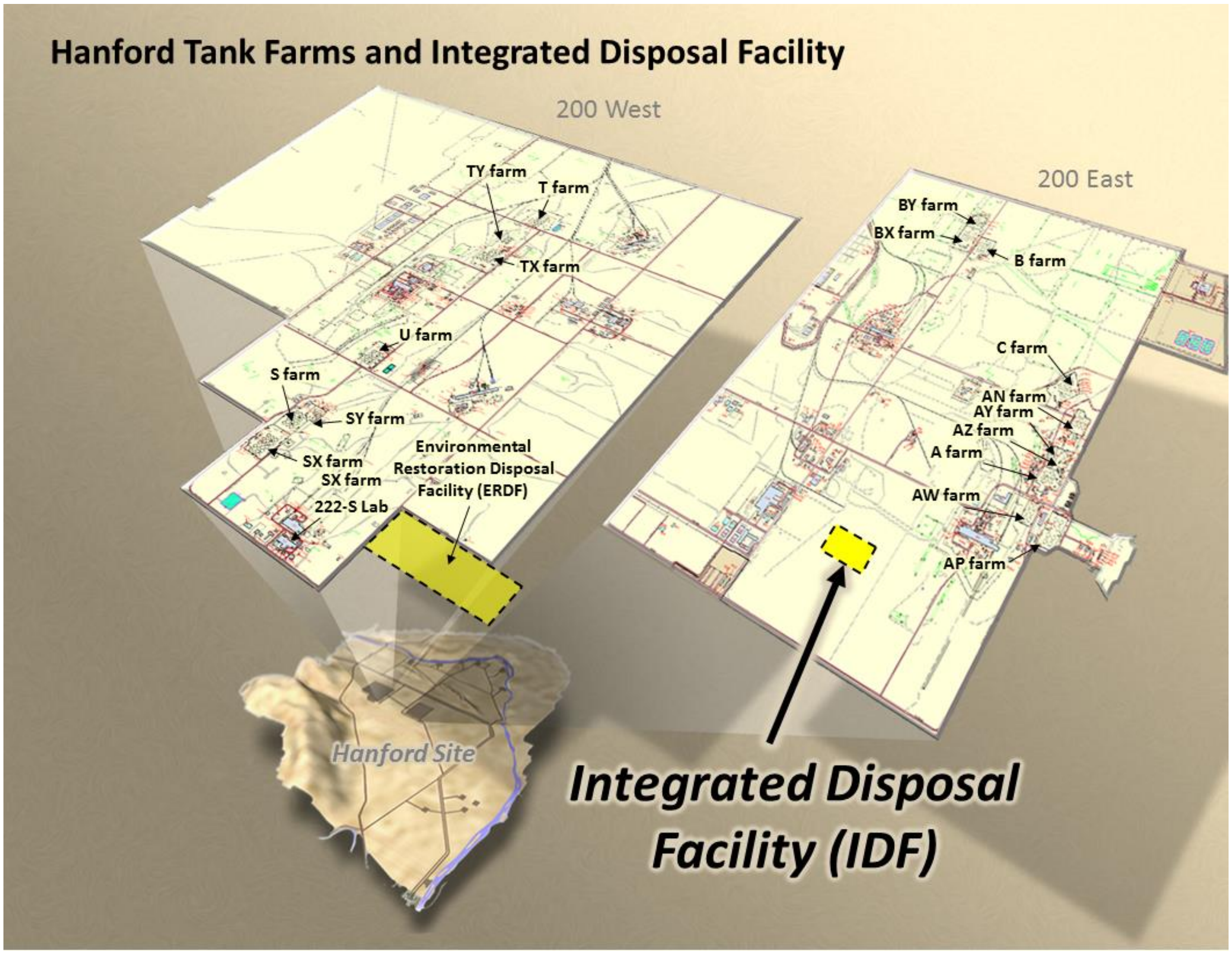
The IDF is an expandable lined landfill designated for permanent disposal of LLW and MLLW located in the 200 East Area of the Hanford Site (Figure 2-1). Construction of the IDF was initiated in 2004, and the initial phase of construction consisting of the first two cells, including the initially permitted Cell 1, was completed in 2006. The planned build out of the IDF will extend the facility further to the south (drawing H-2-830827, *IDF Overall Site Development Plan*). The current Dangerous Waste Permit for IDF (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion Revision 8C for the Treatment, Storage, and Disposal of Dangerous Waste*, Part III Operating Unit 11, hereinafter called the Hanford *Resource Conservation and Recovery Act of 1976* [RCRA] Permit) and associated amendments restrict the scope of the permit to the landfill construction and operation as necessary to dispose of ILAW from the WTP. Future expansion of the RCRA trench, or disposal of other wastes not specified in the current permit, is prohibited unless authorized via modification of the Hanford RCRA Permit (WA7890008967, Unit Specific Condition II.11.B.3).

The IDF consists of an expandable lined landfill that is currently divided lengthwise (north-south orientation) into two distinct cells (Figure 2-2). The initial phase of construction consisting of the first two cells, was completed in 2006 (drawing H-2-830827). The planned build-out of the IDF is illustrated in Figure 2-3. West-east and north-south cross sections through the IDF are depicted in Figure 2-4. The final landfill is envisioned to be comprised of six cells. As analyzed in the PA, the final facility at closure is assumed to have a north-south length at the trench bottom of 501 m (1,645 ft) and an east-west width of 422 m (1,385 ft) (drawing H-2-830827). These dimensions were calculated to provide sufficient volume to accommodate 900,000 m^3 (32,000,000 ft^3) of waste.

The landfill is separated into two separate cells, each designed to meet the RCRA liner requirements with leachate collection and leak detection systems. The current closure planning calls for covering the landfill with a modified RCRA Subtitle C barrier. Each landfill cell has a RCRA-compliant liner system underlying the operations layer (Figure 2-5, Figure 2-6, and Figure 2-7). The liner system consists of layers of different materials, which includes a drain gravel with underlying primary and secondary geomembranes embedding a geosynthetic clay layer and composite drainage net (CDN) representing the leak detection system (LDS) shown in Figure 2-5 and Figure 2-6. The CDN drainage layer and geomembrane liner extend under the entire base and side slopes area of the IDF, whereas the drain gravel and geosynthetic clay layer extends only along the bottom part of the trench. Beneath the secondary geomembrane liner is a 0.9 m (3 ft) thick admix layer. The prepared subgrade material beneath the admix layer is assumed to be compacted native subgrade backfill material. Details of the IDF RCRA-compliant liner system are described in the facilities data package report RPP-20691, *Facility Data for the Hanford Integrated Disposal Facility Performance Assessment*, and summarized in Section 5.2.2. The liner system complies with the RCRA Subtitle C liner requirements.

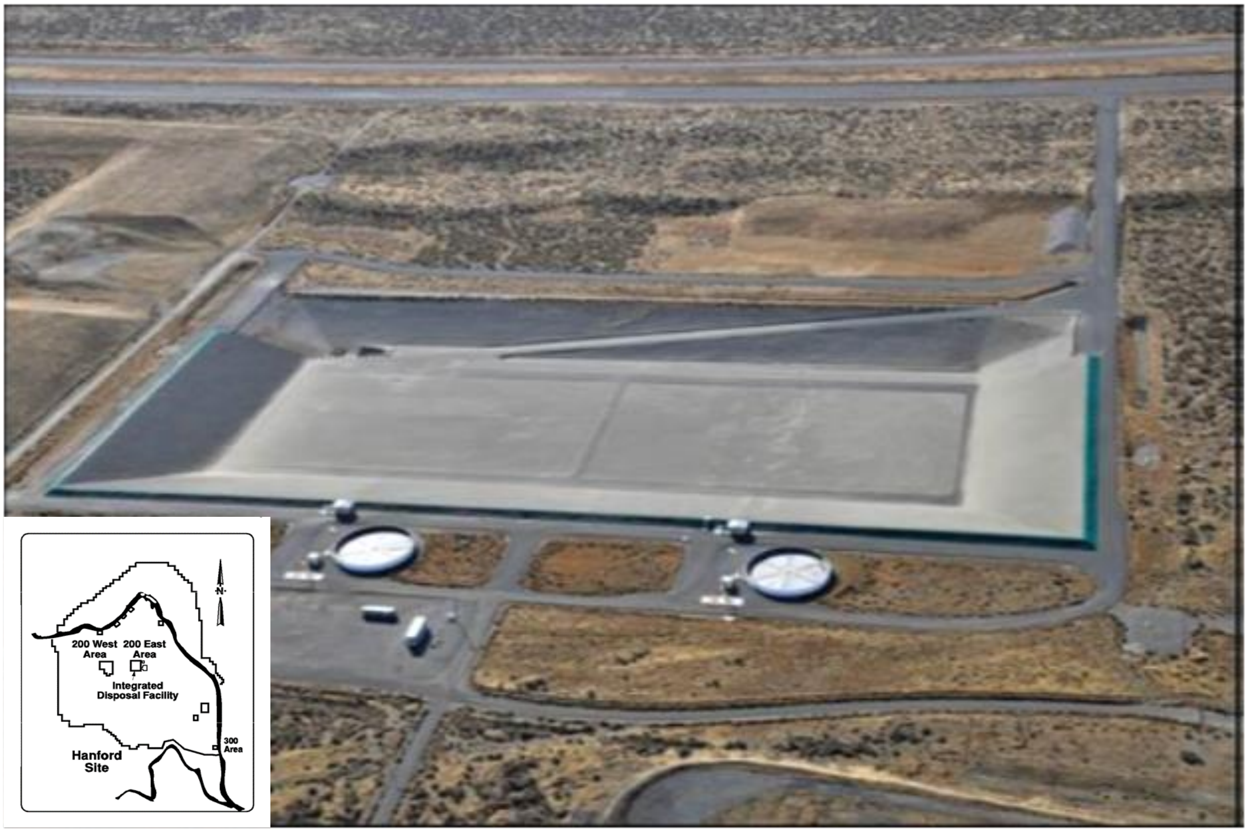
The landfill cells contain sumps for the leachate collection and recovery system (LCRS) and an LDS. The LCRS is a system of liners, drainage layers, and collection piping that will collect any liquids captured on the primary liner and route these liquids to a sump location at the northern edge of Cell 1 and Cell 2. The LDS is like the LCRS and is designed to collect the liquids which pass through the primary liner and the LCRS. CDNs are on top of both the primary and secondary geomembrane liner along the side slopes, consisting of high-density polyethylene. Along the floor, a drain gravel is used above the primary geomembrane as a drainage layer. A 12 in. diameter, LCRS slotted pipe is located along the north-south centerline of each cell. This pipe connects to the LCRS sump at the north end of each cell. The LCRS riser pipes contain the pumps for removing these leachate liquids from the sump area to storage tanks for the temporary holding of these liquids prior to their transfer to a RCRA-compliant treatment facility for treatment and disposal.

Beneath the LDS sump is a secondary leak detection system (SLDS) which consists of operations layer type fill for a foundation of the LDS admix layer, drainage gravel adjacent to a perforated pipe, a CDN, and tertiary geomembrane. A nonwoven separation geotextile is located between the operations layer type material and the drainage gravel to minimize sediment (fine-soil) migration into the SLDS piping. The riser pipe provides access to the secondary leak detection sump for liquid depth measurements and for a low-flow pump. The purpose of this system is to provide access to the area immediately below the LDS sump area. The SLDS collects liquids resulting from potential leakage through the admix layer to the vadose zone. The SLDS liners will convey collected liquids to the SLDS piping for monitoring and removal. The detailed configuration of the monitoring of the LCRS and LDS as well as the SLDS is described in detail in the IDF PA monitoring plan (CHPRC-03347, *Performance Assessment Monitoring Plan for the Integrated Disposal Facility*).



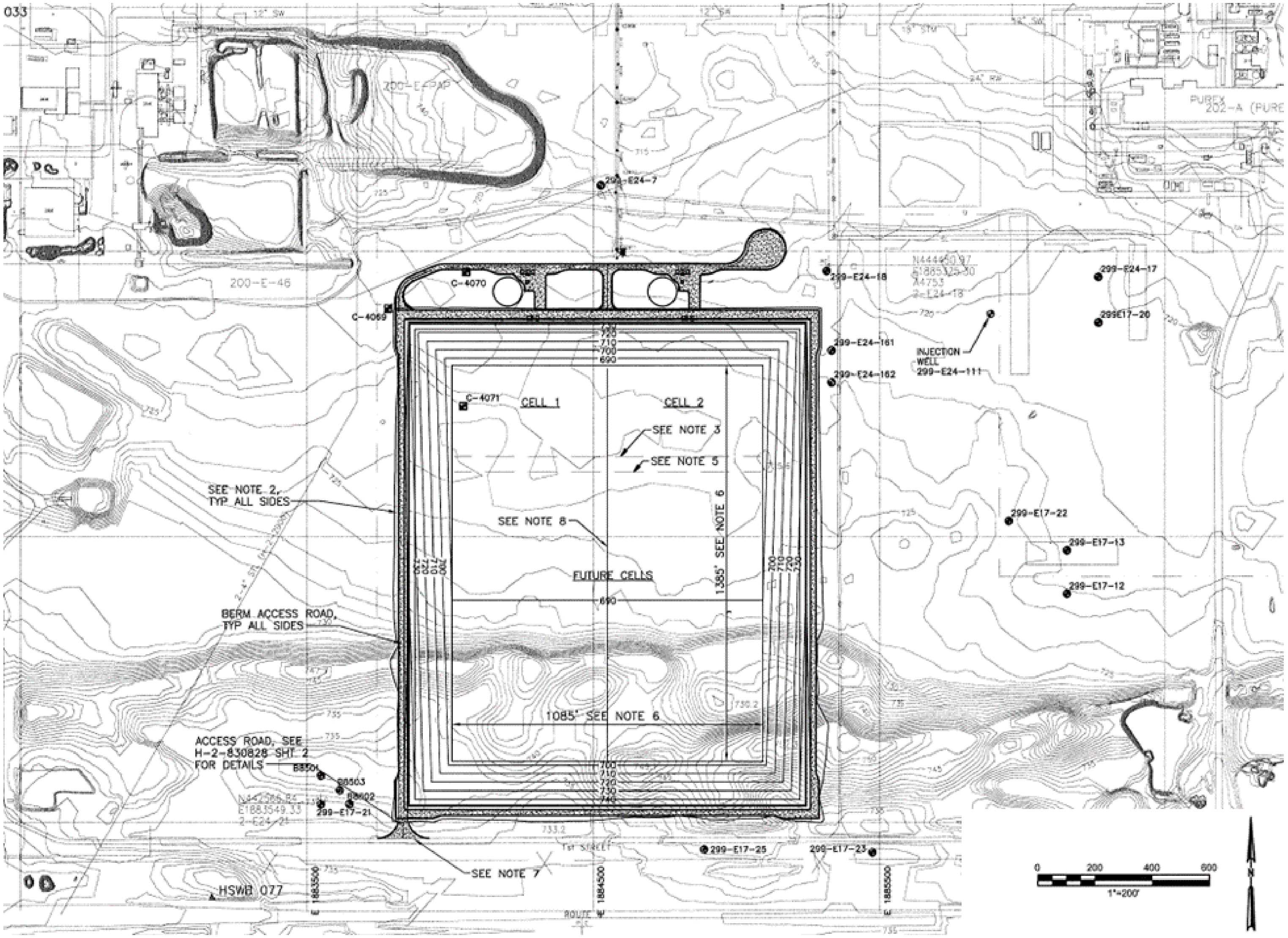
Note: IDF outline shows footprint of current (2017) construction. Future planned build-out of addition cells will extend footprint to the south.

Figure 2-1. Perspective View of Location of Integrated Disposal Facility and Hanford Tank Farms



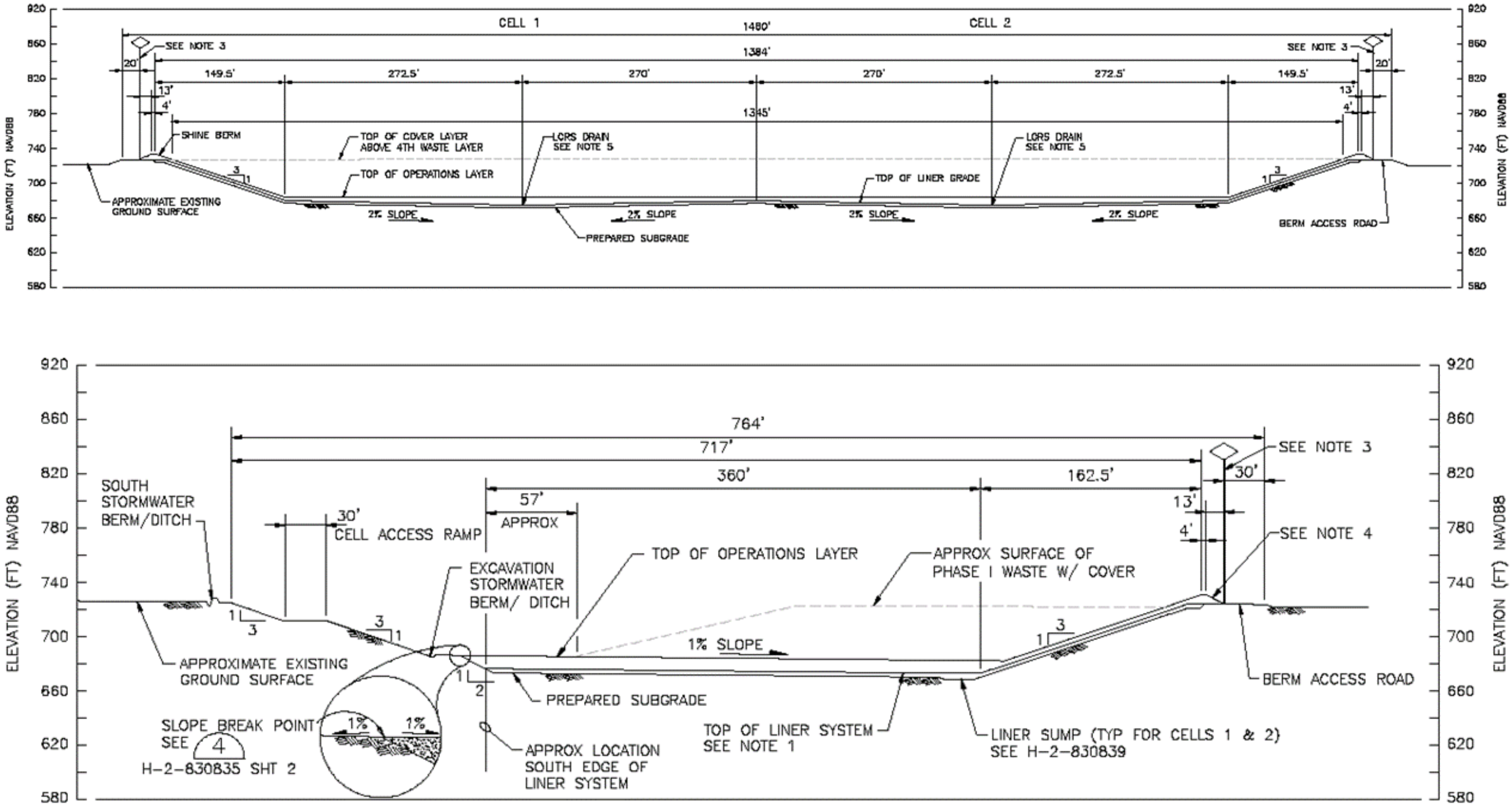
Note: View is to the south. The current configuration represents Phase 1 of the IDF with future expansion planned to the south (upper portion of figure). Cell 1 is to the west (right side of figure) and Cell 2 is to the east (left side of figure). Cell 1 is included in the current Hanford RCRA permit (WA7890008967, Part III Operating Unit 11). The two circular features on the north of the facility are the storage tanks for the leachate collection systems associated with Cell 1 and Cell 2. The shine berm to shine berm east to west width of the current configuration is 421.8 m (1,384 ft) while the width at the floor of the facility is 330 m (1,083 ft). Plans for future expansion of the facility are to the south in the direction of the east-west trending inactive longitudinal sand dunes.

Figure 2-2. Integrated Disposal Facility Current Configuration



Source: Drawing H-2-830827, *IDF Overall Site Development Plan*.

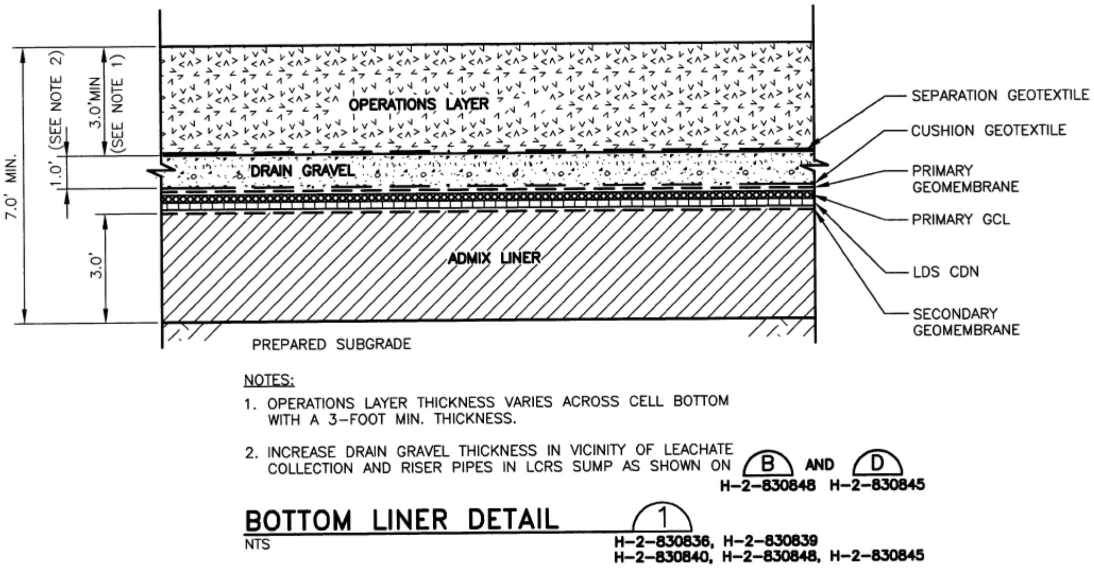
Figure 2-3. Integrated Disposal Facility Planned Layout Configuration



Sources: Drawing H-2-830835, *IDF Grading and Drainage Sections and Details*.

Drawing H-2-830839, *IDF Geosynthetics Sections and Details*.

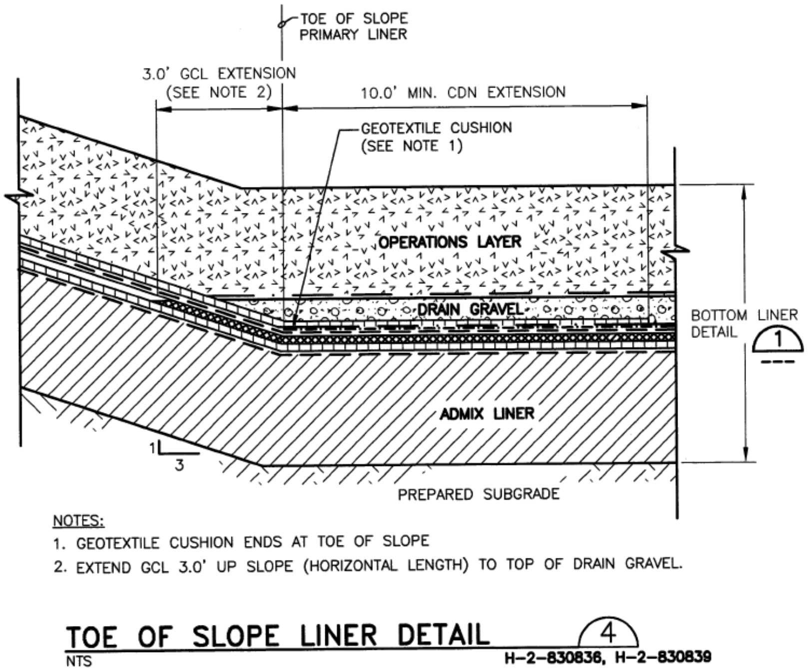
Figure 2-4. Integrated Disposal Facility Trench Cross-Section Dimensions, West-East Cross-Section (top), South-North Cross-Section (bottom)



Source: Drawing H-2-830838, *IDF Geosynthetics Sections and Details,* Sheet 1.

CDN = composite drainage net; GCL = geosynthetic clay liner; LDS = Leak Detection System

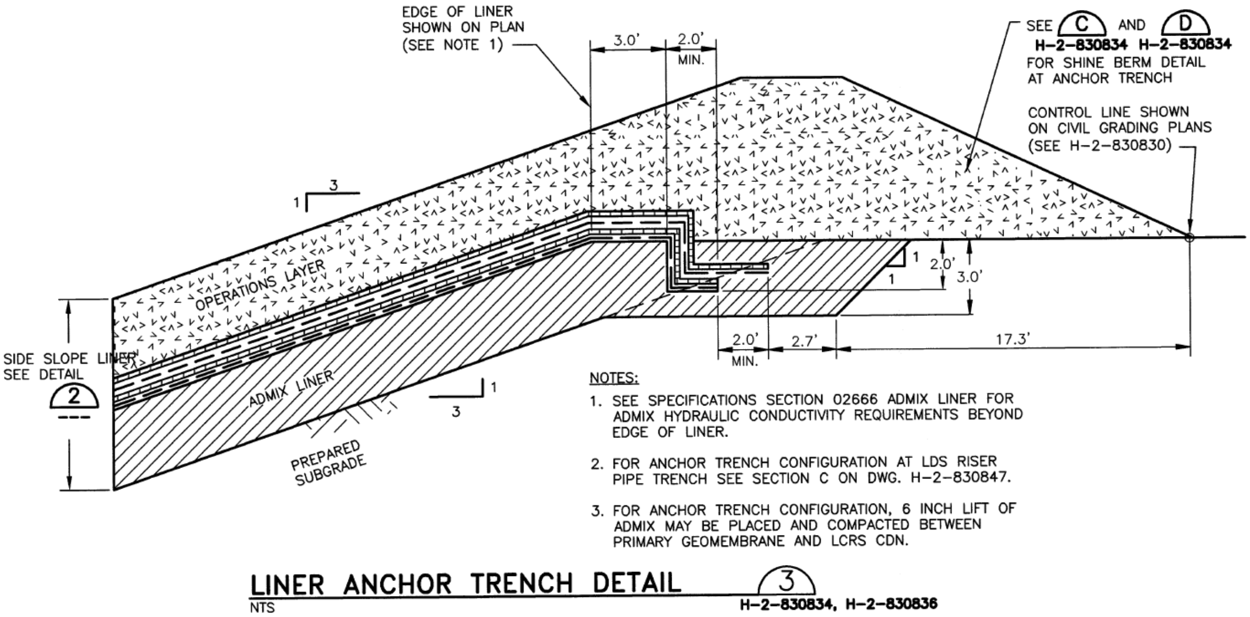
Figure 2-5. Components of the Integrated Disposal Facility Liner



Source: Drawing H-2-830838, *IDF Geosynthetics Sections and Details,* Sheet 1.

CDN = composite drainage net; GCL = geosynthetic clay liner

Figure 2-6. Detailed Cross-Section of Toe of the Integrated Disposal Facility Slope Liner and Operations Layers



NOTES:

1. SEE SPECIFICATIONS SECTION 02666 ADMIX LINER FOR ADMIX HYDRAULIC CONDUCTIVITY REQUIREMENTS BEYOND EDGE OF LINER.
2. FOR ANCHOR TRENCH CONFIGURATION AT LDS RISER PIPE TRENCH SEE SECTION C ON DWG. H-2-830847.
3. FOR ANCHOR TRENCH CONFIGURATION, 6 INCH LIFT OF ADMIX MAY BE PLACED AND COMPACTED BETWEEN PRIMARY GEOMEMBRANE AND LCRS CDN.

Source: Drawing H-2-830838, *IDF Geosynthetics Sections and Details*, Sheet 1.

CDN = composite drainage net; LCRS = leachate collection and recovery system; LDS = Leak Detection System

Figure 2-7. Detailed Cross-Section of the Edge of the Integrated Disposal Facility Liner and Shine Berm

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3 Summary of Closure Approach

The IDF will be closed as a landfill with the waste remaining in place. Site closure will include constructing a closure cover to minimize long-term intrusion or infiltration of water. The closure cover is a modified RCRA Subtitle C barrier (DOE/RL-93-33, *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Area*). The closure cover consists of a topsoil layer, a lateral drainage area, and a barrier layer. The closure cover provides a minimum of 5 m (16 ft) of soil cover above the surface of the top of the uppermost layer of packages and extends at least 6 m (20 ft) beyond the surface edge of the secondary trench liner. The modified RCRA barrier has a requirement to design the low-permeability layer of the cover to have a permeability less than or equal to any natural subsoils present. Additionally, it is required that "for frost protection, the lateral drainage layer and the low-permeability asphalt layer must be located at least 75 cm below final grade" (DOE/RL-93-33).

Existing programs for groundwater monitoring and air sampling and analysis are currently adequate for PA purposes at IDF. Details of the sampling and analyses of these media are provided for groundwater by the following documents:

- DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit* (as modified by TPA-CN-205, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: DOE/RL-2003-04, Revision 1, Sampling and Analysis Plan for the 200-PO-1 Operable Unit*)
- DOE/RL-2007-31, *Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit*
- RPP-PLAN-26534, *Integrated Disposal Facility Operational Monitoring Plan to Meet DOE Order 435.1*
- Hanford RCRA Permit (WA7890008967, Section III.11.E.1.b)

Details of the sampling and analyses of these media are provided for air sampling and analysis by the following documents:

- DOE/RL-2016-10, *Radionuclide Air Emissions Report for the Hanford Site Calendar Year 2015*
- DOE/RL-91-50, *Hanford Site Environmental Monitoring Plan*

Recent annual reports summarizing the results of Hanford monitoring activities include the following:

- DOE/RL-2016-09, *Hanford Site Groundwater Monitoring Report for 2015*, provides an overall appraisal and results of all required groundwater monitoring for the Hanford Site. This report also includes summaries of groundwater and vadose zone research.
- DOE/RL-2016-33, *Hanford Site Environmental Report for Calendar Year 2015*, provides a comprehensive report of monitoring all media and potential pathways.
- DOE/RL-2016-10, documents ambient radionuclide air emissions from the Hanford Site, including several sites near IDF.
- DOE/RL-2016-66, *Hanford Site RCRA Groundwater Monitoring Report for 2016*, provides a summary of groundwater monitoring at RCRA sites, including the IDF.

3.1 Regulatory Context of IDF Closure

The regulatory context for IDF closure, including requirements for the protection of human health and the environment, is complex and regulated by multiple agencies, U.S. Department of Energy (DOE), Washington State Department of Ecology (Ecology), and the U.S. Environmental Protection Agency (EPA). The primary laws and regulations which govern waste management and related closure processes include the following:

- *National Environmental Policy Act of 1969* (NEPA)
- *Hanford Federal Facility Agreement and Consent Order,* hereinafter called the Tri-Party Agreement (Ecology et al., 1989)
- RCRA/*Washington State Hazardous Waste Management Act of 1976* (RCW 70.105, “Hazardous Waste Management”)
- *Atomic Energy Act of 1954* (AEA)

In concert, these laws and regulations provide the overarching guidelines for the cleanup and closure processes. NEPA provides the decision-making structure for Federal agencies. The Tri-Party Agreement describes closure activities, which are driven by both the requirements of the AEA, as amended, regulating the radioactive portion of mixed waste and RCRA/*Washington State Hazardous Waste Management Act of 1976* as implemented through WAC 173-303, regulating the nonradioactive dangerous portion of mixed waste.

3.1.1 *National Environmental Policy Act of 1969*

In December 2012, DOE published a NEPA Environmental Impact Statement for the closure of Hanford Site tanks. DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS),* hereinafter called the TC&WM EIS) in part analyzes wastes planned for disposal at the IDF. The summary to the TC&WM EIS states:

> DOE’s Preferred Alternative for waste management is Alternative 2, disposal of onsite LLW and MLLW streams in a single IDF (IDF-East). Disposal of single shell tank closure waste that is not highly contaminated, such as rubble, soils, and ancillary equipment, in the proposed River Protection Project Disposal Facility is also included under this alternative. After completion of disposal activities, IDF-East and the proposed River Protection Project Disposal Facility would be landfill-closed under an engineered modified RCRA Subtitle C barrier. The final EIS analyses show that, even when mitigation is applied to certain offsite waste streams (e.g., removal of most of the Iodine-129), some environmental impacts of small quantities of Iodine-129 would still occur and, therefore, limitations for that constituent should apply regardless of the alternative selected.
>
> DOE will continue to defer the importation of offsite waste to Hanford, at least until the Hanford Waste Treatment and Immobilization Plant (WTP) is operational, subject to appropriate NEPA review and consistent with its previous Preferred Alternative for waste management (74 FR 67189). The limitations and exemptions defined in DOE’s January 6, 2006, Settlement Agreement with the State of Washington (as amended on June 5, 2008) regarding State of Washington v. Bodman (Civil No. 2:03-cv-05018-AAM), signed by DOE, Ecology, the Washington State Attorney General’s Office, and the U.S. Department of Justice, will remain in place.

DOE issued the TC&WM EIS Record of Decision (ROD) in December 2013 (78 FR 240, "Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington"). The ROD stated:

> For waste management, DOE's preference is for a single IDF in 200-East … The disposal facilities would be closed with RCRA compliant barriers. … DOE would continue to defer the importation of off-site wastes at Hanford, at least until the WTP is operational. … DOE has decided to implement Waste Management Alternative 2, which includes disposal of LLW and MLLW at IDF-East from tank treatment operations, waste generated from WTP and ETF operations, on-site non CERCLA sources, FFTF decommissioning waste and on-site waste management waste.

The Basis for the Decision states,

> In order to treat the tank waste in WTP and implement 1 FFTF Alternative 2 disposal, capacity is needed for waste generated during those activities. For economic and operational efficiencies, DOE has decided to operate one IDF located in the 200-East Area instead of two separate IDFs in 200-East and 200-West. The IDF disposal capacity is needed to dispose of waste from tank waste treatment and FFTF disposition activities.

3.1.2 Tri-Party Agreement

The Tri-Party Agreement, signed by DOE, Ecology, and EPA on May 15, 1989, is an enforceable agreement that requires DOE to clean up and dispose of radioactive and hazardous waste at the Hanford Site and close facilities that have been used to treat, store, or dispose of such waste. The Tri-Party Agreement establishes work requirements (milestones), methods for resolving problems, and an action plan for cleanup that addresses priority activities. The Tri-Party Agreement also recognizes the applicability of RCRA and its amendments to the Hanford Site.

3.1.3 *Resource Conservation and Recovery Act of 1976/Washington State Hazardous Waste Management Act of 1976*

Acceptance of MLLW at the IDF must be in accordance with conditions specified in the Hanford RCRA Permit for the facility (WA7890008967). The decision under the ROD for the TC&M EIS (78 FR 240) is that the IDF will be landfill closed under the Washington Administrative Code regulations. Following the ROD, and in accordance with WAC 173-303-610, DOE will close the IDF and perform closure and post-closure care in accordance with applicable landfill closure and post-closure requirements set forth in WAC 173-303-610 and WAC 173-303-665(6), "Landfills."

3.1.4 *Atomic Energy Act of 1954*

Under its authority of the AEA, DOE regulates the closure of its facilities containing radioactive materials. The primary mechanism for this regulation is DOE O 435.1, *Radioactive Waste Management,* and the associated documents (particularly DOE M 435.1-1).

Where information regarding treatment, management, and disposal of the radioactive source, byproduct material, special nuclear material (as defined by the AEA) and/or the radionuclide component of mixed waste has been incorporated into the Hanford Site-Wide RCRA Permit (WA7890008967), it is not incorporated to regulate the radiation hazards of such components under the authority of this closure plan or RCW 70.105.

3.2 Performance Context of IDF Closure

The safety concept for this system is composed of a set of safety functions of manmade as well as natural components that act together to provide the long-term performance required in closure regulations. The safety functions represent multiple and redundant barriers. The key engineered design features of the system that influence performance include:

- RCRA modified Subtitle C surface barrier placed above the waste to limit water from contacting the waste, minimize the potential for biointrusion into the waste, and limit the release of gaseous contaminants, including radon, from the facility
- Waste containers to limit water from contacting the waste during disposal operations and provide for structural support for overlying waste and backfill
- Engineered backfill placed between and above waste containers to provide for structural support during operations and after closure
- Borosilicate glass waste forms that limit the release of contaminants to the backfill surrounding the waste forms and containers due to the slow dissolution of the glass matrix
- Cementitious waste forms that limit the advective-diffusive release of contaminants to the backfill surrounding the waste forms and containers due to the low diffusion or high sorption of the contaminants in the cementitious waste form or waste substrate
- Liner and leak detection system to limit any water collected during operations and the institutional control period from entering the natural system beneath the facility

The models and parameters used to describe these engineered features of the IDF are relevant to the closure of the facility. The importance of the assumptions related to closure of the facility are summarized in Chapter 4.

4 Summary of Key Assumptions

The IDF consists of both natural and engineered features that have functions that provide barriers to the release of contaminants and therefore contribute to the overall post-closure safety of the facility. The features and associated safety or barrier functions are summarized in Table 4-1. This table is arranged in order of how water may be expected to contact the waste, resulting in the potential release of contaminants to the natural system and hence to any potential receptor. The relative significance of the features to the overall performance is based on the results of RPP-RPT-59958. Schematic depictions of the safety functions of the natural and engineered features of the IDF are provided in Figure 4-1 and Figure 4-2, respectively. The goal of the calculations in the performance assessment described in RPP-RPT-59958 was to evaluate these safety functions, and to provide reasonable expectation of acceptable performance even when some of the safety functions are degraded through time.

Table 4-1. Relative Significance of Safety Functions of Key Engineered and Natural Barriers and Features of the Integrated Disposal Facility

Barrier-Feature	Safety Function	Safety Function Description	Significance to Facility Closure
Institutional Control – Natural Environment	Institutional Control	By rule, it is assumed that control of the site will be retained for 100 years. A strong potential exists that the United States government will retain control of the site for an extended time.	Not significant. It is assumed the facility will be maintained for the first 100 years after closure.
	Societal Memory	Societal memory is represented by records, deed restrictions, and other passive controls that would warn someone that additional care should be taken in the area. For a member of the public to come onsite to experience exposures to contamination from the IDF, records that the Hanford Site existed would need to be forgotten or ignored.	Not significant
	Exposure Point	By rule, it is assumed a post-closure well is established 100 m (328 ft) downgradient at the point of highest exposure. It is highly unlikely that groundwater exposure will occur at this location, and potential wells in other locations or discharges to the Columbia River would produce much lower impacts to a member of the public.	Moderately significant. Exposure points further downgradient would significantly reduce concentration due to increased dispersion and dilution. Exposure location for groundwater and atmospheric pathway assumed to be the same location.
	Climate - Meteorology	The natural environment in the area is characterized by semi-arid conditions with low annual precipitation and high potential evapotranspiration which limit the availability of water to infiltrate below the root zone of the native vegetation.	Highly significant. After the assumed 500-year design life of the surface barrier, the recharge to the vadose zone is directly dependent on the semi-arid conditions that exist at the Hanford Site, which result in a low long-term net infiltration rate. The current average wind speed is assumed for atmospheric pathway.

Table 4-1. Relative Significance of Safety Functions of Key Engineered and Natural Barriers and Features of the Integrated Disposal Facility

Barrier-Feature	Safety Function	Safety Function Description	Significance to Facility Closure
Engineered System – Cap and Backfill	Hydraulic - Flow	The final design cover has not yet been established but is believed to be able to produce very low initial flow rates. Over some period, this function may deteriorate. The inclined cover functions to divert infiltrating water even after the impermeable engineered layer(s) have degraded.	Moderately significant. The flow rate into the surface barrier equals the recharge rate under the IDF. This recharge rate affects the release rate from cementitious waste forms and controls the transport time though the vadose zone to the water table for as long as the surface barrier is assumed to function, nominally 500 years.
	Mechanical Stability	The high-density backfill representing the operational layer between different lifts is compacted to maintain mechanical integrity and prevent uneven settling of the different lifts. In addition, the operational layer will prevent freeze/thaw activities that could affect container and backfill integrity (i.e., caving of backfill, uneven compaction of operations layer).	Not significant.
	Chemical	Water infiltrating through backfill will chemically react with the minerals present. The backfill will buffer the composition of the water to neutral-mildly alkaline conditions.	Not significant.
	Transport - Sorption	The minerals present in the backfill may sorb and delay transport of certain COPCs released from waste packages.	Not significant.
	Transport - Diffusion	Low saturation in the backfill may reduce diffusive fluxes from the waste forms into the backfill. Gaseous diffusion can occur through the pores of the backfill.	Moderately significant. Saturation in the backfill may increase or decreased diffusive release from cementitious waste forms.
Source Term - Container	Mechanical Stability	The metal container provides a durable outer shell to enable safe and efficient emplacement of IDF waste containers. The containers are designed to be stable and structurally sound when emplaced and surrounded by backfill.	Not significant.
	Chemical	Carbon steel boxes or drums will corrode over time, leaving behind corrosion products of (primarily) iron oxides. These corrosion products are highly sorptive toward some dissolved COPCs. The same corrosion process and production of iron oxides can lead to reducing conditions that would limit the solubility of several key radionuclides, particularly technetium.	Not significant.
	Hydraulic	Initially, the containers will isolate the waste form from the environment. The containers are expected to degrade by corrosion (either general corrosion, localized corrosion, or stress corrosion cracking). Degraded containers could continue to attenuate flow and transport of COPCs released from the waste forms into the backfill.	Not significant. Air tight containers are assumed during the institutional control period. After containers degrade, gaseous COPCs can be released to the backfill.

Table 4-1. Relative Significance of Safety Functions of Key Engineered and Natural Barriers and Features of the Integrated Disposal Facility

Barrier-Feature	Safety Function	Safety Function Description	Significance to Facility Closure
Source Term – Glass Waste Form	Hydraulic - Flow	The hydraulic properties of the glass limit fractional release rates of COPCs from the waste form through controls on the volumetric flow rate and moisture content.	Moderately significant. The hydraulic properties of the glass limit the flow rate of water through the glass and the reactive surface area of water contacting the glass.
	Chemical	The chemical properties of the glass limit fractional release rates of COPCs from the waste form through controls on the overall glass reaction rate resulting from matrix dissolution and hydration (due to alkali-H+ ion-exchange).	Highly significant. The dissolution of glass directly affects the COPC release rate which can control the peak dose.
	Mechanical	The mechanical properties of the glass limit fractional release rates of COPCs through the waste form by ensuring the waste form remains mechanically stable.	Not significant.
Source Term – Cementitious Waste Form	Hydraulic - Flow	The cementitious waste form has a low permeability to limit advective flow and transport of COPC out of the cementitious waste form	Not significant.
	Hydraulic - Capillarity	The grout with high suction creates a capillary gradient for water flow from the surrounding backfill into the waste form delaying the release of COPCs from the waste form.	Not significant.
	Mechanical	The composition and curing of the grout is designed to maintain mechanical integrity of the waste form for the expected loading and overburden in the IDF	Not significant.
	Chemical	The composition of the grout can enhance reducing conditions (i.e., BFS) in the grout, as well as hydraulic characteristics (i.e., paste vs. mortar, cement/water ratio). The hydrochemical conditions of the waste form may create reducing conditions, for which certain COPCs (i.e., Tc-99) show significant sorption capacity, while others (i.e., I-129) lose sorption capacity.	Highly significant. The sorption of COPCs on the grout and other substrate materials in the SSW affect the COPC release rate from cementitious waste forms.
	Transport - Diffusion	The cementitious grouts have low effective diffusion limiting the diffusive transport of COPCs out of the waste form.	Highly significant. The effective diffusion coefficient affects the COPC release rate from cementitious waste forms which control the Tc-99 and I-129 release rate, concentration, and dose for the groundwater pathway and H-3 and I-129 release rate for the gaseous pathway.

Table 4-1. Relative Significance of Safety Functions of Key Engineered and Natural Barriers and Features of the Integrated Disposal Facility

Barrier-Feature	Safety Function	Safety Function Description	Significance to Facility Closure
Engineered System – Facility and Liner	Transport	The spatial loading of waste containers has not been determined. The loading of waste containers in the facility can affect the spatial distribution of the COPC release rate at the base of the lowermost operational layer of the facility. Examples of loading include spacing of individual containers, northing and easting location of containers of different waste types, and proximity of waste containers of different waste types.	Moderately significant. Alternative loading of SSW containers can result in reduction of peak concentration in a saturated zone. The base case loading is purposely pessimistic because it concentrates SSW releases near eastern compliance boundary. Placing waste in a north south orientation in either western or eastern cells lowers the peak concentration.
	Hydraulic - Flow	Maintaining low hydraulic conductivity during the operational period allows any COPCs released from waste forms to be retained and removed from sump.	Highly significant. Lateral flow above the liner, which can occur at higher surface barrier infiltration rates, can focus the recharge to the vadose zone under the liner, which in turn decreases the COPC transport time to the water table.

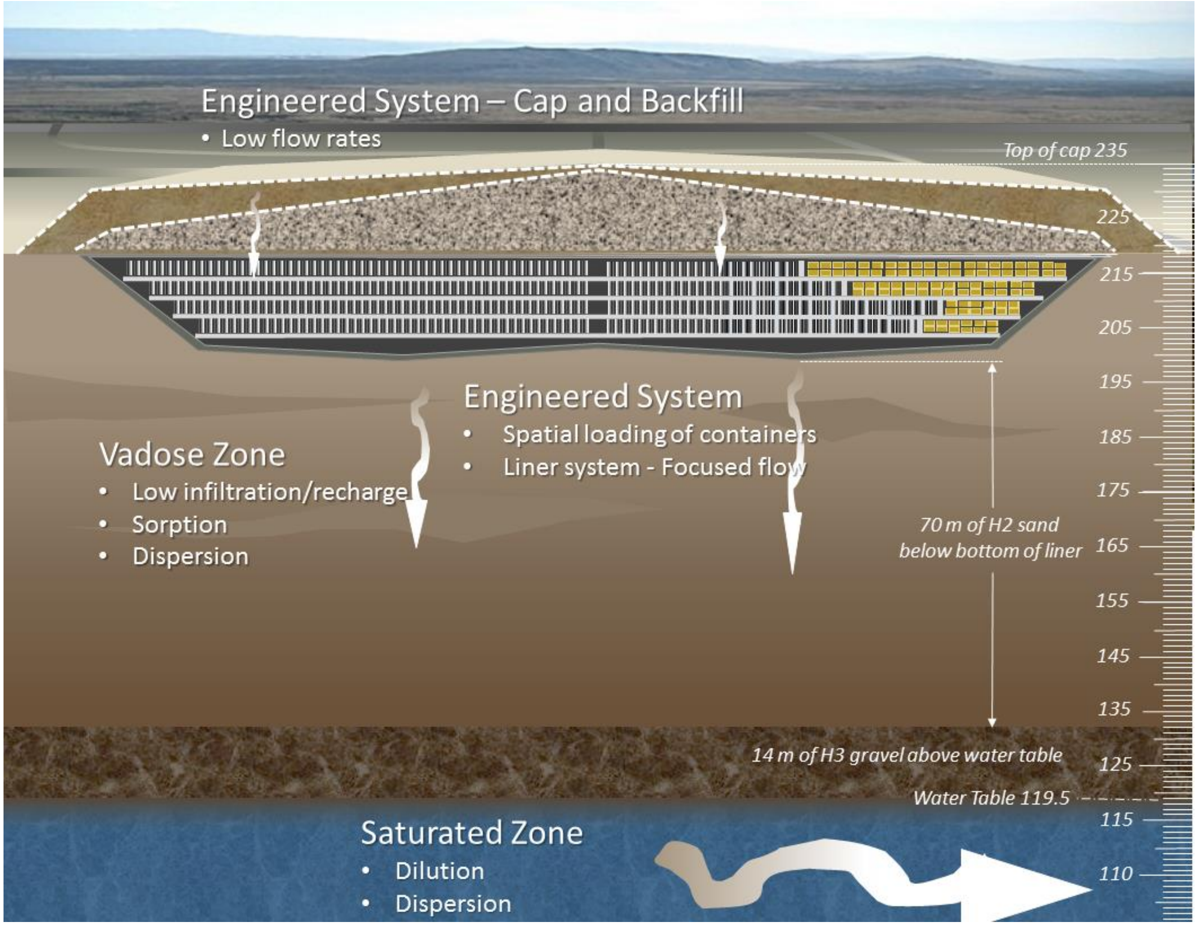
Source: Modified from RPP-RPT-59958, *Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington,* Table 8-6, to focus on the barriers and safety function related to facility closure.

BFS = blast furnace slag
COPC = constituents of potential concern
IDF = Integrated Disposal Facility
SSW = secondary solid waste

The performance of the engineered and natural features to limit the impact of the disposed waste to the environment and public health was assessed using computer model simulations. The simulations evaluated a single model component (i.e., the capability of the surface barrier to limit water flow into the waste zone) with a high-level of detail, referred to as a process-level model, or evaluated the performance of the total integrated system using abstractions of the detailed process models, referred to as a system-level model.

The impact of these assumptions, and the related uncertainties in conceptual models and parameters, on the predicted IDF performance were evaluated using sensitivity and uncertainty analyses summarized in the IDF PA document (RPP-RPT-59958) using the detailed deterministic process models (RPP-RPT-59958, Section 5.0) and an integrated system model (RPP-RPT-59958, Section 6.1). The key conceptual model and parameter assumptions and related uncertainties evaluated in the sensitivity and uncertainty analyses include:

- Near field hydrology (RPP-RPT-59958, Section 5.1.1)
- Cement release (RPP-RPT-59958, Section 5.1.3)
- Immobilized Low-Activity Waste (ILAW) glass release (RPP-RPT-59958, Section 5.1.2)
- Groundwater flow and transport analyses (RPP-RPT-59958, Section 5.2)
- Integrated system model analyses (RPP-RPT-59958, Sections 6.2 and 6.3).



Note: Vertical exaggeration approximately 5x. West-east cross-section with view toward north. Waste containers are placed in four lifts with 1 m (3 ft) of operational fill between each lift. Effluent Treatment Facility-liquid secondary waste and secondary solid waste containers may be placed in different locations for each of the four lifts.

Figure 4-1. Schematic of Key Safety Functions of Natural and Engineered Features of the Integrated Disposal Facility

The IDF PA used the sensitivity and uncertainty analyses to identify the key assumptions that were most significant to meeting the performance objective. The most significant assumptions include:

- Climate/meteorology that control the long-term average net infiltration rate through the surface barrier
- Infiltration and flow rate through the surface barrier
- ILAW glass corrosion characteristics that affect the contaminant of potential concern (COPC) release rate from the ILAW glass
- COPC retention on secondary solid waste (SSW) substrate and grout materials
- Diffusive properties of SSW cementitious waste forms
- Hydraulic properties of IDF liner system
- Water flow rate and properties of the vadose zone materials
- COPC retention on vadose zone materials
- Groundwater flow rate through the saturated zone

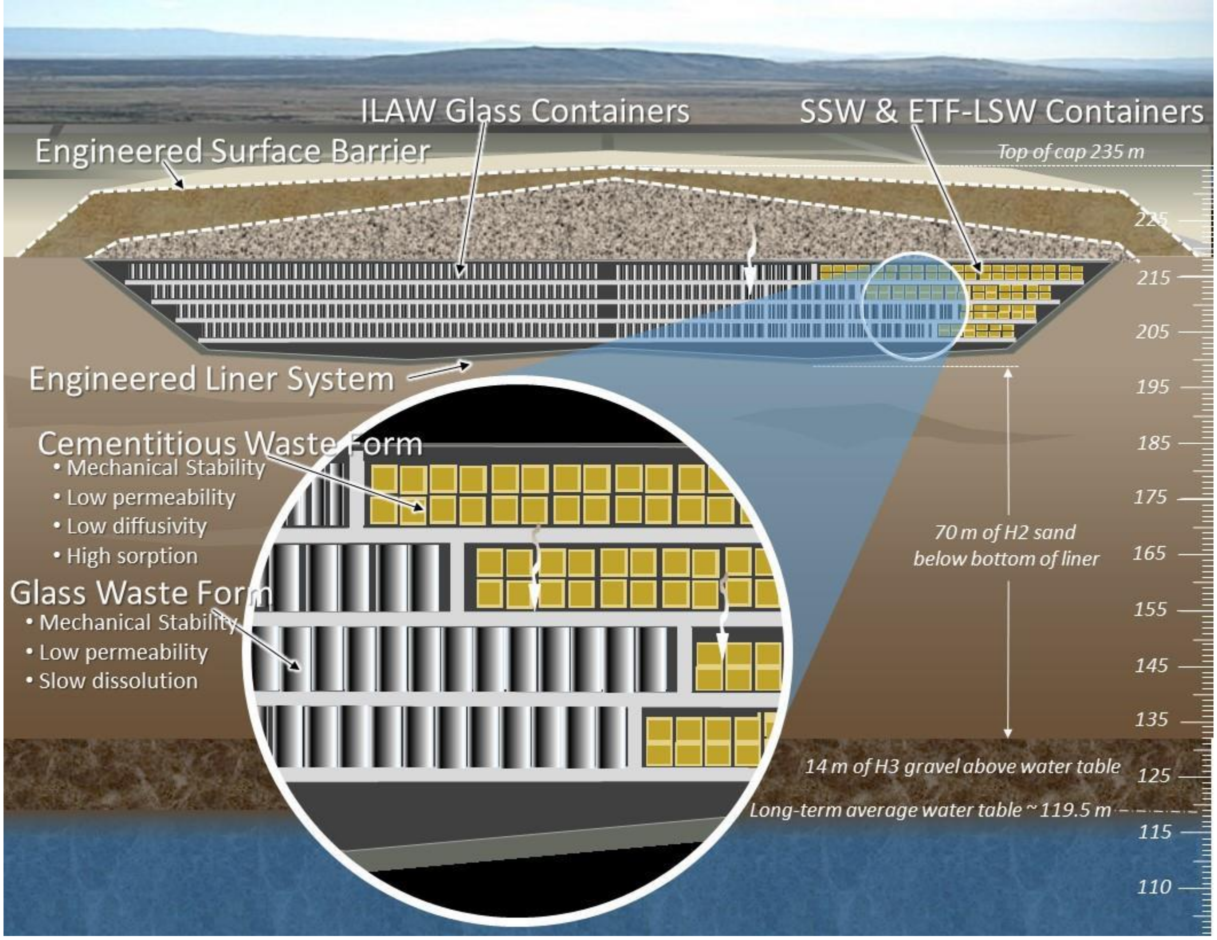


Figure 4-2. Schematic of the Key Safety Functions of Source Term Features for the Integrated Disposal Facility

The key conclusions of the IDF PA are relevant to determining the significance of the assumptions and related uncertainties to the IDF PA results and conclusions and therefore aspects of this closure plan. These conclusions and the associated assumptions that warrant being the focus of IDF PA maintenance activities were described in detail in CHPRC-03348, *Performance Assessment Maintenance Plan for the Integrated Disposal Facility*. The key conclusions related to the IDF closure are:

- During the 1,000-year compliance period, the all-pathway dose performance objective is dominated by the air pathway releases and associated doses; however, the doses associated with this pathway are small (less than about 0.5 mrem/yr for the first year after the cessation of institutional controls). The air pathway analyses made two bounding assumptions: no releases would occur during the operational and institutional control period because it was assumed the waste containers are airtight, and the partitioning of iodine-129 to the gas phase assumes undissociated $I_2(g)$ controls the partitioning gaseous iodine-129 to the gas phase. The first assumption maximizes the tritium release and dose to the public receptor assumed to live 100 m (380 ft) from the IDF excavation while the second assumption maximizes the iodine-129 release and dose for the air pathway. If it is assumed the containers are not airtight, then it is likely that gaseous tritium would be released during operations and the institutional control period, with the expected dose to the nearest off-site public receptor, located about 19 km (12 mi) to the southeast of the IDF, being much less due to the dilution that occurs over that distance.

- For the 1,000-year compliance period, there is a very low likelihood of having a significant release from the IDF that could affect the COPC concentration and resulting dose for the groundwater pathway performance objective. This conclusion is the result of the long (>1,000 years) COPC transport time in the vadose zone. The most significant assumptions and related conceptual models and parameters that affect this conclusion are (1) the assumed design life of the modified RCRA Subtitle C surface barrier, (2) the long-term average net infiltration rate, (3) the properties of the liner system that focus the flow through the liner after the surface barrier has degraded, and (4) the COPC retention properties of the vadose zone.
- For the post-1,000-year period, there is a very low likelihood of having a release from the IDF that would exceed the 25-mrem/yr all pathway dose performance objective. The post-1,000-year dose is dominated by the groundwater pathway and the peak dose occurs in a range from about 2,000 to 7,000 years after closure (depending on different assumptions of source term release and fate and transport in the vadose zone) and is uncertain, ranging from a dose of less than 1.0×10^{-4} to about 23 mrem/yr. The most significant assumptions and related conceptual models and parameters that affect this conclusion are (1) the long-term average net infiltration rate, (2) the fraction of the total inventory assumed to be retained in the ILAW glass, (3) the parameter values that control the corrosion of ILAW glass waste form, (4) the parameter values that control the diffusion and retention of COPCs in grouted waste forms, and (5) the groundwater flow rate in the saturated zone.
- For the post-1,000-year period, one of the principal factors affecting whether the predicted groundwater pathway dose exceeds 25 mrem/yr is the assumed COPC loading in the different waste forms (i.e., ILAW glass vs Effluent Treatment Facility [ETF]-liquid secondary waste [LSW]). Sensitivity cases using either an alternative assumption of a significant fraction of technetium-99 being retained in ETF-LSW or using the TC&WM EIS (DOE/EIS-0391) allocation of technetium-99 and iodine-129 in ETF-LSW, were the only cases that exceeded the 25 mrem/yr-performance objective.
- For the post-1,000-year period, the expected performance results in predicted COPC concentrations that have a sum of fractions that may exceeds the 4 mrem/yr drinking water standard based on EPA's *Safe Drinking Water Act of 1974* maximum contaminant levels (900 pCi/L for technetium-99 and 1.0 pCi/L for iodine-129). This depends on how the wastes are loaded in the facility. The drinking water concentrations are significantly affected by the release of iodine-129 from the different SSW waste streams, which in turn are controlled by assumptions of parameter values that control the diffusion and retention of iodine-129 in grouted waste forms. The predicted COPC drinking water concentrations can be affected by alternative assumptions for waste container loading in the IDF (i.e., by spreading the SSW containers over a larger area of the IDF or placing the SSW containers in a north-south orientation in the IDF footprint rather than concentrating the SSW containers in the most conservative location as assumed in the IDF PA).

In general, IDF maintenance activities were subdivided into two main categories: those maintenance activities that are evaluated using monitoring activities as identified in the CHPRC-03347, and those maintenance activities that are evaluated using research and development activities as identified in the IDF-PA Maintenance Plan (CHPRC-03348). The research and development activities fall into two groups: (1) those activities related to the review and evaluation of the evolution of scientific studies and waste form designs, and (2) those activities related to focused laboratory and in situ testing of waste form materials and site characteristics to reduce the uncertainty in parameter values assumed in the PA.

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5 Disposal Facility Summary

The description of the disposal facility includes descriptions of the relevant site characteristics that could affect closure, the facility characteristics, and the waste characteristics. The site characteristics are summarized in Section 5.1. The facility characteristics are summarized in Section 5.2 and include a detailed description of the cover barrier selected for the IDF trench and emphasizes those features important for the long-term performance of the disposal system. Section 5.3 describes the waste characteristics and provides information on the different waste forms types, container designs, and the volumes and radionuclide and hazardous chemical inventory.

5.1 Summary of Site Characteristics

This section presents information on the Hanford Site, especially the area surrounding the IDF. For additional information on site characteristics the reader should refer to PNNL-14586, *Geologic Data Package for 2005 Integrated Disposal Facility Waste Performance Assessment*, where this topic is discussed in greater detail. This section describes the regional and local environment in which the IDF will be located. The following sections describe the disposal site, along with the climatological, geological, and geographical conditions of the 200 Area plateau.

5.1.1 Geography and Demography

The Hanford Site is an area of approximately 1,450 km^2 (900 mi^2) located in south-central Washington State. The site for the IDF is located on the Hanford Central Plateau in the 200 East Area within the Hanford Site boundary shown in Figure 1-1. The location of the disposal site relative to the 200 East Area is shown in Figure 2-1.

5.1.1.1 Disposal Site Location

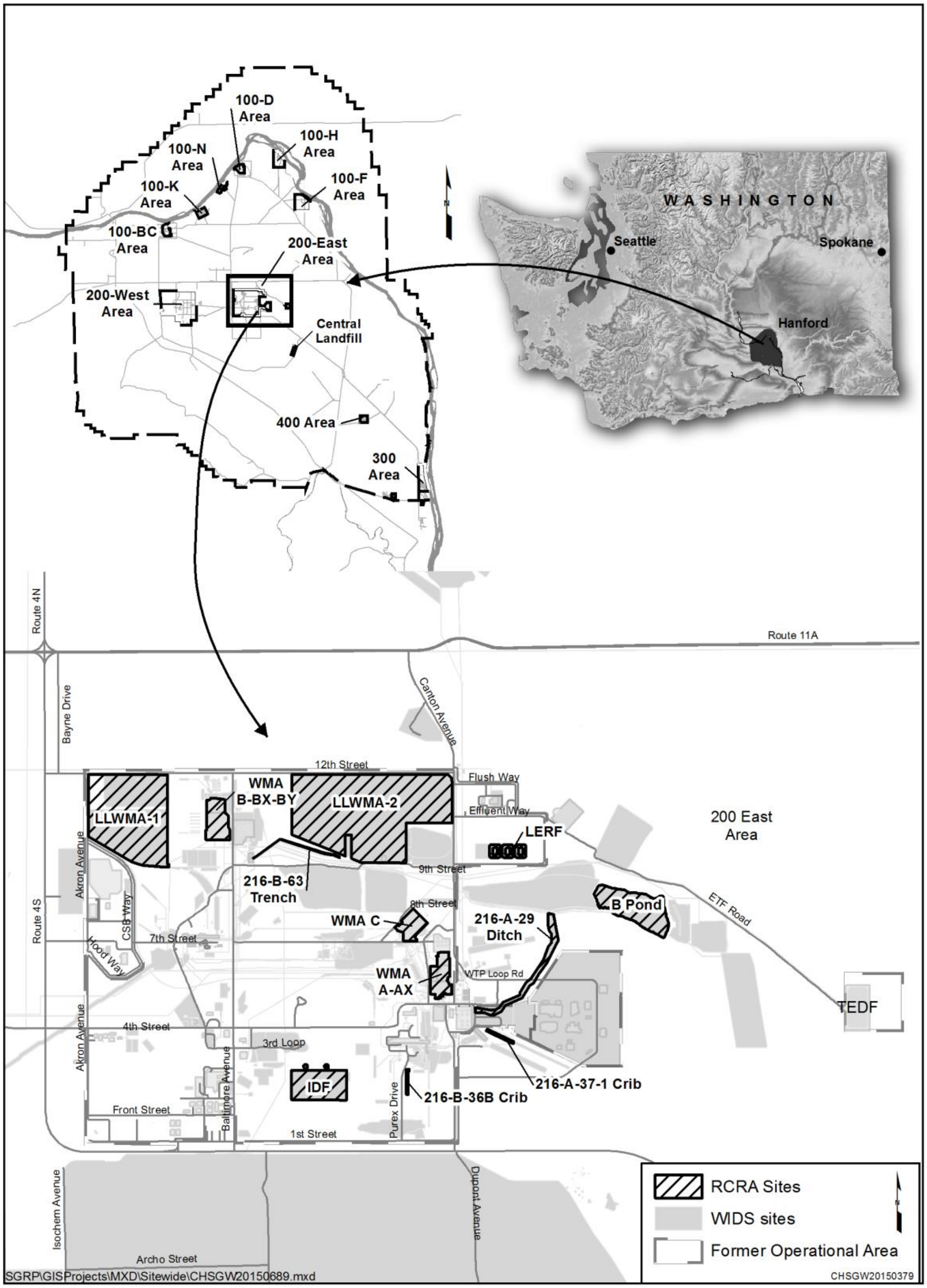
The Hanford Central Plateau is approximately 198 to 229 m (649 to 751 ft) above mean sea level. The major features of regional geography are the nearby rivers (Columbia and Yakima) and mountains (Saddle Mountains and Umtanum to the north, Cascade Mountains to the west, Yakima Ridge to the southwest, and Rattlesnake Ridge to the south). The Columbia River, which forms the eastern boundary of the developed areas of the Hanford Site, is an important source of water and hydroelectric power for the region. Other important rivers near the Hanford Site are the Yakima River to the southwest and the Snake River to the east. The Cascade Mountains, which are about 160 km (100 mi) to the west, have an important influence on the climate of the area in their rain shadow, which includes the Hanford Site.

5.1.1.2 Disposal Site Description

The IDF is on a plateau in the southeastern quadrant of the 200 East Area and is shown in Figure 5-1. The selected disposal site consists of approximately 36.4 ha (90 ac) of vacant land located just southwest of the Plutonium Uranium Extraction facility (Figure 1-2).

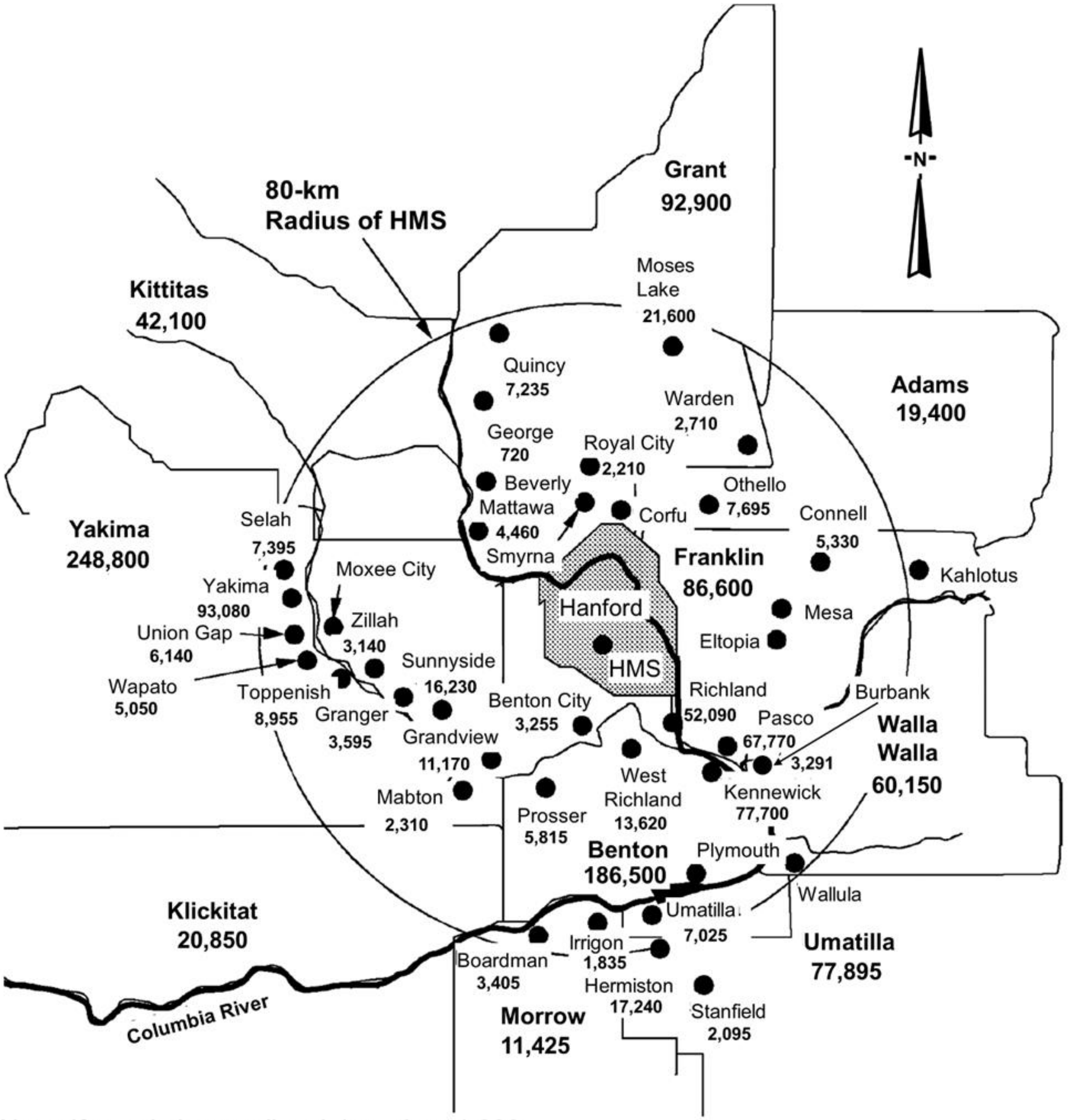
5.1.1.3 Demography

The major population centers within an 80-km (50-mi) radius of the Hanford Site are shown in Figure 5-2, along with their estimated 2013 to 2014 populations. The largest population center within the 80 km (50 mi) radius of the site is the Tri-Cities (i.e., Richland, Kennewick, and Pasco), located approximately 40 km (25 mi) to the southeast of Hanford Meteorological Station (HMS) for Richland, and 56 km (35 mi) to the southeast of HMS for Kennewick and Pasco. Because IDF's location is near the center of the Hanford Site, the resident population within 16 km (10 mi) is estimated to be only 15, and 13,000 within 32 km (20 mi) (PNNL-20631, *Hanford Site Regional Population –2010 Census*). About 186,000 people, located mostly to the southwest and the southeast, live between 32 and 48 km (20 and 30 mi) from IDF (PNNL-20631). The population has grown since 2010.



Source: SGW-58828, *Water Table Maps for the Hanford Site 200 East Area, 2013 and 2014,* Figure 1-1.

Figure 5-1. Location of the Hanford Site 200 East Area and Integrated Disposal Facility



Note: If population not listed, less than 1,000
Data: Washington State April 2014, Oregon July 2013
HMS = Hanford Meteorological Station

Figure 5-2. Population Centers with Estimated Population within 80 km (50 mi) of the Hanford Meteorological Station

In general, the Hanford Site is more than 160 km (99 mi) from any major city (e.g., a city with more than 100,000 inhabitants). The Site is surrounded by a rural-type population distribution associated mostly with agricultural activities. The Tri-Cities (Kennewick, Pasco, and Richland), <40 km (25 mi) from the Site, are the nearest communities of significant size (e.g., more than 20,000 inhabitants). These three cities are grouped together along the Columbia River a few miles downstream and to the southeast of the Site boundary. Several smaller communities lie within 80 km (50 mi) of the Site though none constitute more than 20,000 inhabitants.

5.1.1.4 Uses of Adjacent Lands

In 1992, the Hanford Future Site Uses Working Group (HFSUWG) was charged with determining potential future uses of the various parts of the Hanford Site. This group consisted of local, state, and federal officials, representatives of affected Native American tribes and agricultural and labor organizations, as well as members of environmental and other special interest groups. The efforts of the HFSUWG form the basis of the DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*; DOE, 1999, “Conditional Acceptance of the Immobilized Low-Activity Tank Waste Disposal Facility Performance Assessment and the Hanford Site 200 Plateau Composite Analysis”).

The ROD [64 FR 61615, “Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)”] for DOE/EIS-0222-F prescribes the use in the 200 Areas as exclusively industrial (primarily waste management) with much of the surrounding land having the use of preservation or conservation. The Hanford Reach National Monument was established along the Columbia River corridor as well as inlands at the northern and western edges of the site (65 FR 37253, “Establishment of the Hanford Reach National Monument”). For further discussion of Hanford Site land uses refer to DOE/EIS-0222-F and DOE/RL-2009-10, *Hanford Site Cleanup Completion Framework*.

The “Industrial-Exclusive” designation of the 200 East Area would preserve DOE control of the existing compatible infrastructure required to support activities such as dangerous waste, radioactive waste, and waste treatment, storage, and disposal facilities. If the Industrial-Exclusive use designation is maintained, records of past activities (particularly the disposal of nuclear materials) are likely to be kept. In addition, in an industrial area, liquid discharges to the ground would be highly regulated and kept small.

The Central Plateau and the Horse Heaven Hills, south of the Hanford Site, are near, but at a significantly higher elevation than the Columbia River. Although the amount of irrigation is increasing at certain locations, comparatively little irrigation occurs in the Horse Heaven Hills because of the relatively high energy cost of bringing water to the surface. Dry-land farming continues to be the main use for the land in the Horse Heaven Hills.

East of the Central Plateau, across the Columbia River, irrigated farming is extremely common. The water, however, does not come from the nearby stretches of the Columbia River. The water comes from the Columbia Basin Project, which derives its water from the Grand Coulee Dam, over 322 km (200 mi) upstream of the Hanford Site. The water is gravity-fed to the farms. The regional geography makes such a water delivery system unlikely for the Central Plateau.

The area south of the Central Plateau is a combination of residential, commercial, and industrial zones. Agriculture is practiced on the north side of the Wahluke Slope. Finally, west of the Central Plateau is the Fitzner/Eberhardt Arid Lands Ecology Reserve, a nature preserve.

5.1.1.5 Socioeconomics

The major employers in the Tri-Cities area since 1970 have been DOE and Hanford Site contractors; Energy Northwest (formerly the Washington Public Power Supply System), which operates a nuclear power plant; farms; and a large food processing industry plus several smaller industrial operations. Other than DOE activities, agriculture and food processing are the dominant industries.

The land use around the Hanford Site varies from urban to rural. Most of the land south of the Site is urban, including the Tri-Cities, while much of the land to the north and east is irrigated cropland. Most of the irrigation water comes from the Bureau of Reclamation's Columbia Basin Project, which uses the water behind Grand Coulee Dam as the primary water source. The land to the west of the Hanford Site is used for irrigated agriculture near the Yakima River and dryland farming at the higher elevations.

Area rivers are used primarily as sources of irrigation and drinking water, major sources of power production for the western United States, primary salmon spawning grounds, as well as recreation. Recent designation of a portion of the Hanford Site as a national monument will have no effect on the proposed IDF.

5.1.2 Meteorology and Climatology

The IDF closure design criteria indicate that the disposal facility design can operate under the meteorological conditions provided by the HMS (PNNL-15160, 2005, *Hanford Site, Climatological Summary 2004 with Historical Data*). The long-term stability of the disposed-of waste could be affected by wind or water erosion of the IDF trench barriers. The following sections summarize the regional precipitation, temperatures, wind, and relative humidity conditions that will need to be considered in the closure design are described.

5.1.2.1 Precipitation

Precipitation is one of the most important weather characteristics that can affect the closure of the IDF. The Hanford Site sits within the Pasco Basin, which is characterized as a semi-arid region because of its low annual precipitation levels. Between 1946 and 1998, annual precipitation at the HMS averaged 16 cm (6.3 in.) and varied between 7.6 and 31.3 cm (3 and 12 in.). The wettest season on record was the winter of 1996 to 1997 with 14 cm (5.5 in.) of precipitation; the driest season was the summer of 1973 when only 0.1 cm (0.04 in.) of precipitation was measured. Most precipitation occurs during the winter, with more than half of the annual amount occurring from November through February. Days with more than 1.3 cm (0.5 in.) precipitation occur on average less than once each year. Rainfall intensities of 1.3 cm/h (0.5 in./h) persisting for 1 hour are expected once every 10 years. Rainfall intensities of 2.5 cm/h (1 in./h) for 1 hour are expected only once every 500 years.

About 38% of the precipitation during December through February falls as snow. Winter monthly average snowfall ranges from 0.8 cm (0.3 in.) in March to 13.5 cm (5.3 in.) in January. Only one winter in four is expected to accumulate as much as 15 cm (5.9 in.) of snow on the ground. During these winters, four days, on average, have 15.2 cm (6.0 in.) or more of snow on the ground. However, the 1964 to 1965 winter had 35 days with snow on the ground, 32 of which were consecutive. That winter also provided one of the deepest accumulations, with 31 cm (12 in.) of snow occurring in December 1964. The record accumulation of snow is 62.2 cm (24 in.) in February 1916.

5.1.2.2 Temperature

Temperature is another weather characteristic that can affect the closure of the IDF. Atmospheric temperature directly affects evapotranspiration, which is a factor in determining the amount of precipitation that infiltrates into the IDF barrier layers. The temperature conditions for the Hanford Site and the 200 Area Plateau range from extremely cold during the winter months to extremely warm during the summer months. This can result in local temperatures of below -18°C (0°F), during some winter months, especially at night. During some summer months, the temperature during the day can exceed 40°C (104°F). Characterization of the HMS temperature records is as follows (HNF-2211, *Design Requirements Document for Project W-520, Immobilized Low-Activity Waste Disposal*):

> The mean surface air temperature averages approximately 12°C (53°F) at the HMS. July tends to be the warmest month of the year with temperatures averaging 25 and 33 °C (6 and 92 °F) respectively. The highest temperature ever recorded on the Site is 46 °C (115 °F). January is the coolest month of the year with an average temperature of -2 °C (29 °F). The lowest temperature ever recorded on the Site was -33 °C (-27 °F).

5.1.2.3 Wind

The wind conditions are another site weather characteristic that can affect the closure of the IDF, as it may affect the erosion of the surface barrier. The wind conditions can vary considerably on the 200 Area Plateau throughout the year. The monthly average is about 10 km/h (6 mi/h) during the winter and 15 km/h (9 mi/h) during the summer. Wind speeds at specific times, especially during summer storm activity, can reach many times this average level. The greatest peak gust was 130 km/h (81 mi/h), recorded at 15 m (49 ft) above ground at the Hanford Meteorological Station. Extrapolations based on 35 years of observation indicate a return period of about 200 years for a peak gust more than 145 km/h (90 mi/h) at 15 m (49 ft) above ground level (PNNL-15160, Table 7.5).

5.1.2.4 Relative Humidity

The seasonal variation in the relative humidity is considerable according to the records of the HMS. This weather characteristic is one that must be recognized in designing the barrier system for the IDF. Like temperature, humidity has a direct effect on the evapotranspiration rate and therefore indirectly has a bearing on the moisture-recharge rate. The characterization of these relative humidity records documented in HNF-2211 is as follows:

> The annual mean relative humidity recorded at the IIMS is approximately 54 % with the highest monthly average relative humidity (80 %) occurring in December and lowest average monthly relative humidity (32 %) occurring in July. Daily relative humidity can change 20 to 30 % between early morning and late afternoon, except in the winter months when the changes are less pronounced.

5.1.3 Ecology

This section summarizes the ecology of the Hanford Site, emphasizing plant and animal activities that may affect exposure pathways. The primary impact would be through roots penetrating and animals burrowing through barriers into a disposal facility. Secondarily, the types of plants and animals and their density can affect net groundwater recharge, which is greatly influenced by surface vegetation and burrowing. The terrestrial and aquatic ecology of the Hanford Site is summarized in PNNL-6415, *Hanford Site National Environmental Protection Act (NEPA) Characterization*, which presents extensive listings of plant and animal species. This section considers only terrestrial ecological effects because the proposed immobilized low-activity tank waste disposal facility sites are not located near significant aquatic ecological systems.

The Hanford Site consists of mostly undeveloped land. Only about 6% of the Site is occupied by chemical processing facilities, shut-down nuclear reactors, and supporting facilities. Most of the Hanford Site has not experienced tillage or agricultural grazing since the early 1940s.

The Hanford Site is characterized as a shrub-steppe environment. This environment contains numerous plant and animal species adapted to the region's semiarid climate. Because of the aridity and low water-holding capacity of the soils, the productivity of both plants and animals is relatively low.

5.1.3.1 Flora

The dominant plants on the Hanford Site have changed over time. In the early 1800s, before settlement and agricultural activities, the dominant plants were big sagebrush and an understory consisting of perennial Sandberg's bluegrass and bluebunch wheatgrass. Agriculture opened the area to invasion by alien plants, predominantly cheatgrass. The plant community at the IDF site is shrub-steppe dominated by big sagebrush, Sandberg's bluegrass, and cheatgrass. Root penetration to depths of over 3 m (10 ft) has not been demonstrated in the 200 Areas. Rabbit brush roots have been found only at a depth of 2.4 m (8 ft) near the 200 Areas.

5.1.3.2 Fauna

A variety of birds and mammals inhabit the Hanford Site. Wildlife species observed at the IDF site include mule deer, black-tailed jackrabbits, cottontail rabbits, coyotes, side-blotched lizards, gopher snakes, sage sparrows, shrikes, meadowlarks, and homed larks.

5.1.4 Geology

The physical geology of the 200 East Area, along with much of the Hanford Site, is a layered structure. The geologic structure is composed of multiple layers of sediments, which range from sand, silt, volcanic ash, and clay to coarse gravels and cobbles and conglomerates that overlay thick layers of basaltic lava. The layers of sediments often are heterogeneous in their composition and discontinuous in their physical structure. Some of these sediment layers were deposited during glacier-age floods thousands of years ago. The geology of the near-surface region typically has been modified by the weather, especially the wind; dune and sheet sands cover much of the area.

5.1.4.1 Regional and Site-Specific Geology and Topography

The IDF is on the Hanford Central Plateau, a Pleistocene flood bar most commonly referred to as the 200 Areas Plateau, near the center of the Hanford Site. The Hanford Central Plateau is approximately 198 m (650 ft) to 229 m (750 ft) above mean sea level. The plateau decreases in elevation to the north, northwest, and east toward the Columbia River. It also decreases to the south, although not as abruptly as it does to the east. The plateau escarpments have elevation changes of 15 to 30 m (50 to 100 ft).

Site Geologic History

The Hanford Site is situated within the Pasco Basin of south-central Washington State. The Pasco Basin is one of many topographic depressions located within the Columbia lntermontane Province, a broad basin located between the Cascade Range and the Rocky Mountains. The sediment package of the Pasco Basin consists of a relatively thick sequence of fluvial, lacustrine, and glacio-fluvial sediments over the past several million years. The Columbia Intermontane Province is the product of Miocene continental flood, basalt volcanism, and regional deformation that occurred over the past 17.5 million years. The Pasco Basin is bounded on the north by the Saddle Mountains; on the west by the Hog Ranch-Nanen Ridge anticline; on the south by Rattlesnake Mountain and the Horse Heaven Hills; and on the east by the Palouse Slope.

The physical geography of the Hanford Site is dominated by the low-relief plains of the Pasco Basin and anticlinal ridges of the Yakima Folds physiographic region. The surface topography of the Hanford Site is the result of the following events:

- Uplift of anticlinal ridges
- Pleistocene cataclysmic flooding
- Holocene eolian activity

Uplift of the ridges began in the Miocene epoch (starting about 17 million years ago) and continues to the present. This uplift is occurring on geologic time scales (i.e., over tens of millions of years). The uplift is not incorporated into the conceptual model of the IDF, which addresses a time scale of ten thousand years (RPP-RPT-59958).

Flooding

Glacier-related flooding has had a major impact on the physical geography of the region. Cataclysmic flooding occurred when ice dams in western Montana and northern Idaho were breached, allowing large volumes of water to spill across eastern and central Washington. The last major flood occurred about 13,000 years ago, during the late Pleistocene epoch. Interconnected flood channels, giant current ripples, and giant floor bars are among the landforms created by the floods. These formations resulted in heterogeneous and discontinuous characteristics for sediments ranging in size from silts to coarse gravels. These sediments yield a wide range of vadose zone hydraulic properties.

Landslides

Landslides have had a limited effect on the Hanford Site’s geography. Previous landslide activity in the area is generally limited to the White Bluffs area east of the Hanford Site and the Rattlesnake Hills south of the Site. No landslide activity is observed in the Hanford Central Plateau.

Sand Dune Activity

The location of the Hanford Site in an intermontane basin helps maintain a semiarid climate with low recharge. Eolian activity at the Hanford Site is relevant in evaluating the disposal facility because winds can cause erosion and create sand dunes and indirectly affect the rate of percolation of water into the IDF trench (PNNL-13033, *Recharge Data Package for the Immobilized Low-Activity Waste 2001 Performance Assessment*).

The IDF lies along the northern margin of a giant dune field. The existence and characteristics of the dune field appear to be controlled by wind moving from west to east, down the adjacent Dry Creek and Cold Creek valleys and across the expansive Hanford Site plains toward the Columbia River. A long, stabilized dune lying in an east-west direction can be seen along the southern border of the IDF site north of Route 4S (Figure 2-2).

The history of sand dune development in this area dates to the last cataclysmic flood (approximately 13,000 years ago). During the Holocene Epoch (the last 11,000 years), winds have locally reworked the flood sediments. It has been estimated that sand transport was most active earlier than 4,400 years ago and the dunes stabilized thereafter. Most sand dunes on the Hanford Site are located southeast of the 200 East Area and are stabilized by vegetation. However, they have been reactivated where vegetation has been disturbed, by fire or other activity.

The closest point of active dune formation to the IDF Site is approximately 3 km (1.9 mi) south of this area. Its location approximately downwind of the new disposal site, coupled with the planned closure cap vegetation layer, suggests that wind will have an insignificant effect on the percolation of water into the IDF in the future.

5.1.4.2 Seismology

The disposal site is in a relatively quiet seismic region. The past seismic history of the Hanford Site and surrounding area has been quite extensively characterized as part of previous Hanford Site program activities. DOE has had a seismic monitoring network operating in and around the Site since 1969. The design basis ground motion used for design will be obtained from the latest revision of TFC-ENG-STD-06, *Design Loads for Tank Farm Facilities*.

5.1.4.3 Volcanic Activity

The Cascade Mountain range contains the only volcanoes in the region. The nearest of these is Mount Adams, approximately 160 km (100 mi.) away. The most active of these nearby volcanoes in recent times has been Mount St. Helens, located approximately 220 km (136 mi) from the Site. Volcanic flows are not expected from these mountains because of their locations. The only expected effect of an eruption would be ashfall. The impacts of any such ash fall are not expected to have any long-term significance to contaminant movement.

5.1.4.4 Other Natural Processes and Events at the IDF

The following paragraphs briefly describe other natural processes and events that can potentially affect the operations and closure of the facility and their frequency at the Hanford Site.

Tornadoes

The regional weather records do not support a major concern about tornadoes being a significant occurrence and hence a threat to this disposal facility. However, the design requirements for this disposal facility require that they be designed to survive specified tornado conditions.

Range Fires

Fire is an event that could disrupt the performance capabilities of certain features of the disposal facility. Fire protection and prevention design must recognize this potential and account for its effects. The Hanford Site has a historical record of experiencing fires that damage or even destroy relatively large tracts of vegetation. Occasionally even some buildings have been endangered. Such fires have occurred from either lightning strikes or human activities; most commonly along the public highway that runs northwest to southeast across the southwestern edge of the Hanford Site. Such fires could pose a threat to certain engineered features of the disposal facility, particularly during the operations period. In particular, fires could pose a threat to engineered vegetation features incorporated into the outermost layer of the closure cap barrier system. Such vegetation destruction could increase the risk of wind and/or water erosion. The design needs to ensure that the barrier performance would not be unacceptably degraded by fire.

5.1.5 Hydrology

The following paragraphs briefly describe the hydrology conditions for the Hanford Site and most specifically the 200 Area Plateau.

5.1.5.1 Surface Water

Although large rivers are near the Hanford Site, no significant long-term surface water features are near the disposal site. Several disposal ponds, used during past fuel reprocessing activities at the Hanford Site for cooling water discharge, are near enough to the proposed disposal site that they could have an artificial influence on net contributions to the water table. However, these disposal ponds are not expected to exist when current operations end, thereby negating any effect that they may currently have. Except for catastrophic glacial flooding, which is not expected for tens of thousands of years, no floods are expected to affect the 200 Area Plateau.

5.1.5.2 Groundwater

Groundwater beneath the Hanford Site is found in both an upper unconfined aquifer system and deeper basalt-confined aquifers. The unconfined aquifer system is also referred to as the suprabasalt aquifer system because it is within the sediments that overlie the basalt bedrock. Portions of the suprabasalt aquifer system are locally confined. However, because the entire suprabasalt aquifer system is interconnected on a site-wide scale, it is referred to as the Hanford unconfined aquifer system. This relatively thin aquifer is considered the primary contaminant pathway for evaluating exposure scenarios. The aquifer intercepts infiltration from the vadose (unsaturated) zone above it, providing a pathway for water and contaminant transport to the Columbia River. The aquifer under the proposed disposal site is approximately 95 to 102 m (312 to 335 ft) below the surface grade.

The groundwater pathway is considered the most likely pathway for contaminants released from an IDF for the following reasons:

- Low precipitation in the Pasco Basin
- Lack of surface transport pathways near the disposal facility
- Subsurface location of the disposal facility
- Near-surface lysimeter measurements showing downward movement of water
- Samples showing the existence of radioactive contamination plumes in the groundwater because of past Hanford Site operations

5.1.5.3 Recharge

Recharge is the amount of total precipitation that infiltrates into the unsaturated zone (vadose zone) after runoff, evaporation, and transpiration by plants have occurred. Recharge from rain and snow melt is a major hydrologic variable affecting contaminant transport from an immobilized low-activity tank waste disposal facility. For the sites of interest to the IDF, surface soils are dominated by Rupert Sands and Burbank Loamy Sand.

5.1.6 Natural Resources

Geologic resources at the Hanford Site are very limited. Hanford Site mineral resources include sand, gravel, silt, clay, and aggregate. Historically, these resources were extracted at several quarries or pits at the Hanford Site and used for road construction and maintenance, and waste burial activities. No major mining operations exist in the Hanford Site area. Oil and gas exploration have occurred; however, no economically viable accumulations were found.

The Columbia River is used as a source of both drinking water and industrial water. The water systems of Richland, Pasco, and Kennewick withdrew a large portion of the 48.8 billion L (12.9 billion gal) used during 2006 from the Columbia River. Each city operates its own supply and treatment system, located downgradient and downriver of the Site. The Richland water supply system derives approximately 82% of its water directly from the Columbia River, while the remainder is split between a well field in north Richland (that is recharged from the river) and groundwater wells.

5.2 Facility Characteristics

This section provides information on the engineered features of the disposal facility and their effectiveness in meeting performance standards. The topics covered are the integrity and design of the closure cap for protecting and safeguarding the waste against water infiltration and inadvertent intruders.

5.2.1 Water Infiltration

Water flow in the near-surface unsaturated zone at the Hanford Site is transient because of intermittent precipitation events. Transient water flow begins when water enters at the ground surface and infiltrates downward into the soil column. At some distance from the ground surface, transient effects will dampen out, and the downward-flowing water will reach a steady rate. The distance at which steady infiltration occurs is sometimes referred to as the penetration depth. Thus, the unsaturated zone essentially consists of two regions: an unsteady-flow region between the ground surface and penetration depth, and a steady flux in the lower unsaturated region is equal to the annual rate of groundwater recharge and therefore is composed of contributions not only from the most recent pulse, but from previous precipitation events as well.

The IDF is situated below the penetration depth in the region of steady flow. The natural rate of moisture infiltration is approximately 3.5 mm/yr. However, the natural rate of moisture infiltration will change because construction of the disposal system will destroy the natural soil-sediment profile and remove surface vegetation. To prevent or minimize infiltration, a protective surface barrier will be engineered with sediment layers and one or more capillary barriers. The closure cover proposed is a modified RCRA Subtitle C barrier. The current best estimate rate of infiltration through such a barrier is 0.1 mm/yr (0.004 in./yr) with a range from 0.008 to 0.2 mm/yr (0.0003 to 0.008 in./yr) (PNNL-14744, *Recharge Data Package for the 2005 Integrated Disposal Facility Performance Assessment*). Infiltration beyond the root zone depends on the soil-atmosphere interface where surface soils and sediments and vegetation interact with the climate. The frequency, duration, and magnitude of precipitation and runoff events in part determine the infiltration rate into the disposal facility. Other parameters are the unsaturated hydraulic properties of the surface and subsurface infiltration barriers and the surrounding soil.

5.2.2 Disposal Unit Cover Integrity

The IDF trench closure cap forms an essential part of the disposal facility. This section identifies the design features used to ensure its long-term integrity and effectiveness. As noted earlier, the *Washington Administrative Code*, Nuclear Regulatory Commission (NRC), EPA, and DOE each have provided guidance and/or requirements that are applicable to the IDF onsite disposal planning and implementation. The regulatory requirements and guidance offer considerable flexibility in configuring the barriers and barrier components for an acceptable closure cap design. The closure cap system design can be tailored with respect to the characteristics of the disposal facility and the specific nature of the waste to ensure that the defined PA objectives of the disposal system are met. Closure cap design and construction for the IDF will require approval from Ecology in accordance with WAC 173-303-806, “Final Facility Permits,” and WAC 173-303-665.

5.2.2.1 Major Topical Concerns of Regulations and Guidance

The applicable regulations and guidance provide several major topical requirements for ensuring the stability and integrity of the closure cap system. The following are the major topical concerns that are the basis for the requirements:

- Failure of engineered barriers of the closure cap and the rest of disposal facility barrier system (i.e., seismic or slope stability)
- Subsidence of emplaced disposal product (waste) and other engineered barriers of the disposal system
- Surface erosion by wind and water
- Excess water infiltration (i.e., through the closure cap and/or underlying barrier system of the waste emplacement assemblage) causing percolating water to contact and interact with the waste

- Intrusion into emplaced waste by humans, plants, or animals

Tables 5-1, 5-2, and 5-3 in EPA, 1989, *Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments*, provide informative examples of recommended design specifications for categories of recommended barrier types to consider in designing closure cover systems.

Specific Regulations and Guidance Concerning Water and Leachate Control

Specific emphasis regarding how the design will deal with water and leachate diversion and/or collection are suggested by the NRC (10 CFR 61, “Licensing Requirements for Land Disposal of Radioactive Waste”) and prescribed by the EPA (40 CFR 264 and 40 CFR 265, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities”), and other related regulations and guidance such as WAC 173-303.

The topical considerations of concern can be summarized as follows:

- 10 CFR 61.7(b)(2), “Concepts” (NRC) – The long-term stability of the waste and disposal site requires minimization of the access by water.
- 10 CFR 61.51(a)(6), “Disposal Site Design for Land Disposal” (NRC) – The disposal site should be designed to minimize to the extent practicable the contact of water with waste during storage and the contact of standing water with waste after disposal.[10]
- DOE M 435.1-1 IV (M)(3)(d) – LLW disposal facilities shall be designed to minimize to the extent practical, the contact of waste with water during and after disposal.
- WAC 173-303-600 through WAC 173-303-806 – The facility permitting, design, closure, and post closure requirements to minimize impacts to human health and the environment.

5.2.2.2 Barrier Design Selection

The principal design objective of a disposal facility for waste is to effectively contribute to protection of the public and the environment through effective long-term isolation of the waste material. The principal design objective for the closure system is to ensure that it transforms the facility from operational status to inactive status in a manner that ensures the disposal site's integrity and ability to continue isolating the waste. The design of a disposal site and closure system requires integration with closure plan requirements.

Detailed assessments of four surface barrier designs that constitute potential generic remedial alternatives for 200 Area waste sites were performed in a focused feasibility study (FFS) (DOE/RL-93-33). The designs presented in this study are as follows:

- Hanford Barrier. Designed to provide 1,000-year isolation of waste sites containing Greater than Class C LLW, Greater than Class C mixed waste, and significant inventories of transuranic constituents.

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[10] This NRC guidance is particularly directed at avoiding a design/performance development of a "bathtub" effect in which the waste could become immersed in liquid within a disposal unit located below grade with a low-permeability bottom surface. This applies to the closure cover system design, as far as its performance could help avoid or mitigate such performance problems.

- Modified RCRA Subtitle C Barrier. Designed to provide 500-year isolation of waste sites with dangerous waste, Category 3 LLW, Category 3 MLLW, and Category I MLLW as defined by HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*).
- Standard RCRA Subtitle C Barrier. Designed to provide 30-year isolation of dangerous waste sites.
- Modified RCRA Subtitle D Barrier. Designed to provide 100-year isolation of waste sites with Category I LLW and nonhazardous-nonradioactive solid waste.

The modified RCRA Subtitle C barrier has been identified as the appropriate surface barrier design for the IDF. This surface barrier design was used in the IDF PA calculations.

5.2.2.3 Design Criteria

Lists of design criteria for various barrier systems were assembled in DOE/RL-93-33. The set of design criteria for the modified RCRA Subtitle C barrier is summarized as follows:

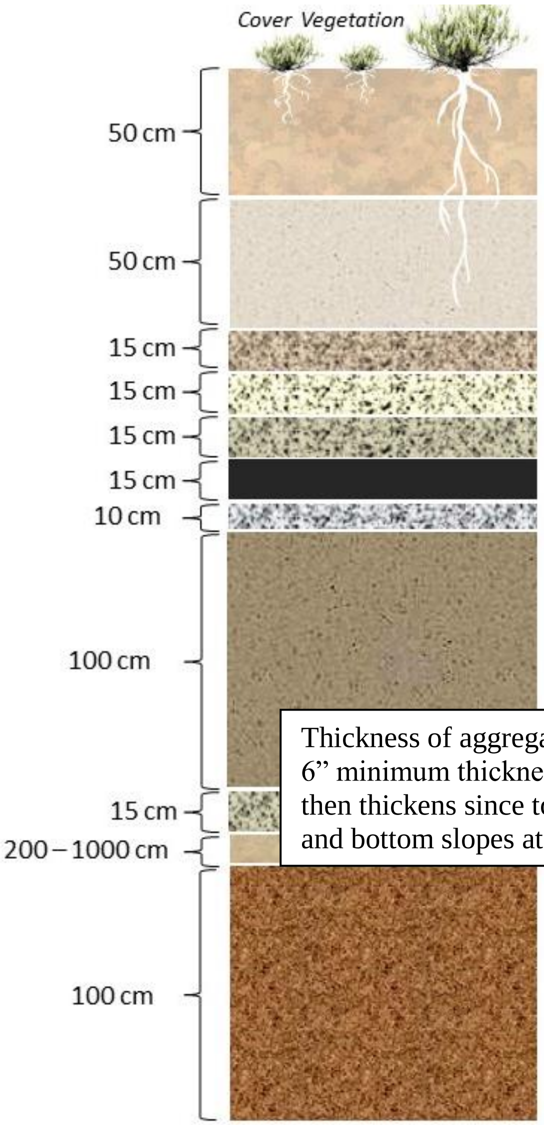
1. Minimize moisture infiltration through the cover
2. Design a multilayer cover of materials that are resistant to natural degradation processes
3. Design a durable cover that needs minimal maintenance during its design life
4. Design a cover with a functional life of 500 years
5. Prevent plants from accessing and mobilizing contamination (i.e., prevent root penetration into the waste zone)
6. Prevent burrowing animals from accessing and mobilizing contamination
7. Ensure that the top of the waste is at least 5 m (16 ft) below final grade or include appropriate design provisions to limit inadvertent human intrusion
8. Facilitate drainage and minimize surface erosion by wind and water
9. Design the low-permeability layer of the cover to have a permeability less than or equal to any natural subsoils present
10. Design the cover to prevent the migration and accumulation of topsoil material within the lateral drainage layer (i.e., clogging of the lateral drainage layer)
11. For frost protection, the lateral drainage layer and the low-permeability asphalt layer must be located at least 1.9 cm (0.75 in.) below final grade

5.2.2.4 Barrier Configuration and Sizing

The IDF closure cap barrier system will be composed of a layered assemblage of different engineered barriers (Figure 5-3). Figure 5-4 is a west-east cross section of the IDF facility implemented in a numerical model, accounting for the detailed geometry of the surface barrier, waste containers, high density backfill placed between waste container lifts, low density backfill placed between waste containers, and the key layers of the liner. Detailed depictions of the key layers of the surface barrier and the liner are illustrated in Figure 5-5 and Figure 5-6, respectively. The main elements of the liner system implemented in the model include the drainage layer between the operational layer and the geomembrane. In the model, the geomembrane and geosynthetic clay liner are combined, representing the low-permeability layer of the liner. The specifications for the materials comprising the IDF trench construction are provided in RPP-19941, *200 East Area Integrated Disposal Facility (IDF) Detailed*

Design Drawings, and summarized in Table 5-1. Table 5-2 and Table 5-3 provide best estimate hydraulic properties for the various engineered materials included in the IDF.

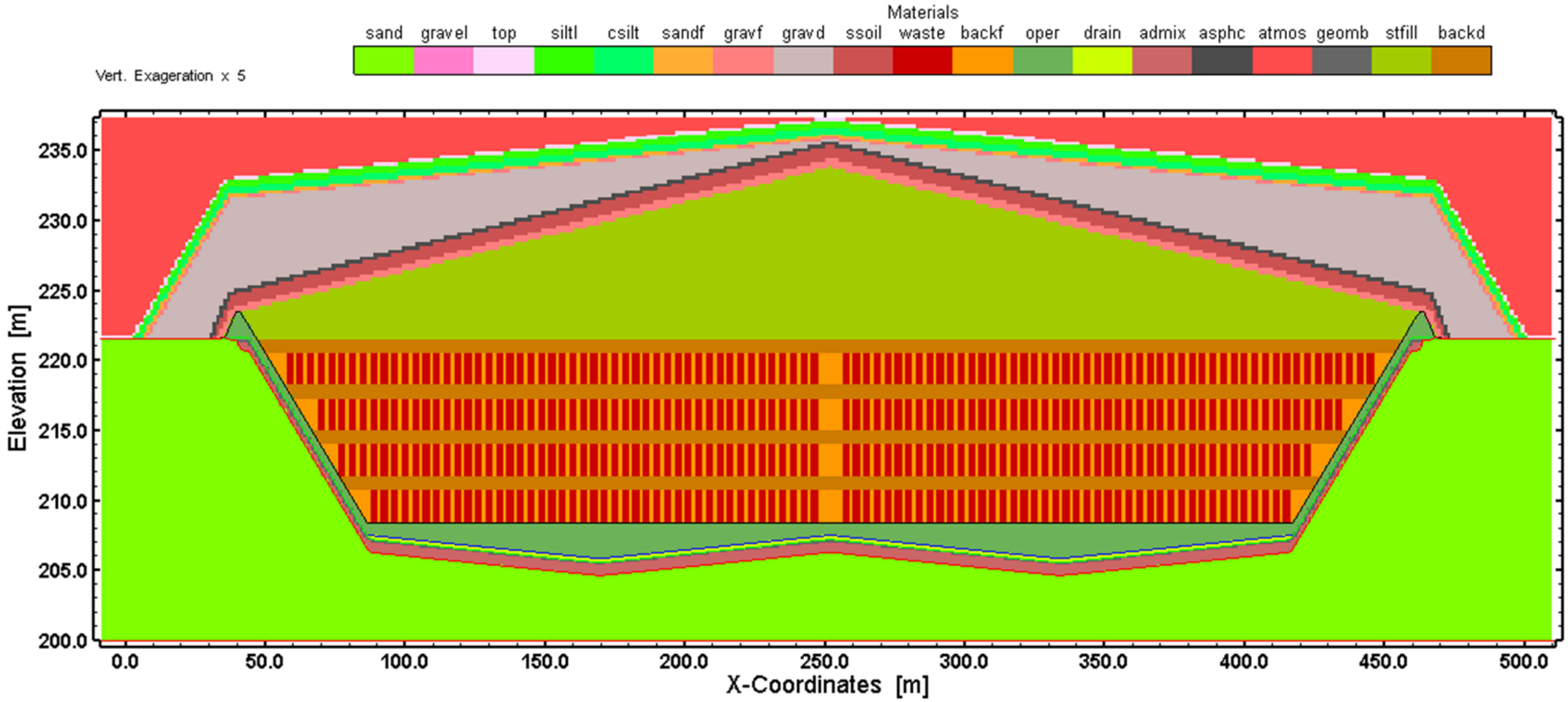
Each layer within the closure cap will be sloped to allow runoff and minimize erosion. A barrier overhang will be used to control potential water infiltration problems at the edges of the barrier. “Barrier overhang” is the term used to describe the projection of the functional barrier surface beyond the perimeter of the waste zone. The barrier overhang will extend 2 m (6.6 ft) beyond the edge of the disposal trench. Beyond the barrier overhang, the barrier layers above the low-permeability layers will extend farther, but at a steeper slope of 3:1 (horizontal:vertical) until they reach the existing ground elevation. The grading fill layer of the barrier located underneath the low-permeability layers will extend beyond the barrier overhang as well. This layer will support the 3:1 sloped layers extending beyond the barrier overhang.



Layer Number	Thickness In inch	Layer Description
1	20”	Silt/loam w/pea Gravel admix
2	20”	Compacted topsoil
3	6”	Sand filter
4	6”	Gravel filter
5	6”	Aggregate
6	6”	Asphaltic concrete
7	4”	Asphalt
8	40”	Sandy soil
		Gravel filter
	00”	Structural Fil
11	40”	Backfill operations layer - 1 meter above top of canisters

Thickness of aggregate layer varies: 6” minimum thickness at crown and then thickens since top slopes at 2% and bottom slopes at 5%?

Figure 5-3. ***Resource Conservation and Recovery Act of 1976*** **Cover Layers**

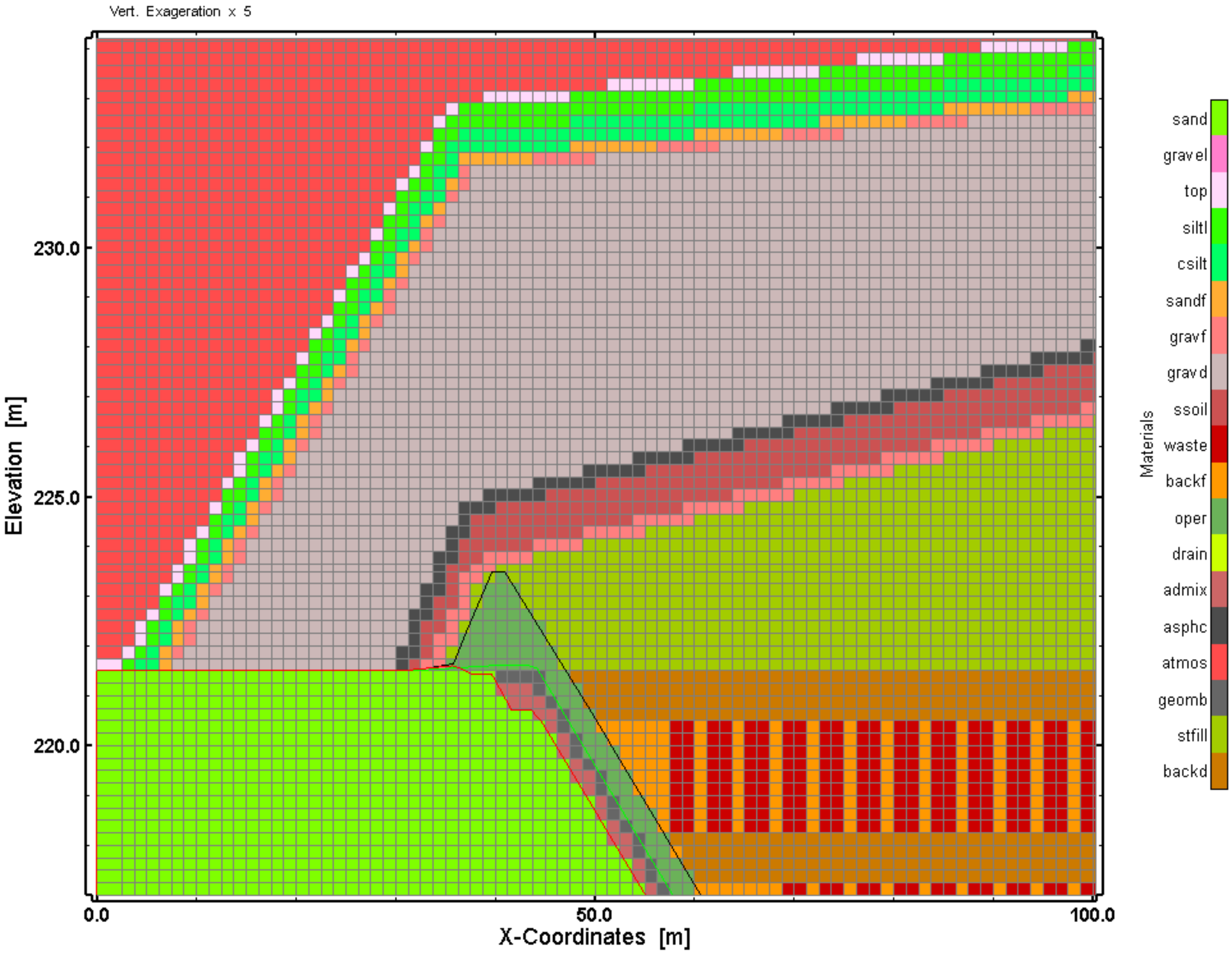


Source: RPP-CALC-61029, *Two-Dimensional, Two-Phase Flow Model Calculations for the Integrated Disposal Facility Performance Assessment*, Figure 2-3.

Note: Assumes four lifts of waste containers separated by about 1 m (3 ft) of compacted backfill operational layer. The slope of top of structural fill and gravel filter is assumed to be 5% while the slope of top of cap is assumed to be 2% to the side slope of the cap where the slope increases to about 30%. It is assumed that rip rap is placed on the side slope of the cap to minimize erosion.

sand = sand-dominated; gravel = gravel dominated; top = topsoil; siltl = silty loam; csilt = compacted silty loam; sandf = sand filter; gravf = gravel filter; gravd = drainage gravel; ssoil = sandy soil; waste = waste; backf = backfill; oper = compacted backfill for operations layer at bottom of the facility; drain = drainage layer; admix = admix layer; asphc = asphalt with base course; atmos = atmosphere; geomb = geomembrane/GCL; stfill = structural fill; backd = compacted backfill for operation layers between lifts

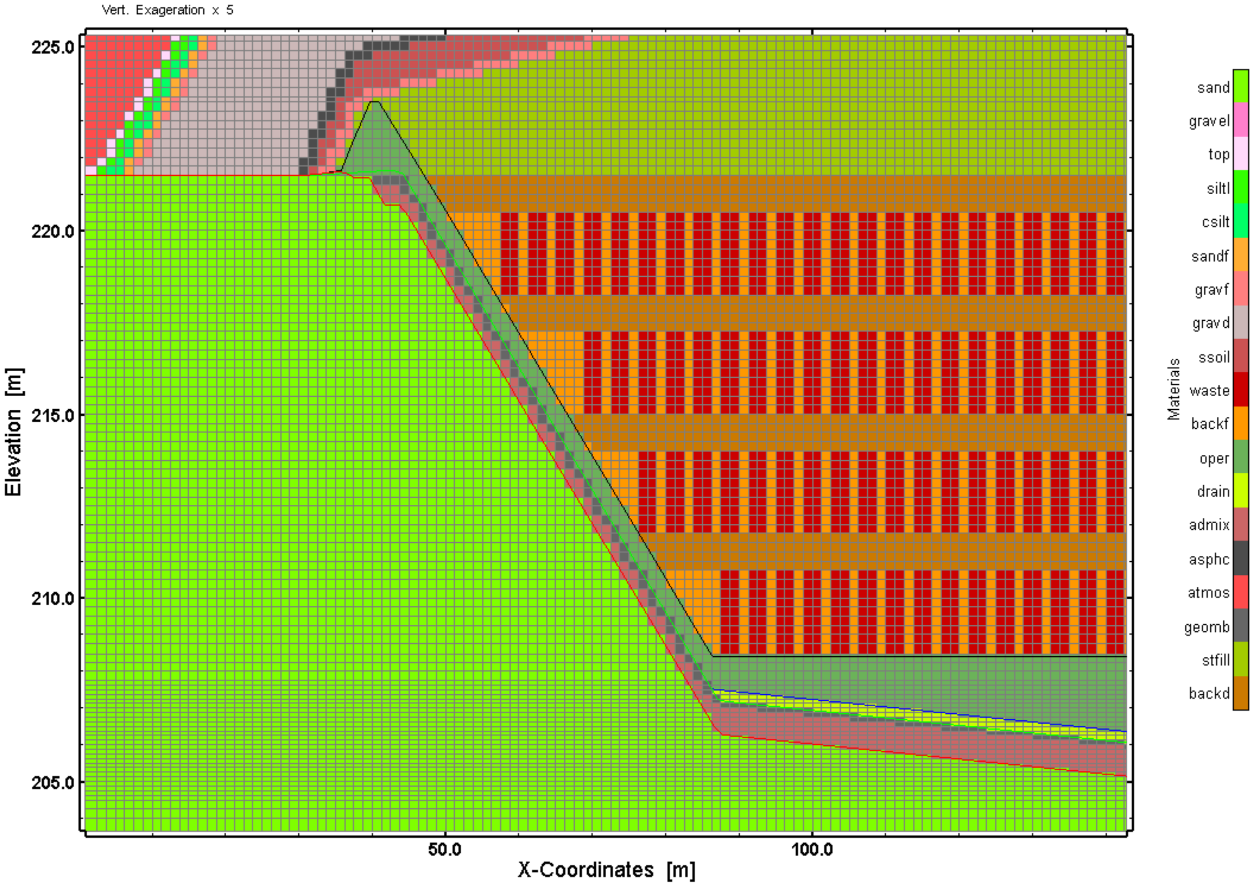
Figure 5-4. Two-Dimensional Vertical Cross-Section Model of Integrated Disposal Facility



Source: RPP-CALC-61029, *Two-Dimensional, Two-Phase Flow Model Calculations for the Integrated Disposal Facility Performance Assessment*, Figure 2-3.

sand = sand-dominated; gravel = gravel dominated; top = topsoil; siltl = silty loam; csilt = compacted silty loam; sandf = sand filter; gravf = gravel filter; gravd = drainage gravel; ssoil = sandy soil; waste = waste; back f = backfill; oper = compacted backfill for operations layer at bottom of the facility; drain = drainage layer; admix = admix layer; asphc = asphalt with base course; atmos = atmosphere; geomb = geomembrane/GCL; stfill = structural fill; back d = compacted backfill for operation layers between lifts

Figure 5-5. Two-Dimensional Vertical Cross-Section Model of Integrated Disposal Facility Showing Numerical Grid and Surface Barrier Materials



Source: RPP-CALC-61029, *Two-Dimensional, Two-Phase Flow Model Calculations for the Integrated Disposal Facility Performance Assessment*, Figure 2-3.

sand = sand-dominated; gravel = gravel dominated; top = topsoil; siltl = silty loam; csilt = compacted silty loam; sandf = sand filter; gravf = gravel filter; gravd = drainage gravel; ssoil = sandy soil; waste = waste; back f = backfill; oper = compacted backfill for operations layer at bottom of the facility; drain = drainage layer; admix = admix layer; asphc = asphalt with base course; atmos = atmosphere; geomb = geomembrane/GCL; stfill = structural fill; back d = compacted backfill for operation layers between lifts

Figure 5-6. Two-Dimensional Vertical Cross-Section Model of Integrated Disposal Facility Showing Detail of Numerical Grid and Container, Backfill, and Liner Materials

Table 5-1. Integrated Disposal Facility Liner Material Specification

Material	Relevant Dimensions	Model Name	Specification (RPP-18489)
Structural Fill	Not applicable	SFILL	Conform to the requirements of Standard Specification* Section 9-03.9(3) Crushed Surfacing – Base Course.
Operations Layer	Minimum 1 m (3 ft) thick	OPER	Meet earth fill requirements; have a maximum of 25% by weight passing through No. 200 U.S. sieve; maximum particle size of 5 cm (2 in.)
Drain Gravels	Minimum 0.3 m (1 ft) thick	DRAIN	Conform to the requirements of Section 9-03.12(4) of the Standard Specifications, except material shall be subrounded to rounded gravel (crushed rock and angular gravel shall not be allowed).
Geotextiles Type 1 - separation	6 oz/yd^2	GEOMB	Needle punched polypropylene.
Geotextiles Type 2 - separation	12 oz/yd^2		Needle punched polypropylene.
Composite Drainage Net	Not applicable		Geonet – high-density polyethylene manufactured by extruding two crossing strands to form a bi-planar drainage net structure; Type 1 geotextile thermally bonded to each side of the geonet.
Geomembranes	60-mil nominal thickness		Unreinforced, high-density polyethylene; textured on both sides.
Geosynthetic Clay Liner	Permeability $\leq 5\times10^{-9}$ cm/s		Bentonite shall be sodium montmorillonite clay encapsulated in polypropylene geotextile (needle punched); non-woven components have a nominal mass per unit are of 6 oz/yd^2.
Admix Layer	Permeability $\leq 1\times10^{-7}$ cm/s	ADMIX	Base soil mixed with 12% (min 11% - max 14%) by dry weight bentonite; base soil shall be free of roots, woody vegetation, frozen material, rubbish, and other deleterious materials, rocks >2.54 cm (1 in.) in dimension shall not comprise more than 2% weight of the base soil; shall have a 20% minimum passing No. 200 U.S. sieve; Bentonite shall be Bara-Kade 90, manufactured by Bentonite Performance Materials, Inc., or approved equivalent.

Source: RPP-20691, *Facility Data for the Hanford Integrated Disposal Facility Performance Assessment*, Table 2-2.

Reference: RPP-18489, *Integrated Disposal Facility (IDF), Detailed Design: Specifications.*

*WDOT, 2002, *Standard Specifications for Road, Bridge and Municipal Construction*.

Table 5-2. Summary of Best-Estimate Parameter Values for Components of the Integrated Disposal Facility Surface Barrier

Material	ρ_g (g/cm^3)	ρ_b(g/cm^3)	θs	θr	α(1/cm)	n	K_s(cm/s)
Silt Loam-Gravel Admix	2.72	1.48	0.456	0.0045	0.0163	1.37	8.40E-05
Compacted Silt Loam	2.72	1.58	0.39	0.09	0.006	1.92	5.20E-05
Sand Filter	2.76	1.88	0.318	0.03	0.538	1.68	8.58E-05
Gravel Filter	2.72	1.94	0.29	0.026	8.1	1.78	1.39E-02
Gravel Drainage	2.72	1.94	0.29	0.006	17.8	4.84	2
Asphaltic Concrete	2.63	2.52	0.04	0	1.00E-07	2	1.00E-11

Sources: PNNL-23711, *Physical, Hydraulic, and Transport Properties of Sediments and Engineered Materials Associated with Hanford Immobilized Low-Activity Waste*, Table 4.8.

ρ_g = particle density θ_r = residual water content K_s = saturated hydraulic conductivity
ρ_b = bulk density α = water retention parameter
θs = saturated water content n = water retention parameter

Table 5-3. Summary of Best-Estimate Parameter Values for Integrated Disposal Facility Near-Field Materials

Material	ρ_g(g/cm^3)	ρ_b(g/cm^3)	θs	θr	α(1/cm)	n	K_s(cm/s)
Immobilized Low-Activity Waste Glass	2.68	2.63	0.02	0.0006	0.044	1.88	3.10E-05
Concrete	2.63	2.46	0.067	0	3.87E-05	1.29	1.33E-09
Fully Corroded Steel	4.16	2.3	0.39	0.04	0.0008	1.77	2.20E-06
Bulk Vitrification Cast Material	3.1	2.26	0.15	0	0.00064	1.9	1.10E-06
Low-Density Backfill	2.71	1.51	0.37	0.03	0.057	2.8	1.86E-02
High-Density Backfill	2.71	1.66	0.35	0.03	0.065	1.7	4.91E-03

Source: PNNL-23711, *Physical, Hydraulic, and Transport Properties of Sediments and Engineered Materials Associated with Hanford Immobilized Low-Activity Waste*, Table 4.9.

ρg = particle density θr = residual water content Ks = saturated hydraulic conductivity
ρb = bulk density α = water retention parameter
θs = saturated water content n = water retention parameter

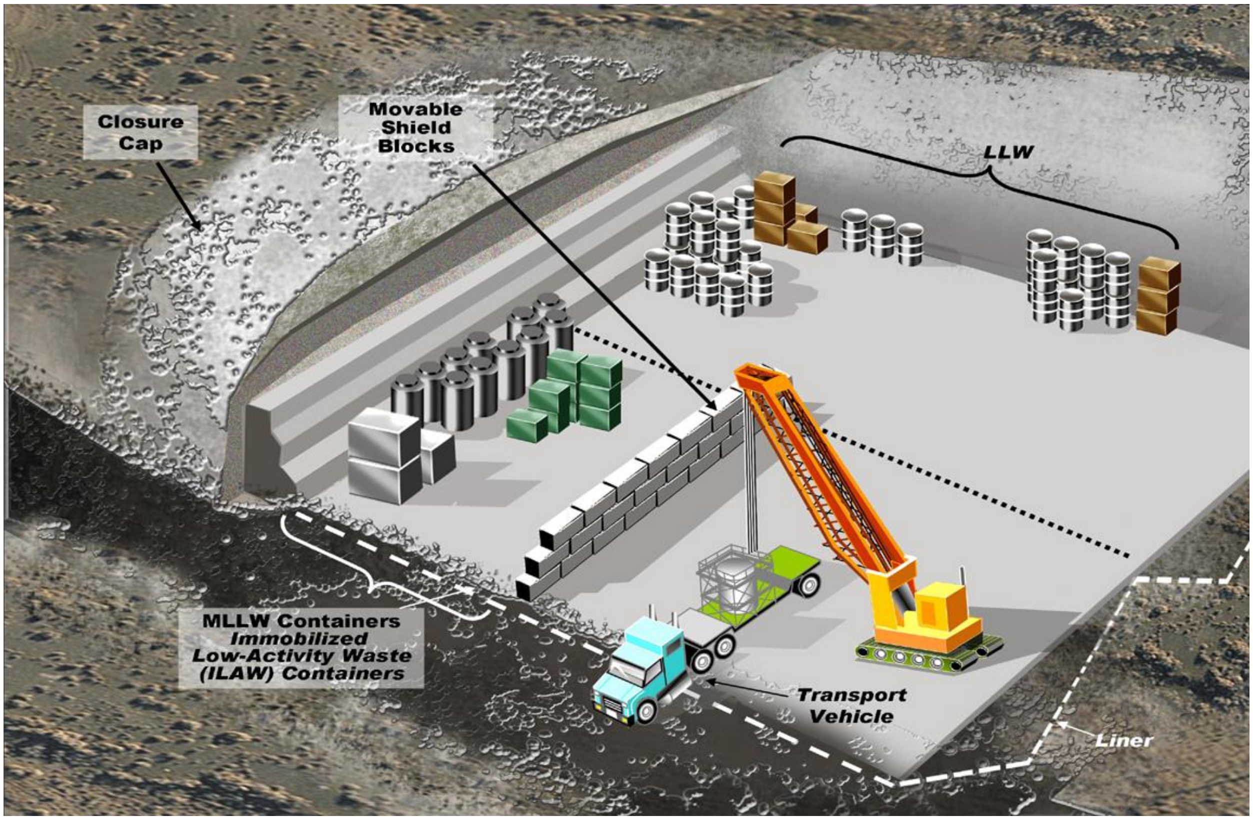
5.2.3 Structural Stability

DOE guidance (DOE, 1992, *Considerations for Closure of Low-Level Radioactive Waste Engineered Disposal Facilities*; DOE, 1999) on stabilization and closure of disposal facilities provides listings of characteristics needed by an acceptable disposal site. The NRC, Ecology, EPA, and DOE regulations and guidance all impose similar requirements regarding the need for such disposal facilities to have adequate physical stability. The NRC guidance and DOE requirements are primarily performance based, while the EPA hazardous waste regulations include specific design requirements. Key concerns addressed by such requirements will be met as described in the following paragraphs.

The waste package is the single most important building block in ensuring the structural stability of the disposal facility. All waste generators must provide waste packages that conform to waste acceptance criteria, which conform to minimum fill volume percentage, subsidence, and void space requirements.

Information on the exact contents of a package, including filler material, will be documented by the waste generator and provided to the DOE.

The waste containers are expected to be placed in four lifts (each 2.3 m [7.5 ft] high, representing the height of ILAW glass containers) separated by operational layers consisting of 1 m (3 ft) thick compacted backfill material. In general, the placement of the containers within a lift can be expected to be as close as possible with the interface filled with pea gravel or similar low density (i.e., poorly compacted) material. A schematic illustration of the placement and location of different waste form containers is illustrated in Figure 5-7.



Source: *Hanford Vit Plant Low-Activity Waste Vitrification Facility*, Fact Sheet (BNI, 2017).

*Not to scale. Closure cap surface barrier is not expected to be placed during waste disposal operations.

Figure 5-7. Conceptual Depiction of Waste Emplacement in the Integrated Disposal Facility

The slope stability of the disposal system will not be compromised in case of subsidence, thus ensuring continued effectiveness of the modified RCRA Subtitle C barrier. Water infiltration can be the single most destructive element in waste degradation and release of contaminants. Water infiltration is reduced considerably by the barrier and additionally, the IDF trench is located sufficiently above the water table that groundwater contact will not occur directly.

The operational and interim closure activities and final closure minimize the potential ingress of water into the disposal facility during all phases of the disposal program. The modified RCRA Subtitle C barrier design also provides appropriate deterrence to intrusion into the disposal facility by plants, animals, and humans and minimizes surface erosion of the engineered barrier system, including the closure system.

5.2.4 RCRA Barrier Description

The primary purpose of the combination of engineered barriers of an LLW disposal facility is to support the waste isolation function of the disposal facility. The barriers support the waste isolation function primarily by preventing and/or impeding the ingress of intruders that could degrade the waste and result in release of waste constituents.

The modified RCRA Subtitle C barrier design is the baseline design for waste containing dangerous waste. The barrier is designed to provide hydrologic protection and containment for a performance period of 500 years (DOE/RL-93-33). The term “modified” designates that this design differs in certain key aspects from the EPA's minimum technology guidance for RCRA covers. The minimum technology guidance design has a 30-year design life.

The modified RCRA Subtitle C barrier as proposed in the FFS (DOE/RL-93-33) would include multiple layers of variable thickness. For waste disposal at the Hanford Site, the initial choice of barrier materials, barrier thickness, and degree of capping barrier slope are presented in Figure 5-3, but are subject to change during closure cap detailed design. They will be tailored to the function and performance requirements for these uppermost layers. The modified RCRA Subtitle C barrier shown in Figure 5-3 differs from the FFS. A second capillary break has been added. This, or a similar barrier layer system, will be built over the trench following completion of waste emplacement, backfilling, and then temporary closure of each trench.

The modified RCRA Subtitle C barrier is constructed over the waste packages to ensure a total depth below the surface of at least 5 m (16 ft) and a 2% slope for the upper layers of the barrier, as measured from the center to the longer edge of each trench.

Various design guidance documents recommend that the minimum slope of the internal drainage layer of the cover be no less than 3% after any settlement that may occur over the life of the trench. To ensure that the 3% post-settlement slope is maintained, a layer of common structural fill is built up to provide a 5% grade for the internal drainage layer (Figure 5-3). A 15 cm (6 in.) thick gravel filter layer is placed over the common structural fill (Figure 5-3). This layer provides a capillary break for any water reaching this depth. The next layer consists of 1 m (3 ft) of sandy soil. The sand layer will be smoothed to establish a planar base surface for accurate and controlled placement of the overlying layers. A 10 cm (4 in.) thick asphalt base course will provide a stable base for placing the overlying low-permeability asphalt layer (the water infiltration barrier). This is the uppermost layer of the modified RCRA Subtitle C barrier to be built at a 5% grade. The asphaltic concrete mixture will be specially formulated to minimize hydraulic conductivity and will be applied 15 cm (6 in.) thick. A spray-applied asphalt then will be applied over the layer to seal any voids or defects in the surface. This layer will function as a low-permeability barrier as well as a human-intrusion barrier. The asphalt layer also is expected to serve as a highly effective deterrent to intrusion by plant roots and burrowing animals. The 5% slope will carry infiltrated water to the layer edges where it will enter the surrounding soil.

Next, at least a 15 cm (6 in.) thick layer of drainage gravel will be laid down. The function of this layer will be to allow moisture that reaches this layer to laterally migrate to the barrier edge and to reduce the slope of the upper layers of the barrier to 2% for erosion control.

The next task will be installing the second two-part graded filter layer. The lower layer will be a 15 cm (6 in.) thick sand filter layer. The gravel in this layer will be sized to be compatible with the lateral drainage gravel layer below and the sand filter layer above to prevent fine-textured sand from moving downward. Once the gravel filter layer is installed, a 15 cm (6 in.) thick sand filter layer will be installed.

The purpose of these two layers is to prevent topsoil particles from moving downward and clogging the lateral drainage layer. They also serve as another capillary break to divert infiltration.

After the filter layers are installed, a 50 cm (20 in.) thick layer of compacted topsoil will be installed. This layer (Layer 2 in Figure 5-3) will supplement the moisture storage capacity of the layer to be installed above it. The material used for the topsoil will be McGee Ranch silt loam without pea gravel. This layer of topsoil will be compacted to at least 85% of optimum dry density.

Another 50 cm (20 in.) thick layer of topsoil will be installed next. This layer will contain McGee Ranch silt loam, along with 15 wt. % pea gravel, 2.4 to 9.5 mm (0.1 to 0.4 in.) in diameter, mixed uniformly. The topsoil mixture will be placed at a bulk density of approximately 1.46 g/cm^3, which would be conducive to plant growth. The pea gravel is designed to minimize wind erosion of the silt loam without significantly affecting its moisture retention capabilities. Construction quality control will be conducted throughout installation of each layer to ensure that the appropriate slopes are maintained and that the desired compaction is attained. Appropriate quality assurance records will be kept during construction and will be made part of the permanent facility logbook.

Next, the ground will be prepared for planting and fertilization. Once this is complete, the ground will be seeded with mixed perennial grasses and planted with shrubs and sagebrush.

A fence will surround the perimeter of the IDF. This fence will prevent medium to large animals from accessing the cover. The cover will be inspected quarterly for signs of burrowing animals. Small animals are not expected to penetrate the low-permeability components of the cover. Typical small-animal species living on the Hanford Site tend to live in the upper 1.2 m (3.9 ft) of earth.

5.2.5 Conformance to Design Criteria

Table 5-4 summarizes how the modified RCRA Subtitle C barrier conforms to the design criteria. Layer numbers referenced in the table refer to the corresponding cover layers shown in Figure 5-3.

Table 5-4. Conformance of Modified RCRA Subtitle C Barrier to Design Criteria

Design Criteria	Conformance of Modified RCRA Subtitle C Barrier to Design Criteria
Minimize moisture infiltration through the cover.	Design facilitates moisture retention in the topsoil layers for removal by evaporation and plant transpiration. Capillary barrier interface at the base of the topsoil will restrict drainage and increase moisture storage capacity in the topsoil layers. A high-saturated hydraulic conductivity value (1 cm/sec [0.03 in./sec]) is specified for the lateral drainage layer to prevent significant hydraulic head buildup within the layer. The low-permeability (approximately 10 cm/s [0.33 in./sec]) asphalt layer will be highly impervious to water penetration. Numerical performance assessments predict that infiltration through the barrier will be negligible (i.e., <0.2 % of precipitation).
Design a multilayer cover of materials that are resistant to natural degradation processes.	Long-term durability of asphalt is being evaluated through natural analog studies. Preliminary results indicate that asphalt offers adequate durability over periods in excess of 5,000 years. Except for the asphalt layer, the modified RCRA Subtitle C barrier is designed entirely of natural soil and rock that will provide appropriate long-term resistance to chemical and physical weathering.

Table 5-4. Conformance of Modified RCRA Subtitle C Barrier to Design Criteria

Design Criteria	Conformance of Modified RCRA Subtitle C Barrier to Design Criteria
Design a durable cover that needs minimal maintenance during its design life.	Perennial vegetation will be cultivated on the cover surface to minimize susceptibility to wind and water minimal maintenance during its erosion. The topsoil in Layer 1 will contain 15 wt. % pea gravel. As silt particles are removed from the surface by erosion, pea gravel will form a lag deposit that will tend to protect the surface from further erosion. The surface slope has been limited to 2% to limit wind erosion.
Design a cover with a functional life of 500 years.	The thickness of topsoil in the modified RCRA Subtitle C barrier is sufficient to accommodate soil losses at a rate of 2 tons per acre per year for 500 years with no significant adverse effect on performance. (Note: The PA takes no credit for engineered features.) The modified RCRA Subtitle C barrier can accommodate substantial increases in annual precipitation (up to twice ambient) with no significant adverse effect on performance. The 500-year, 24-hour storm has been evaluated. Although the design storm delivers 6.2 cm (2.47 in.) of precipitation, runoff during the 24-hr period is <2.5 cm (1 in.) (i.e., runoff is not excessive, and the design storm is unlikely to cause severe erosion of the cover surface).
Prevent plants from accessing and mobilizing contamination (i.e., prevent root penetration into the waste zone).	Extremely low soil moisture conditions are expected to be maintained in the coarse-textured soil layer (i.e., Layer 5) below the capillary barrier interface. These conditions are expected to deter root zone development below the topsoil layers. The low-permeability asphalt in Layer 6 is expected to present an impenetrable barrier to plant roots.
Prevent burrowing animals from accessing and mobilizing contamination.	The low-permeability asphalt in Layer 6 is expected to present an impenetrable barrier to burrowing animals.
Ensure that the top of the waste is at least 5 m (16 ft) below final grade or include appropriate design provisions to limit inadvertent human intrusion.	Human habitation of the site surface is considered the most potentially adverse human intrusion scenario for LLW sites. Many radiological waste sites in the 200 Areas have already been stabilized with coarse fill that would approach or exceed these criteria. At other sites, the criteria could be met by placing additional grading fill. Layer 6 represents a substantial barrier to inadvertent human intrusion. Layer 6 could be excavated, but only with the aid of mechanized equipment.
Facilitate drainage and minimize surface erosion by wind and water.	The surface slope is specified at 2% to provide for coherent drainage off the barrier surface while limiting wind and water erosion potential. Perennial vegetation will be cultivated on the cover surface to minimize susceptibility to erosion. The topsoil in Layer I will contain 15 wt. % pea gravel. As silt particles are eroded from the surface, pea gravel will form a lag deposit that will tend to protect the surface from further erosion.
Design the low-permeability layer of the cover to have a permeability less than or equal to any natural subsoil present.	The low-permeability asphalt layer is expected to demonstrate an in-field saturated hydraulic conductivity value on the order of 10 cm/s (0.33 in./sec). This value is several orders of magnitude lower than the conductivity values of natural subsoils in the 200 Areas.
Design the cover to prevent the migration and accumulation of topsoil material within the lateral drainage layer (i.e., clogging of the lateral drainage layer).	A two-layer graded filter (Layers 3 and 4) separates the topsoil layers from the underlying layers of coarse-textured aggregate materials that will perform the biointrusion prevention and drainage functions. Design specifications for the two graded filter layers conform to standard filter criteria.

Table 5-4. Conformance of Modified RCRA Subtitle C Barrier to Design Criteria

Design Criteria	Conformance of Modified RCRA Subtitle C Barrier to Design Criteria
For frost protection, the lateral drainage layer and the low-permeability asphalt layer must be located at least 0.76 m (2.5 ft) below final grade.	The top of the lateral drainage layer will be situated at least approximately 1.3 m (4.33 ft) below final grade.

Reference: DOE/RL-93-33, *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas*, Table 2-5.

LLW = low-level waste

PA = performance assessment

RCRA = *Resource Conservation and Recovery Act of 1976*

5.3 Waste Characteristics

This section provides a description of important characteristics of the waste that may be disposed of at the IDF. The characteristics of relevance include the waste form and waste stream descriptions, as well as the waste container designs and inventory.

5.3.1 Waste Forms and Waste Streams Descriptions

This description is based on the contents of the inventory data package, RPP-ENV-58562, *Inventory Data Summary for the Integrated Disposal Facility Performance Assessment*. Figure 5-8 from SRNL-STI-2016-00175, *Solid Secondary Waste Data Package Supporting Hanford Integrated Disposal Facility Performance Assessment*, provides a basic overview schematic diagram related to the generation and disposal pathways for each of these waste streams. The waste stream includes LLW and MLLW that were retrieved from large underground tanks, then treated in the WTP to separate the low-activity fraction from the high-level/transuranic fraction. Both fractions will then be immobilized into different waste-form matrices, whereby the small volume of high-level waste immobilized in borosilicate glass will be stored on the Hanford Site until it is sent to a federal deep-geological repository. The LAW fraction from the WTP together with some non-WTP waste generated at Hanford amount to about 340,000 m^3, equal to about 11,990,000 ft^3, which will be buried in the near-surface IDF on the Hanford Site.

The waste generated by the WTP as a result of the vitrification process include the following waste streams (RPP-ENV-58562):

- ILAW glass
- LAW melters and components (in which contamination arises from adhering particles of radioactive ILAW glass)

The WTP will also generate secondary solid and secondary liquid wastes. SSWs destined for the IDF include solidified spent media waste and encapsulated debris waste, which are comprised of the following (Figure 5-8):

- Granular activated carbon nondebris waste
- Ion exchange resin nondebris waste
- Silver mordenite nondebris waste
- High-efficiency particulate air (HEPA) filter debris waste
- Other debris waste

The ETF-generated LSW will be solidified and then disposed at the IDF.

The additional waste streams generated on the Hanford Site for disposal at the IDF that are not a result of the WTP process include (Figure 5-8):

- Fast Flux Treatment Facility (FFTF) decommissioning waste (any demolition waste from the FFTF facility).
- Secondary waste management LLW and MLLW from general operations (protective equipment, tools and contaminated materials from operations of tank farms, trenches, waste receiving and processing facility, and T Plant complex).
- Onsite non-*Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), nontank LLW, and MLLW from onsite generators such as the Central Waste Complex, Plutonium Finishing Plant, T Plant complex, Waste Encapsulation and Storage Facility, waste receiving and processing facility, groundwater sampling activities, Pacific Northwest National Laboratory, Cold Vacuum Drying Facility, canister storage building, and liquid waste processing facilities (Liquid Effluent Retention Facility, ETF, state-approved land disposal sites, and Treated Effluent Disposal Facility).

5.3.2 Waste Container Designs

This section describes the potential waste package geometries associated with each waste form. These waste forms are provided as examples and will be updated as the program decides on final waste forms.

5.3.2.1 Waste Treatment Plant Immobilized Low-Activity Waste Glass Waste Container Design

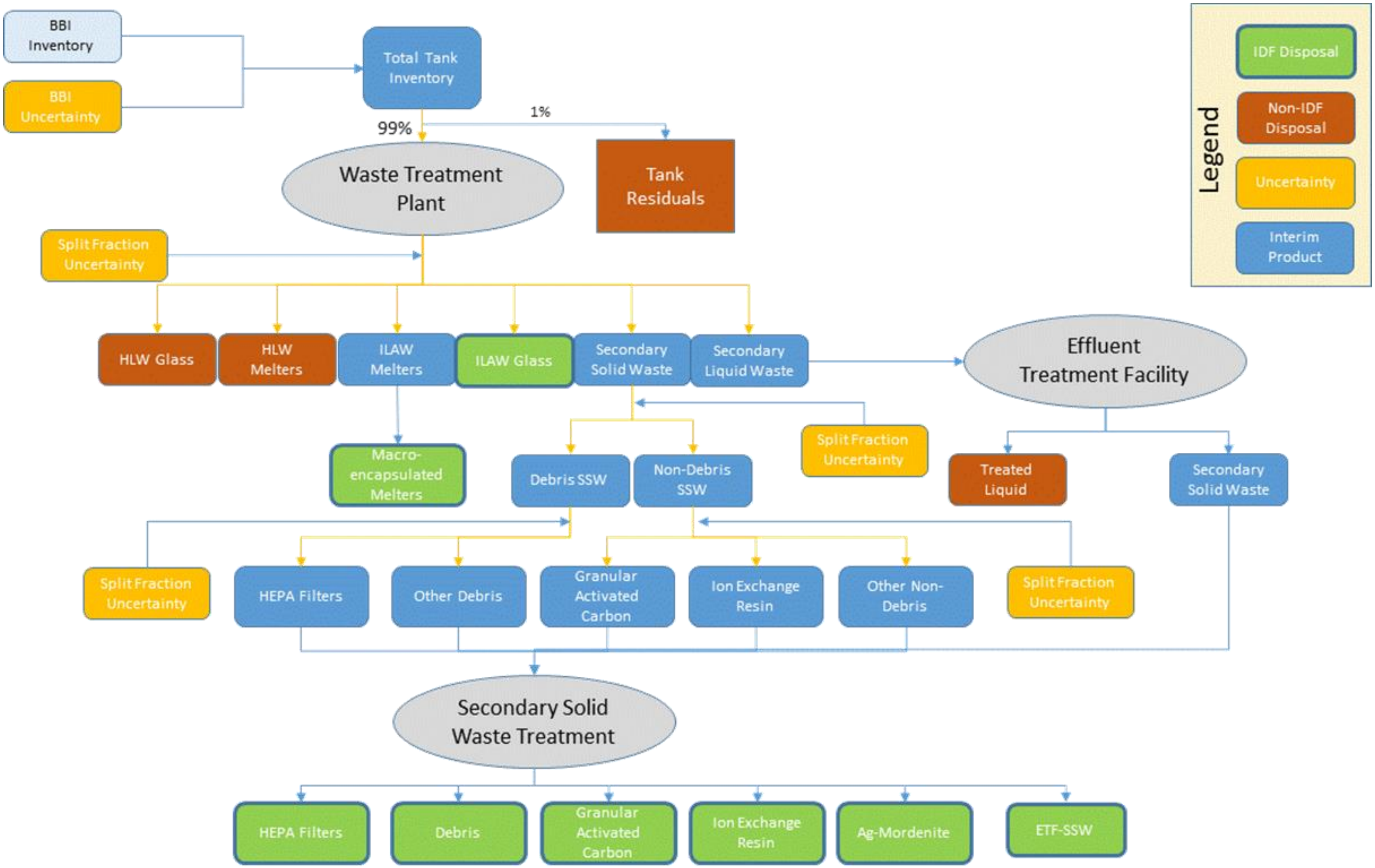
The WTP ILAW glass waste form is expected to be contained in right circular, 304L stainless-steel cylinder containers that are 1.22 m (4 ft) in diameter and 2.29 m (7.5 ft) tall (RPP-ENV-58562). Together, the glass and container is referred to as the waste package. The waste package volume is 2.55 m^3 (90.0 ft^3). The WTP LAW glass container is assumed to be filled to 85% by volume with waste glass, resulting in a total glass volume of 2.17 m^3 (77 ft^3), based on a glass density of 2.6 MT/m^3 (HNF-SD-WM-SP-012, *Tank Farm Contractor Operation and Utilization Plan*). Additional filler material will be added so that the WTP LAW glass container is at least 90% full. The number of WTP ILAW glass waste packages disposed in the IDF will depend on the amount of WTP ILAW glass produced (RPP-20691 and RPP-ENV-58562).

5.3.2.2 Waste Treatment Plant Spent Melter Waste Container Design.

Planning for the disposal of the LAW melters is still under development. As an initial assumption for the earlier performance assessment, a 2.54 cm (1 in.) thick steel rectangular overpack was used for the LAW melters and the melters were assumed to be grouted into overpacks. The number of spent melters disposed in the IDF will depend on a number of assumptions including operating specifications. Estimates for the number of spent melters disposed in the IDF have been provided in RPP-20691, and different disposal alternatives examined (RPP-60058, *Low-Activity Waste Melter Replacement and Disposition Logistics Alternatives Analysis*).

5.3.2.3 Cementitious Grout Low-Level and Mixed Low-Level Waste Container Designs

The waste package designs that will be used to dispose of cementitious SSW and ETF-LSW in the IDF are expected to be similar to those currently used for disposal at the Hanford Solid Waste Burial Grounds. The Hanford Solid Waste Burial Grounds has had experience with the disposal of many different container geometries during its operation. Two designs, 208 L (55 gal) drums and B25 rectangular containers, have been used at the Hanford Solid Waste Burial Grounds, providing waste volumes of 0.208 m^3 and 3.62 m^3, respectively.



Source: SRNL-STI-2016-00175, *Solid Secondary Waste Data Package Supporting Hanford Integrated Disposal Facility Performance Assessment*, Figure 3-1.

Figure 5-8. Hanford Tank Waste Treatment and Immobilization Plant, Effluent Treatment Facility and Secondary Solid Waste Streams Intended for Disposal in the Integrated Disposal Facility

Estimates for the volume of LLW and MLLW disposed in the IDF are provided in RPP-20691 and have been updated by RPP-ENV-58562. The void fraction for the LLW and MLLW loaded into these container geometries is required to be <10% (RPP-8402, *Waste Acceptance Criteria for the Immobilized Low Activity Waste (ILAW) Disposal Facility*). However, there are currently no requirements addressing compressibility of these filled waste packages.

5.3.3 Inventory and Volumes

The current estimates of the waste inventories arising from the WTP to be disposed in the IDF are reported in RPP-ENV-58562. Because resolution of many operational factors and programmatic decisions are in the future, RPP-ENV-58562 notes that it is not possible to define exactly what the inventory of contaminants will be in each waste form to be disposed at the IDF. Instead, RPP-ENV-58562 proposes a range of inventory cases that might occur, realizing that the WTP process flowsheet may continue to develop over time, given ongoing and future regulatory discussions, technical evaluations, and management decisions. The inventory and volumes reported in RPP-ENV-58562 are estimated based on the following:

- The best-basis inventory (BBI) provides the official estimates of tank-waste inventory for 177 single-shell tanks and double-shell tanks at the Hanford Site (RPP-7625, *Guidelines for Updating Best-Basis Inventory*). BBI estimates are made for each individual waste-phase in a tank and provides inventory estimates for each standard BBI constituent (25 chemicals and 46 radionuclides).

- The Hanford Tank Waste Operations Simulator (RPP-17152, *Hanford Tank Waste Operations Simulator (HTWOS) Version 8.1 Model Design Document*) is a dynamic-event simulation model that incorporates the BBI, the tank-farm operations processes that will be used to retrieve and transfer the waste from the tanks, the WTP processes that will be used to separate the waste into high-level and low-activity fractions, and the processes that will be used to generate the final waste form(s).

In addition to the ILAW glass waste forms, the IDF is expected to receive two cementitious waste form types: a grouted waste form from the ETF for liquid secondary wastes from the WTP, other SSW from WTP including debris and other non-WTP LLW and MLLW, FFTF wastes, and onsite non-CERCLA nontank waste. The different waste forms and waste streams and their associated volumes are summarized in Table 5-5 and Table 5-6. The associated inventory for the base case inventory assumptions are presented in Table 5-7 and Table 5-8, for radionuclide and hazardous chemical COPCs, respectively.

Table 5-5. Volumes of Waste Types Planned for Disposal in the Integrated Disposal Facility

Waste Stream	Waste Volume [a] (m^3)	As-Disposed Waste Volume [b]	Volume of Waste and Backfill [c]	Volume Fraction of Waste Type in the IDF [d]
ILAW glass	278,797	278,797	700,000	0.859
ILAW melters and overpack	373	14,992 [e]	37,000	0.045
ETF-generated secondary solid waste	18,900	18,900	48,000	0.059
Secondary solid waste and other waste (Table 5-6)	41,447	11,436	30,000	0.037

Source: RPP-ENV-58562, *Inventory Data Package for the Integrated Disposal Facility Performance Assessment*.

a. Volumes provided in RPP-ENV-58562. For ILAW glass and ETF-generated secondary solid waste these represent Case 7.

b. Waste volumes as received at the offsite treatment facility are modified to account for compaction and solidification volume reduction or increase.

Table 5-5. Volumes of Waste Types Planned for Disposal in the Integrated Disposal Facility

Waste Stream	Waste Volume [a] (m^3)	As-Disposed Waste Volume [b]	Volume of Waste and Backfill [c]	Volume Fraction of Waste Type in the IDF [d]

c. It is assumed that the waste loading is 40%, with the remainder of the volume being comprised of backfill between containers (both horizontally between containers and vertically between lifts). These volumes are reported to two significant figures because the loading efficiency is presented to two significant figures.

d. The total volume of the IDF includes areas where waste containers are disposed, including the backfill around and above the waste containers, as well as other areas used for operations, including Ecology block shield walls used when ILAW glass containers are emplaced. It is reasonable to assume the total IDF volume, including the volume where waste containers are not emplaced, will be minimized to the extent practicable to minimize costs. Therefore, it is assumed the total volume is simply the sum of the volume in which waste containers are emplaced, which is about 815,000 m^3.

e. The volume of ILAW melters and overpack are presented in RPP-ENV-58562, Table 8-3.

ETF = effluent treatment facility

IDF = Integrated Disposal Facility

ILAW = immobilized low-activity waste

Table 5-6. Volumes of Secondary Solid Waste Streams and Other Wastes Planned for Disposal in the Integrated Disposal Facility

Waste Stream	Waste Form Categories	Waste Stream Volume [a] (m^3)	As-disposed Waste Stream Volume [b] (m^3)	Volume of Waste Stream and Backfill [c] (m^3)	Volume Fraction of Waste Stream and Backfill in SSW and Other Waste (-)
Secondary Solid Waste (debris)	HEPA	1,832	183.2	1,800	0.064
	IX resin	686	1,029	2,600	0.093
	LAW CAB	1,137	1,706	4,300	0.154
	Silver mordenite	104	156	390	0.014
	Other debris	26,546	5,309	13,000	0.464
Secondary Waste Management	LLW MLLW	9,489	1,898	4,700	0.114
FFTF	MLLW	1,030	1,030	2,600	0.093
Onsite non-CERCLA nontank	LLW MLLW	623	125	300	0.011
Total		41,447	11,436	29,690	1.007

Source: RPP-ENV-58562, *Inventory Data Package for the Integrated Disposal Facility Performance Assessment*.

a. Values represent as-disposed volumes except for SSW, secondary waste, and onsite non-CERCLA, nontank waste, which represent as-received volumes prior to compaction and encapsulation.

Table 5-6. Volumes of Secondary Solid Waste Streams and Other Wastes Planned for Disposal in the Integrated Disposal Facility

Waste Stream	Waste Form Categories	Waste Stream Volume [a] (m^3)	As-disposed Waste Stream Volume [b] (m^3)	Volume of Waste Stream and Backfill [c] (m^3)	Volume Fraction of Waste Stream and Backfill in SSW and Other Waste (-)

b. Waste volumes as received at the offsite treatment facility are modified to account for compaction and solidification volume reduction or increase using values recommended in RPP-ENV-58562. HEPA filters are compacted 10 x, other debris SSW is compacted 5 x, non-debris SSW volumes are increased 1.5 x, secondary waste management and onsite, non CERCLA, nontank waste volumes are compacted 5 x.

c. It is assumed that the waste loading is 40%, with the remainder of the volume being comprised of backfill between containers (both horizontally between containers and vertically between lifts). The HEPA filter total volumes assume the 40% waste loading and that the compacted HEPA filters are placed in about 285 B-25 boxes in the IDF comprising a total volume of about 730 m^3. These volumes are reported to two significant figures because the loading efficiency is reported to two significant figures.

CAB = carbon adsorber bed
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
FFTF = Fast Flux Test Facility
HEPA = high-efficiency particulate air (filter)
IDF = Integrated Disposal Facility
IX = ion exchange
LAW = low-activity waste
LLW = low-level waste
MLLW = mixed low-level waste
SSW = secondary solid waste

Table 5-7. Radioactive Constituents of Potential Concern Inventory for Inventory Case 7 at IDF Closure (CY 2051)

COPC	ILAW Glass [a]	ETF-LSW	Total SSW [b]	WTP SSW						Non-WTP SSW	
				Agm	GAC	IX	HEPA	OD	FFTF	nCERC	SWM
Ac-227	3.322	1.48E-02	3.90E-04	0	0	0	0	0	0	3.89E-04	5.552E-07
Am-241	5927	1.96E-02	9.87E-03	7.74E-15	1.31E-14	3.78E-04	6.98E-03	2.51E-03	0	0	0
Am-243	3.085	1.09E-05	0	0	0	0	0	0	0	0	0
C-14	0	3.499	0.8197	0	0	0	0	0	6.29E-04	0.819	4.02E-5
Cd-113m	401.7	1.507	0	0	0	0	0	0	0	0	0
Cm-243	4.794	1.76E-02	0	0	0	0	0	0	0	0	0
Cm-244	56.94	0.209	0	0	0	0	0	0	0	0	0
Co-60	6.63E-07	3.18E-7	6.25E-08	8.64E-20	4.04E-19	1.19E-08	3.92E-08	1.14E-08	0	0	0
Cs-137	3930	0.2499	2351	4.66E-07	2.35E-07	138.2	757.1	594.8	9.67E-04	860.2	0.3301
Eu-152	9.86E-6	5.14E-11	7.69E-08	3.99E-20	1.59E-19	5.87E-09	5.02E-08	2.09E-08	0	0	0
Eu-154	2.80E-5	6.67E-09	1.31E-06	8.68E-19	2.82E-18	1.01E-07	8.52E-07	3.58E-07	0	0	0
Eu-155	2.25E-6	1.68E-10	4.10E-08	2.64E-20	8.74E-20	3.12E-09	2.68E-08	1.11E-08	0	0	0
H-3	0	0.21	214.3	0	0	0	0	0	0.1616	212.3	1.833
I-129	16.52	6.42E-02	12.10	7.545	4.413	1.66E-02	0.1249	1.09E-03	0	1.32E-03	1.43E-5
Nb-93m	7.51E-04	9.26E-04	0	0	0	0	0	0	0	0	0
Ni-59	50.43	0.1302	4.23E-04	2.84E-14	1.76E-14	8.59E-5	2.41E-04	9.63E-5	0	0	0
Ni-63	3352	8.627	2.82E-02	1.884E-12	1.168E-12	5.60E-03	1.63E-02	6.29E-03	0	0	0
Np-237	17.39	7.11E-5	7.38E-03	1.41E-20	2.17E-17	9.14E-07	1.18E-6	5.97E-08	0	7.37E-03	6.17E-6
Pa-231	1.11E-04	1.10E-07	7.79E-04	0	0	0	0	0	0	7.78E-04	1.11E-6
Pb-210	6.75E-03	1.32E-04	1.34E-06	0	0	0	0	0	0	1.34E-6	1.915E-09
Pu-238	164.9	2.27E-04	7.95E-03	6.12E-15	3.06E-15	5.75E-08	5.46E-03	2.49E-03	0	0	0
Pu-239	4477	6.20E-03	9.8951	1.56E-14	7.81E-15	1.47E-07	1.38E-02	6.34E-03	0	8.018	1.857
Pu-240	942.7	3.67E-03	9.8577	1.52E-14	7.62E-15	1.44E-07	1.35E-02	6.21E-03	0	7.988	1.85
Pu-241	935.6	1.23E-03	1.12E-04	8.82E-17	4.41E-17	8.32E-10	7.65E-5	3.59E-5	0	0	0

Table 5-7. Radioactive Constituents of Potential Concern Inventory for Inventory Case 7 at IDF Closure (CY 2051)

COPC	ILAW Glass [a]	ETF-LSW	Total SSW [b]	WTP SSW						Non-WTP SSW	
				Agm	GAC	IX	HEPA	OD	FFTF	nCERC	SWM
Pu-242	7.38E-02	3.41E-04	0	0	0	0	0	0	0	0	0
Ra-226	9.08E-03	1.77E-04	3.65E-06	0	0	0	0	0	0	3.65E-6	5.2E-09
Ra-228	1.263	3.14E-02	1.31E-14	0	0	0	0	0	0	1.06E-14	2.46E-15
Se-79	140.8	2.856	5.41E-03	4.83E-14	3.94E-13	1.41E-03	3.88E-03	1.17E-04	0	0	0
Sm-151	0.16	1.24E-5	0	0	0	0	0	0	0	0	0
Sn-126	387.6	1.664	1.92E-02	1.92E-16	1.99E-13	8.39E-03	9.93E-03	8.41E-04	0	0	0
Sr-90	9.16E+04	35.03	1057	2.17E-09	1.08E-09	8.76E-03	6.147	3.194	0	1046	1.887
Tc-99	2.64E+04	0.229	21.22	2.21E-12	2.63E-09	2.361	17.43	0.1071	1.48E-02	1.21	9.95E-02
Th-229	4.03E-02	7.20E-08	3.47E-03	0	0	0	0	0	0	3.47E-03	4.95E-6
Th-230	1.20E-03	1.14E-6	3.39E-04	0	0	0	0	0	0	3.38E-04	4.83E-07
Th-232	9.46E-08	7.17E-14	1.81E-14	0	0	0	0	0	0	1.47E-14	3.40E-15
U-232	9.28E-02	1.941E-07	0	0	0	0	0	0	0	0	0
U-233	9.954	1.78E-05	0.7369	1.24E-18	6.18E-19	5.54E-13	1.14E-6	5.13E-07	0	0.7358	1.05E-03
U-234	3.036	2.89E-03	0.7371	1.38E-18	6.89E-19	5.74E-13	1.15E-6	5.17E-07	0	0.736	1.05E-03
U-235	0.1222	1.21E-04	0.7371	1.86E-20	9.31E-21	6.39E-15	1.50E-08	6.78E-09	0	0.736	1.05E-03
U-236	9.65E-02	3.38E-05	1.46E-05	4.35E-20	2.18E-20	1.92E-14	2.82E-08	1.27E-08	0	1.19E-5	2.75E-06
U-238	2.705	2.78E-03	0.7371	3.90E-19	1.95E-19	1.63E-13	3.18E-07	1.47E-7	0	0.736	1.05E-03
Zr-93	8.04E-04	2.12E-07	0	0	0	0	0	0	0	0	0
Rn-222	9.08E-03	1.77E-04	3.65E-06	0	0	0	0	0	0	3.64E-06	5.20E-09

Source: RPP-CALC-61194, *System Model Calculations for the Integrated Disposal Facility Performance Assessment*, Table 2.2-1 derived from RPP-ENV-58562, *Inventory Data Package for the Integrated Disposal Facility Performance Assessment*, Table A-1 (for ILAW glass, ETF-LSW, and WTP-generated SSW streams), and Tables 7-1, 7-2, and 7-3 for FFTF, SWM, and nCERC waste inventory, respectively.

Note: all values recorded in curies.

Table 5-7. Radioactive Constituents of Potential Concern Inventory for Inventory Case 7 at IDF Closure (CY 2051)

COPC	ILAW Glass [a]	ETF-LSW	Total SSW [b]	WTP SSW						Non-WTP SSW	
				Agm	GAC	IX	HEPA	OD	FFTF	nCERC	SWM

a. ILAW glass inventory is the summed inventory from both ILAW glass containers and inventory from ILAW glass spent melters. The residual inventory in the spent melters that are planned for disposal in the IDF is on the order of 0.1% of the total ILAW glass inventory. It has been added to the ILAW glass inventory because the release rates are assumed to be controlled by the dissolution of the residual glass in the spent melters. A similar approach was adopted in the TC&WM EIS (DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)*).

b. Total SSW inventory includes both WTP-generated SSW and non-WTP-generated SSW. WTP-generated SSW includes: Agm, GAC, IX, HEPA, and OD waste streams. Non-WTP-generated SSW includes FFTF, nCERC, and SWM waste streams.

Agm = silver mordenite
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COPC = contaminant of potential concern
CY = calendar year
ETF-LSW = Effluent Treatment Facility – Liquid Secondary Waste
FFTF = Fast-Flux Test Facility
GAC = granulated activated carbon
HEPA = high-efficiency particulate (filter)
IDF = Integrated Disposal Facility
ILAW = immobilized low-activity waste
IX = ion exchange resin
nCERC = on site, non-CERCLA, nontank waste
OD = other debris
SSW = secondary solid waste
SWM = solid waste management waste
WTP = Waste Treatment and Immobilization Plant

Table 5-8. Chemical Constituents of Potential Concern Inventory for Inventory Case 7

COPC	ILAW Glass [a]	ETF-LSW	Total SSW [b]	WTP SSW					Non-WTP SSW		
				Agm	GAC	IX	HEPA	OD	FFTF	nCERC	SWM
Acetonitrile	0	0	3.91	0	0	0	0	0	0	3.91	0
Al	2.37E+07	18.48	21.74	8.36E-11	2.54E-09	13.51	3.781	4.454	0	0	0
As	4688	96.30	6.995	1.09E-10	7.44E-11	0.1583	5.28E-02	8.43E-02	0	6.7	0
B	2.23E+07	58.74	32.46	1.53E-10	1.33E-08	0.1543	17.88	10.76	0	3.66	0
Ba	9.964	0.7556	4.14E-02	1.45E-13	3.59E-13	9.15E-03	2.66E-03	2.96E-02	0	0	0
Be	496.8	2.033	5.56E-05	1.66E-19	1.24E-15	5.22E-5	8.13E-08	3.31E-6	0	0	0
Benzene	0	0	1.02	0	0	0	0	0	0	1.02	0
Butanol	0	0	1.39E-03	0	0	0	0	0	0	1.39E-03	0
Cd	5093	0.4774	49.83	3.82E-10	2.50E-10	7.72E-02	0.1674	8.50E-02	0	49.5	0
Cl	7.41E+05	882.7	8.06E+04	2.18E-07	4.22E-02	7.71E+04	0	3518	0	0	0
Cr	4.91E+05	4.299	936.8	6.11E-10	7.26E-10	39.77	699.6	3.472	7.50E-03	180	13.9
Cu	360.2	3.557	0	0	0	0	0	0	0	0	0
F	1.13E+06	4986	1.07E+05	1693	1.05E+05	89.89	0.1687	5.578	0	274	0
Fe	2.84E+07	313.3	0.1387	2.71E-13	3.65E-11	5.52E-07	6.14E-02	7.74E-02	0	0	0
Hg	0	958.4	1094	7.92E-03	1002	2.24E-02	0	2.01E-03	0	89.9	2.29
Li	7.76E+06	7.966	0	0	0	0	0	0	0	0	0
Mn	7.11E-05	34.37	47.69	1.88E-11	1.09E-11	1.88E-08	1.09E-02	7.44E-02	0	47.6	0
Mo	6503	28.59	9.39E-05	0	0	0	0	0	0	9.39E-5	0
Ni	2276	6.466	2.596	8.0E-11	7.37E-11	0.2383	8.23E-02	0.3059	0	1.97	0
NO2	0	46.37	0	0	0	0	0	0	0	0	0
NO3	0	1.64E+05	2970	0	0	0	0	0	0	2970	0

Table 5-8. Chemical Constituents of Potential Concern Inventory for Inventory Case 7

COPC	ILAW Glass [a]	ETF-LSW	Total SSW [b]	WTP SSW					Non-WTP SSW		
				Agm	GAC	IX	HEPA	OD	FFTF	nCERC	SWM
Pb	7.01E+04	8822	2.60E+04	2.76E-09	5.40E-09	2.326	7.27	2.313	5.64E-03	2.58E+04	232
PCB	0	0	25	0	0	0	0	0	0	25	0
Total U	8111	8.321	0.9807	0	0	0	0	0	3.27E-02	0.948	0
Zn	1.74E+07	22.51	0	0	0	0	0	0	0	0	0

Source: RPP-CALC-61194, *System Model Calculations for the Integrated Disposal Facility Performance Assessment*, Table 2.2-2 derived from RPP-ENV-58562, *Inventory Data Package for the Integrated Disposal Facility Performance Assessment*, Table A-2 (for ILAW glass, ETF-LSW, and WTP-generated SSW) and Tables 7-1, 7-2, and 7-4 for FFTF, SWM, and nCERC waste inventory, respectively.

Note: all values reported in kilograms.

a. ILAW glass inventory is the summed inventory from both ILAW glass containers and inventory from ILAW glass spent melters. The residual inventory in the spent melters that are planned for disposal in the IDF is on the order of 0.1% of the total ILAW glass inventory. It has been added to the ILAW glass inventory because the release rates are assumed to be controlled by the dissolution of the residual glass in the spent melters. A similar approach was adopted in the TC&WM EIS (DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)*).

b. Total SSW inventory includes both WTP-generated SSW and non-WTP-generated SSW. WTP-generated SSW includes: Agm, GAC, IX, HEPA, and OD waste streams. Non-WTP-generated SSW includes FFTF, nCERC, and SWM waste streams.

Agm = silver mordenite

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

COPC = contaminant of potential concern

CY = calendar year

ETF-LSW = Effluent Treatment Facility – Liquid Secondary Waste

FFTF = Fast-Flux Test Facility

GAC = granulated activated carbon

HEPA = high-efficiency particulate (filter)

IDF = Integrated Disposal Facility

ILAW = immobilized low-activity waste

IX = ion exchange resin

nCERC = on site, non-CERCLA, nontank waste

OD = other debris

SSW = secondary solid waste

SWM = solid waste management waste

WTP = Waste Treatment and Immobilization Plant

6 Approach to Closure

DOE provides requirements and guidance through its system of orders, manuals, and guides. The primary driver for this closure plan is DOE O 435.1. The objective of this order is to ensure that radioactive waste is managed in a manner that protects workers, public health and safety, and the environment.

This section of the IDF Closure Plan describes the conceptual technical approach for specific activities that will be conducted to close the facility in a manner that will meet the requirements of DOE O 435.1, DOE M 435.1-1, DOE O 458.1, *Radiation Protection of the Public and the Environment*, and applicable EPA and Washington State requirements and NRC guidance.

6.1 Detailed Closure Action

This section describes the various closure activities that will occur in stages. Preliminary trench closure, consisting primarily of backfilling activities, begins soon after placement of the first few packages of waste in the IDF. These operational/interim closure activities continue until the IDF is filled to capacity with waste packages. The final closure stage of the IDF trench begins after the last waste package is placed and backfilled.

An engineered barrier cover, as described in Section 3.2, will be installed in accordance with RCRA regulatory requirements to minimize infiltration of precipitation into the trench and hinder the inadvertent intruder from accessing the waste packages. Once the IDF is closed, operations are reduced to the continuance of monitoring and maintenance of security systems for this facility; the waste is safeguarded and monitored by institutional control.

6.1.1 Operational/Interim Closure

The first major step in the operation of the disposal facility will be the receipt of waste packages at the IDF. Waste packages will be delivered by a transport vehicle likely consisting of a tractor truck and trailer. A mobile system will be used to remove the ILAW packages from the trailer-mounted shipping container. Other waste package types may be contact handled. Each waste package placement will be closely monitored for future package retrievability.

As an array of ILAW and other waste packages advances, the space between the packages is backfilled with previously excavated soil or pea gravel. Soil also is added around the packages that are exposed in the outer column of the arrays. Loaders, dump trucks, bulldozers, and compactors are used to place a backfill layer of soil up to 1 m (3 ft) thick above the top of the waste packages. These steps during operations help to minimize the exposed surface area of waste packages. A temporary rain curtain may be used to control the amount of clean stormwater runoff that enters the leachate collection system. The rain curtain can be used in areas where no waste has been placed or in the areas where waste packages and the full operations layer have been placed. Because the collected water will not have contacted waste packages, it can be discharged as stormwater and reduce the amount of precipitation that ends up as leachate.

At present, there are no plans for operational or interim covers during the operational period of the facility. Any precipitation that occurs during operations is assumed to freely drain through the high-density and low-density backfill and be collected in the sumps at the northern end of the leak detection and monitoring system (Figure 2-2). The LDS has been in operation since the completion of the Phase 1 construction in 2006. The amount of water removed from the LDS is equivalent to the precipitation minus evaporation in the facility.

6.1.2 Final Disposal Site Closure

Final disposal site closure consists of the following:

- Installing the modified RCRA Subtitle C barrier on the IDF
- Decontaminating and decommissioning no-longer-needed ancillary facilities
- Compiling a final inventory of the waste disposed in the facility
- Placing permanent facility location markers
- Preparing the disposal site for post-closure monitoring and maintenance
- Submitting the required certifications that the IDF has been closed to the regulatory authority

A description of the modified RCRA Subtitle C barrier, which is an important part of final site closure, is provided in Section 5.2.2. Equipment decontamination will comply with DOE/RL-96-109, *Hanford Site Radiological Control Manual*.

6.1.2.1 Closure Cover Installation

The waste packages will be backfilled during the disposal operations. The closure cover installation process is described in detail in Section 6.2.

6.1.2.2 Records Management Plan for Documents and Records Generated During Final Closure

Records concerning the disposal-product receipt acceptance and the total inventory of waste placed in the facility will be maintained as a part of the permanent closure documentation (DOE O 435.1 and WAC 246-247, “Radiation Protection—Air Emissions”). Records must also include 40 CFR 268, “Land Disposal Restrictions,” and WAC 173-303-801, “Types of dangerous waste management facility permits,” and disposal restriction certification and records supporting waste verification and confirmation through the operating life of the IDF.

Before final closure of the disposal facility, records of the final inventory of waste placed in the facility will be made available for additional updating of the PA and the closure plan.

Inventory
At the time of final closure of the disposal facility, the PA (DOE O 435.1) will be updated to include the final inventory of waste placed in the facility and potential changes from those summarized in Section 6.3.2 that were based on the inventory data package report RPP-ENV-58562.

Records
Records concerning the disposal-product receipt acceptance and the total inventory of waste placed in the facility will be maintained as a part of closure (DOE O 435.1 and WAC 246-247).

6.1.3 Institutional Control

Institutional control shall continue until the facility can be released (DOE O 435.1) pursuant to DOE O 458.1.

6.1.4 Unrestricted Release of Site

For the site to be released, it must meet all pertinent requirements of DOE/RL-96-109; 10 CFR 835, “Occupational Radiation Protection”; and WAC 173-303.

DOE, along with the U.S. Department of Interior, local governments, and affected tribal nations, has issued a comprehensive land use plan for the Hanford Site for at least the next 50 years (DOE/EIS-0222-F). The plan indicates that the 200 Areas (or Central Plateau) would be used exclusively for the management of Hanford Site waste.

In 1992, the HFSUWG (consisting of local, state, and federal officials, representatives of tribal nations, people from agriculture and labor, as well as members of environmental and special interest groups) was charged to determine potential future uses of the various parts of the Hanford Site. Their summary report (Drummond, 1992, *The Future for Hanford: Uses and Cleanup: The Final Report of the Hanford Future Site Uses Working Group*) makes the following statement:

> In general, the Working Group desires that the overall cleanup criteria for the Central Plateau should enable general usage of the land and groundwater for other than waste management activities in the horizon of 100 years from the decommissioning of waste management facilities and closure of disposal areas.

However, except for the inadvertent intruder scenario, the scenarios described here assume that some controls remain in place to prevent public intrusion into the disposal site (i.e., the barriers and markers that have been left are effective in preventing open use of the land directly above the disposal site).

6.1.4.1 Authorized Limits for Residual Radioactive Material

Limits for residual radioactive material will comply with the current version of DOE/RL-96-109 and 10 CFR 835. The closed site will be posted as an Underground Radioactive Material Area. The closed site is not expected to be a contamination area or a radiation area.

6.1.4.2 Identification of Other Requirements Applicable to Release of Property

No other requirements have been identified for this revision; but should other requirements be identified, they will be added to future versions of this closure plan.

6.1.4.3 Comparison of Existing Site Conditions to Requirements for Unrestricted Release

Because the closed site will be posted as an Underground Radioactive Material Area, it is not expected to meet requirements for unrestricted release.

6.2 Closure Schedule

The IDF was constructed between 2004 and 2006. The constructed facility is in a pre-operational state awaiting authorization to receive waste.

Disposal operations are expected to last for 30 years or more. Operations are contingent upon waste production from sources including WTP ILAW, Hanford Site cleanup activities (such as tank farms), and decontamination and decommissioning of the WTP. Operations are also contingent upon space availability in the IDF. Operations are tentatively expected to continue until 2050 when the retrieval of all tank waste and production of the last ILAW package is expected to be completed. Closure activities will be instituted when the IDF is at final capacity, approximately 2051.

The project dates may change as a result of renegotiation of the Tri-Party Agreement (Ecology et al., 1989), which sets the cleanup schedule for the Hanford Site, and as a result of contract renegotiation related to the extension of the treatment contract.

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7 Compliance

Closure of the IDF is predicated on the ability to meet the performance objectives defined in DOE M 435.1-1. The IDF PA (RPP-RPT-59958) describes the basis of the models and parameter used in the prediction of the post-closure performance and the associated assumptions. This section provides a summary of the compliance of the IDF with the performance objectives with a focus on the key assumptions related to the closure of the facility.

7.1 Compliance with Performance Objectives

The DOE 435.1 performance objectives relate to the potential exposure that an individual may receive from atmospheric or groundwater contamination resulting from the long-term release of COPCs to the environment (Figure 7-1). In addition, performance measures related to the potential acute and chronic doses a driller may receive who unintentionally drills into the facility have been evaluated.

In addition to the DOE requirements, the facility RCRA permit also specifies operating conditions that require modeling be performed to provide a reasonable basis for assurance that facility will be adequately protective of human health and the environment and will not violate or be projected to violate all applicable state and federal laws, regulations, and environmental standards. The groundwater impact was modeled to evaluate fate and transport in the groundwater aquifer(s) and was compared against various performance standards including but not limited to drinking water standards (40 CFR 141, “National Primary Drinking Water Regulations,” and 40 CFR 143, “National Secondary Drinking Water Regulations”).

These performance requirements are summarized in Table 7-1, along with the predicted concentrations and drinking water doses determined by the PA both during the 1,000-year compliance period and a post-compliance period that extends to 10,000 years after closure. Sensitivity and uncertainty analyses are used to develop an understanding of the parameters and processes that could potentially change the conclusions derived from the base case results that are compared to the performance objectives.

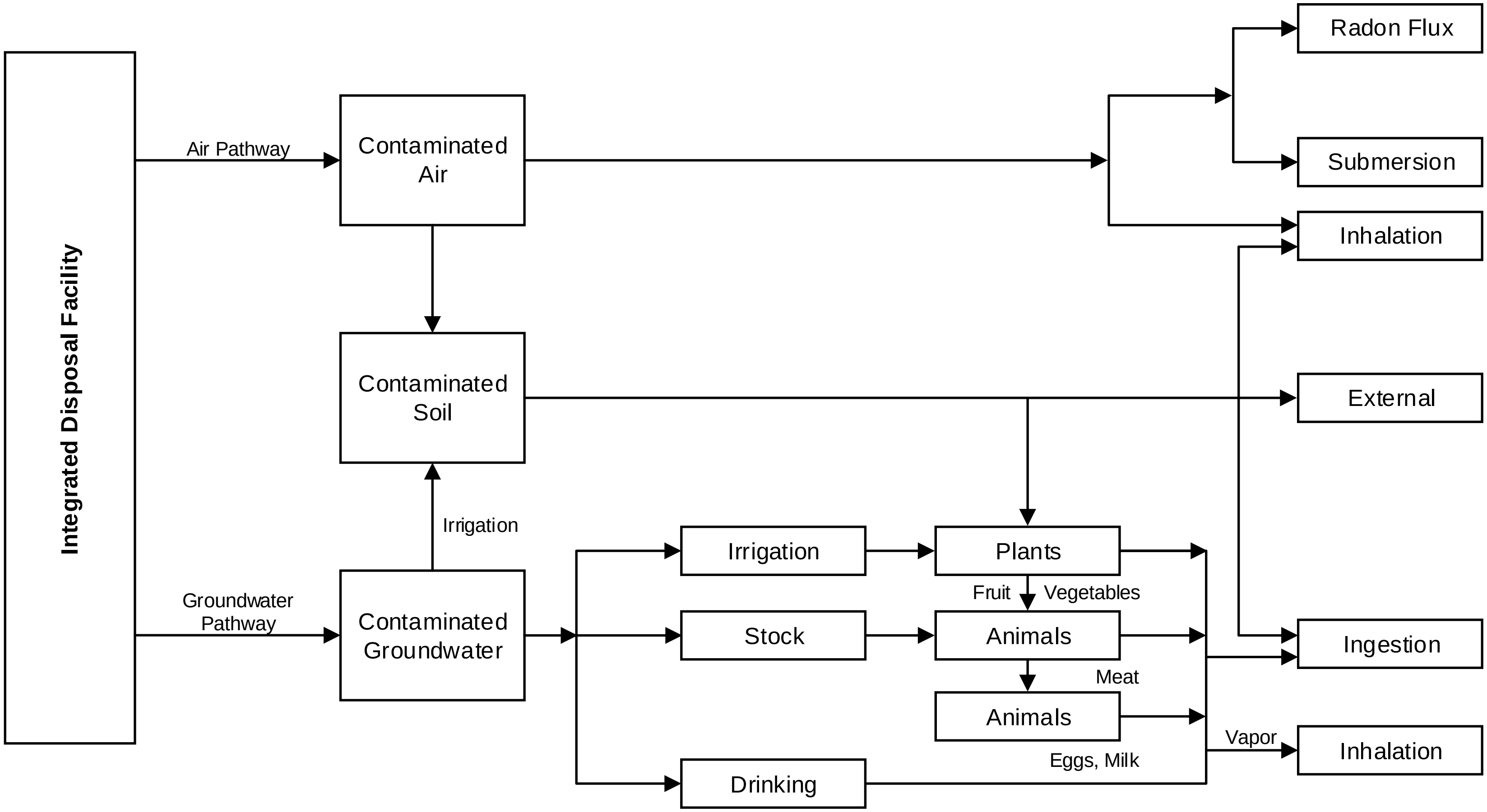


Figure 7-1. Overview of the Exposure Routes for Dose Calculations for the Groundwater and Air Pathway for the Integrated Disposal Facility Performance Assessment

Table 7-1. Comparison of Performance Objectives and Measures with the Integrated Disposal Facility Performance Assessment Results for the Compliance and Post-Compliance Periods

Performance Objective and/or Measure	Standard	Performance Assessment Results	
		Compliance Period (2051-3051) [a]	Post-Compliance Period (3051-12051) [a]
All Pathways (DOE O 435.1 Chg 1)	25 mrem/yr	0.19 mrem/yr	1.5 mrem/yr [b]
Atmospheric (40 CFR 61, Subpart H)	10 mrem/yr	0.19 mrem/yr	0.01 mrem/yr
Atmospheric (40 CFR 61, Subpart Q)	20 pCi m^{-2} s^{-1} radon flux (at surface of disposal facility)	0.016 pCi m^{-2} s^{-1}	0.016 pCi m^{-2} s^{-1}
Acute Inadvertent Intruder (DOE O 435.1, Chg 1)	500 mrem	9.28 mrem	NA [c]
Chronic Inadvertent Intruder (DOE O 435.1, Chg 1)	100 mrem/yr	43.3 mrem/yr [d]	NA [e]
Groundwater Protection (Water Resources) (40 CFR 141)	Beta-gamma dose equivalent (≤4 mrem/yr) (EPA dosimetry [f])	0 mrem/yr	4.9 mrem/yr [f]
	Beta-gamma dose equivalent (≤4 mrem/yr) (DOE dosimetry [g])	0 mrem/yr	0.82 mrem/yr [g]
	Gross alpha activity concentration (excluding radon and uranium) ≤15 pCi/L	0 pCi/L	1.7E-4 pCi/L
	Combined Ra-226 and Ra-228 concentration ≤5 pCi/L	0 pCi/L	1.3E-5 pCi/L
	Uranium concentration ≤30 µg/L	0 µg/L	1.5E-2 µg /L
	Sr-90 concentration ≤8 pCi/L [h]	0 pCi/L [h]	0 pCi/L [h]
	H-3 concentration ≤20,000 pCi/L [h]	0 pCi/L [h]	0 pCi/L [h]

Source: RPP-RPT-59958, Table 1-1.

Note: complete reference citations are provided in Chapter 9.

a. Compliance at 100 m (328 ft) from Integrated Disposal Facility except for inadvertent intruder scenarios.

b. Value based on deterministic process model results.

c. Not applicable for post-compliance time period.

d. Peak dose based on assumed inadvertent intrusion into silver mordenite. Peak dose occurs at 500 years after closure.

e. The peak dose based on assumed inadvertent intrusion occurs immediately following the intrusion and the dose subsequently decreases after that due to radionuclide decay of short-lived radionuclides. Therefore, the peak dose in the sensitivity phase is lower than the peak dose during the compliance period.

f. Calculated for the base case SSW loading configuration using the EPA dosimetry yielding a 4 mrem/yr drinking water dose (i.e., 1.0 pCi/L for I-129 and 900 pCi/L for Tc-99) (40 CFR 141.66 and NCRP Report No. 22).

g. Calculated for the base case SSW loading configuration using DOE dosimetry yielding a 4 mrem/yr drinking water dose (i.e., 13.2 pCi/L for I-129 and 1,760 pCi/L for Tc-99) (DOE-STD-1196-2011).

h. Sr-90 and H-3 were not released to the groundwater pathway during the compliance period because of transport times and were also not released to the groundwater during the 10,000-year period due to relatively short half-lives.

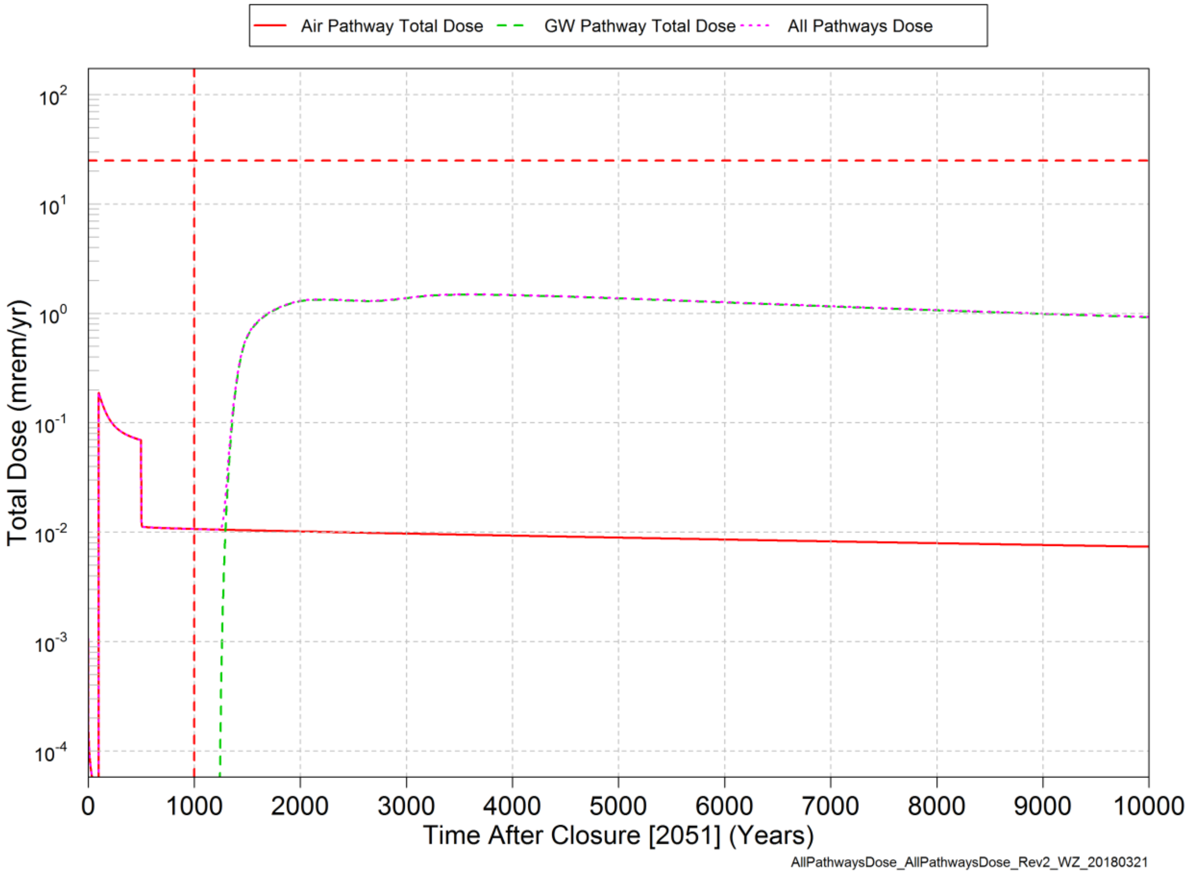
DOE = U.S. Department of Energy
EDE = effective dose equivalent
EPA = U.S. Environmental Protection Agency
SSW = secondary solid waste

7.1.1 Air and Groundwater Pathway Dose Performance Objectives

Deterministic simulations using the process-level models and the integrated system model were combined to calculate values that are compared to the compliance standards. For comparison to the all-pathway performance objectives, the process model dose for technetium-99 and iodine-129, which are the dominant COPCs contributing to the groundwater pathway dose, are combined with the doses calculated using the air pathway system model. The combined air and groundwater pathway dose to the receptor assumed to live and use groundwater withdrawn from a well located 100 m (328 ft) from the IDF boundary are presented in Figure 7-2.

The air pathway is the principal pathway tritium contributing to the all-pathway dose to the representative member of the public during the 1,000-year compliance period. As summarized in RPP-RPT-59958, the predicted air pathway dose is significantly affected by two assumptions used in the analysis. First, it is assumed that the waste containers are not air-tight throughout the operations and institutional control period thus allowing the release of tritium and other potential gaseous COPCs at the time of closure. The diffusive release of gaseous tritium occurs in the first year after closure and then decreases significantly. Second it is assumed that the gaseous form of iodine-129 exists as undissociated $I_2(g)$ rather than the more likely form of HI(g) based on the chemical conditions in the IDF. The Henry's Law constant for HI(g) would preclude the partitioning of iodine-129 into the gas phase. Had it been assumed that iodine-129 did not partition to $I_2(g)$, there would have been no significant dose from iodine-129 in the air pathway.

The properties of the backfill and the surface barrier materials can affect the release rate of gaseous COPCs to the surface of the facility. However, in the IDF PA it is assumed that the backfill is only partially saturated due to the low infiltration rate into the surface barrier. No credit is taken in the IDF PA for the engineered materials of the surface barrier that might limit or preclude migration of gaseous COPCs. Based on the bounding assumptions used in the IDF PA for the air pathway models, there are no relevant design and construction constraints related to the closure of the facility.



Source: RPP-RPT-59958, *Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington*, Figure 1-5.

Note: Groundwater pathway dose is the deterministic base case dose based on technetium-99 and iodine-129 concentrations at the 100 m (328 ft) buffer boundary calculated using the base case process models. Air pathway dose is deterministic integrated system model dose. The initial peak atmospheric pathway dose occurs immediately after the cessation of the institutional control period because it is assumed that the receptor moves from the Hanford Site boundary to 100 m (328 ft) from the edge of the Integrated Disposal Facility.

GW = groundwater

Figure 7-2. All-Pathway, Groundwater, and Atmospheric All-Pathway Dose for 10,000-Year Sensitivity Analysis Period

The groundwater pathway is the principal pathway contributing to the all-pathway dose to the representative member of the public after the 1,000-year compliance period. The timing of the arrival of aqueous COPCs at the water table and at the 100-m boundary of the buffer zone in the saturated zone, is a function of (1) the assumed design life of the surface barrier, (2) the assumed long-term average net infiltration rate through the surface barrier, and (3) the assumed properties of the liner system. The magnitude of the COPC concentration at the 100 m (328 ft) boundary of the buffer zone in the saturated zone is a function in part of the spatial arrangement and location of key waste forms in the IDF. These factors relate to the closure of the facility.

The groundwater pathway results are predicated on the assumption that the facility will be closed with a RCRA Subtitle C compliant surface barrier that is able to perform its function for the assumed 500-year design life. This implies that potential degradation modes of the surface barrier, including but not limited to wind and water erosion, compaction, and subsidence do not significantly degrade the performance during this period. It also assumes that there is sufficient overhang of the surface barrier that lateral drainage, either from the surface or from perched zones created within the surface barrier during times of higher precipitation, occurs outside of the footprint of the IDF trench to limit the potential for water to seep into the disposal trench. In addition, this assumes that the side slopes of the surface barrier, which are designed to limit water and wind erosion of the surface barrier, are located outside of the footprint of the IDF trench to limit the potential for water to seep into the disposal trench. The long-term average net infiltration rate is based on the premise that the surface of the IDF will return to the native soil and vegetation conditions similar to those currently existing near the IDF, a shrub-steppe vegetation community on sandy loam soils.

If the surface barrier degrades more rapidly than the currently assumed 500-year design life, aqueous COPCs may arrive at the water table and the 100 m (328 ft) buffer boundary earlier, but the peak concentration and groundwater pathway dose are not likely to be significantly affected because they are more controlled by the release rate from the source term which is controlled by the waste form release properties. Similarly, a higher water flow rate through the facility does not significantly affect the release rate or concentration of the COPCs of greatest significance.

The IDF PA has taken no credit for COPC retention in backfill in the facility or the time it takes to be transported through the liner system. In addition, the IDF PA has evaluated the two end members of the possible hydrologic behavior of the liner system; either the liner system focusing flow due to a low hydraulic conductivity of the admix layer or the liner system not focusing flow due to an assumed higher hydraulic conductivity of the admix and other layers of the liner system. Because the IDF PA results are not significantly affected by the conceptual model of flow through the liner system, there are no post-closure constraints imposed on the operations of the facility.

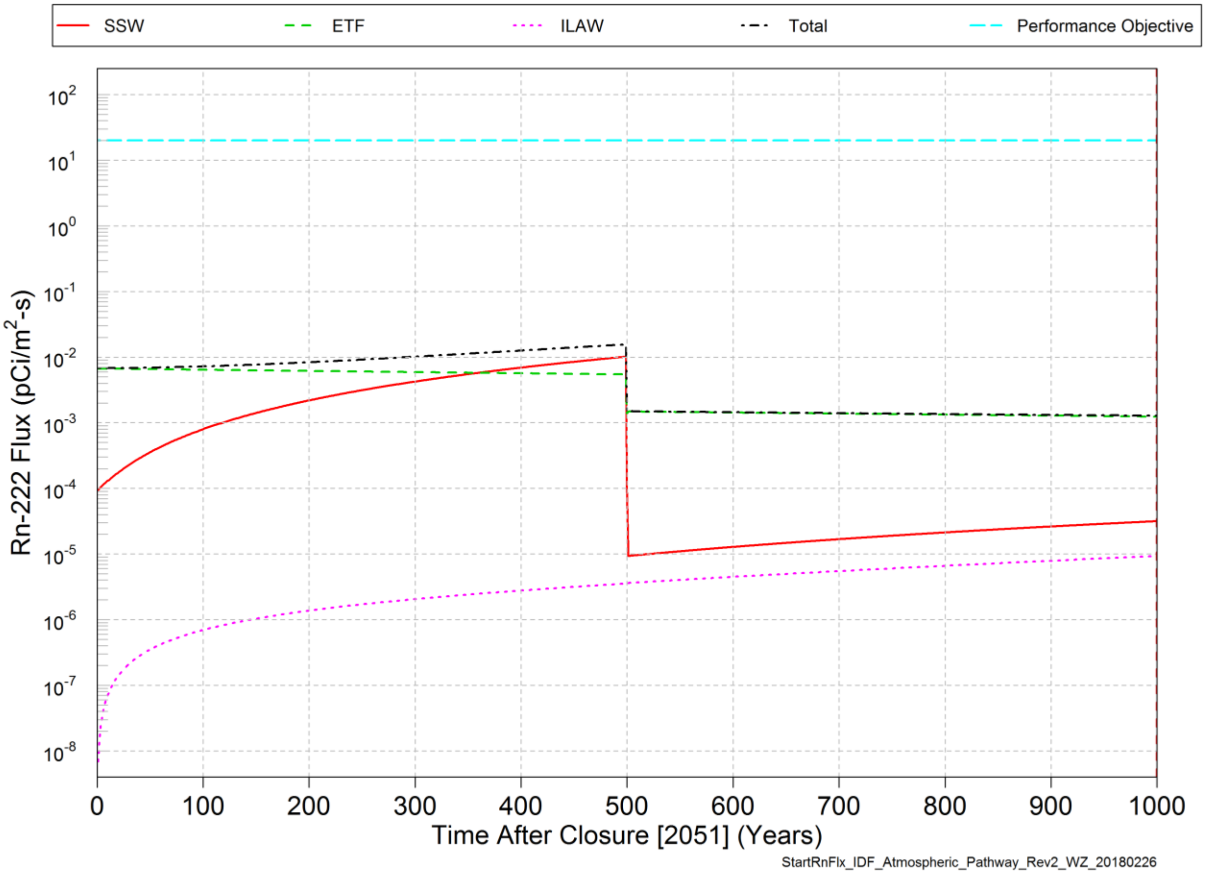
The air pathway and groundwater pathway doses are well below DOE performance objectives during the period of compliance. Sensitivity studies performed for these pathways indicate that the most important aspect of the model to maintain compliance is the capability of the surface barrier to limit flow into and through the disposal facility. Simulations with infiltration rates that are about ten times higher than the long-term recharge rate assumed in the base case result in peak technetium-99 releases to the saturated zone that are four to five times higher than the base case peak result but occur within the first 1,000 years after closure. A factor of five increase in the dose would not result in exceeding a performance objective.

7.1.2 Radon Flux Performance Objective

The integrated system model was used to evaluate the peak instantaneous radon-222 flux at the surface of the IDF for the compliance period. The calculated peak radon-222 flux was compared directly to the performance objective of 20 pCi/m^2/s (specified in 40 CFR 61, Subpart Q). Figure 7-3 presents the results of total and waste-specific radon-222 fluxes for the atmospheric pathway. The modeling results demonstrate that the total radon-222 flux and fluxes for individual waste forms are well below the performance objective of 20 pCi/m^2/s through the 1,000-year period. It also can be observed that ILAW is the primary contributing source to the radon flux, principally because most of the inventory or its precursors resides in this waste stream.

7.1.3 Groundwater Resource Protection Performance Measure

The low infiltration rate through the facility coupled with the relatively low moisture content in the thick vadose zone results in long travel times to the water table so that there is no impact to groundwater during the first 1,000 years after closure.

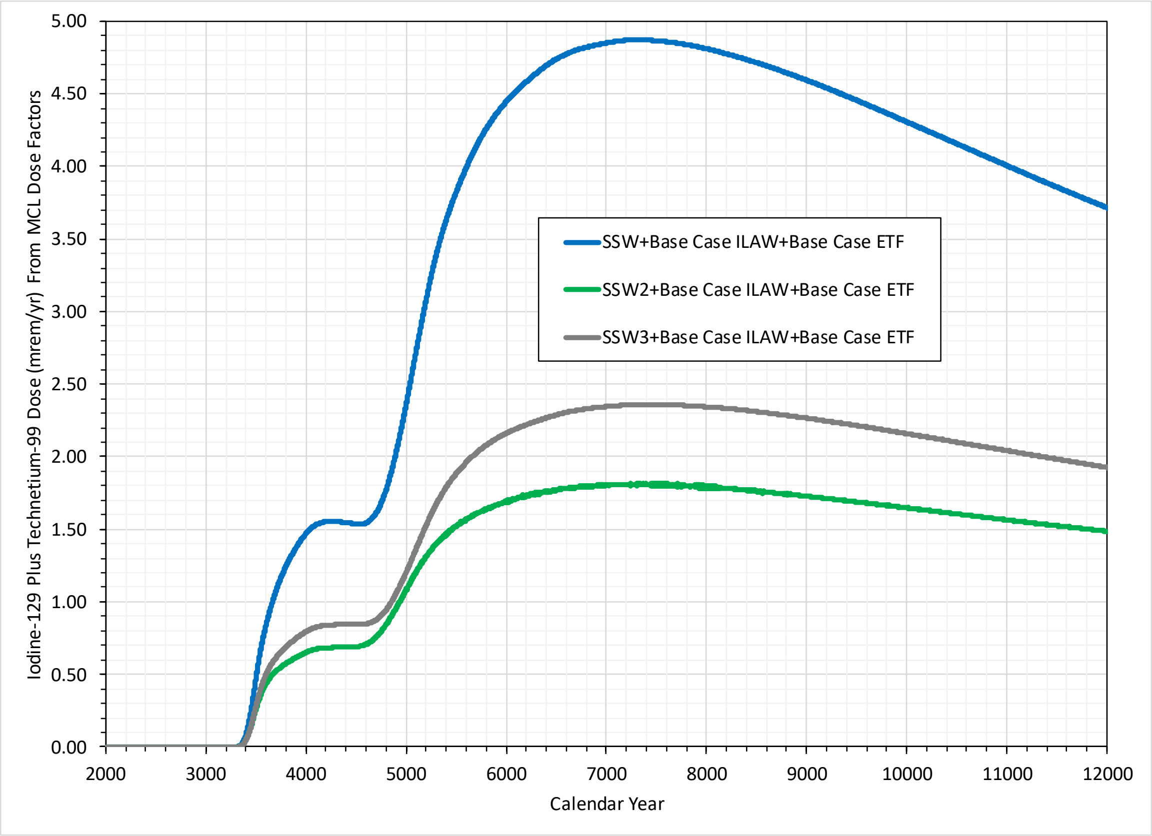


Source: RPP-RPT-59958, *Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington,* Figure 1-6.

Note: The decrease in radon flux that occurs 500 years after closure is the result of the assumed degradation of the surface barrier resulting in an increase in percolation into the facility and an increase in the liquid saturation of the waste form which results in a decrease in the gaseous diffusive flux out of the waste form.

Figure 7-3. Total and Waste Form Specific Radon-222 Flux at the Surface

The principal radionuclides of relevance to the groundwater protection performance measure after the compliance period are technetium-99 and iodine-129. The drinking water dose associated with the calculated groundwater concentration for these two radionuclides, along the 100 m (328 ft) boundary simulated using the suite of base case process models, is illustrated in Figure 7-4. The peak drinking water dose from beta and gamma emitting radionuclides for the base case analysis (indicated as SSW in Figure 7-4) is 4.9 mrem/yr and exceeds the 4.0 mrem/yr standard of the *Safe Water Drinking Act of 1974*. Analysis of the results indicates that SSW is the dominant contributor to the technetium-99 concentration until about 5,000 years after closure, after which releases from ILAW glass become more significant. This is the result of the relatively rapid release of the technetium-99 inventory from containers of encapsulated HEPA filters. SSW is the dominant contributor to iodine-129 concentration for the entire 10,000-year sensitivity analysis period.



Source: RPP- RPT-59958, *Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington*, Figure 5-198.

Note: Time axis is calendar year. Closure is assumed to occur in calendar year 2051. Doses are based on assumed dose factors of 4 mrem/yr per 1 pCi/L of iodine-129 and 4 mrem/yr per 900 pCi/L of technetium-99, consistent with U.S. Environmental Protection Agency Maximum Contaminant Levels. Total groundwater doses for cases SSW, SSW2, and SSW3 are approximated as the sum of doses from secondary solid waste in each case with doses from base case groundwater concentrations from ILAW (immobilized low-activity waste glass source release) and ETF (Effluent-Treatment-Facility-generated secondary solid waste source release) using the peak impact location for each source. Absolute doses may be somewhat higher or lower depending on the rearrangement of ILAW and ETF sources consistent with the modeled SSW footprint and the different locations of peak impacts in the superposed plumes.

Figure 7-4. Drinking Water Doses from All Sources for Iodine-129 plus Technetium-99 at the 100 m (328 ft) Buffer Zone Boundary from EPA Maximum-Contaminant-Level-Based Dose Factors

After the 1,000-year compliance period, at about 3,500 years after closure, the simulated concentration for iodine-129 in the groundwater at the point of calculation is equivalent to the maximum contaminant level and exceeds a threshold requiring discussion with Ecology to evaluate mitigation options. In this iteration of the PA, there are some modeling decisions that could result in an overestimation of the technetium-99 and iodine-129 concentrations in groundwater. The base case process model assumed the solid secondary waste would be collocated in the worst possible configuration (all wastes in the same area) and in the worst possible location (along the east central portion of the facility). This configuration is the worst because it concentrates releases from SSW into a small area. This location is the worst because it is closest to the boundary of the 100 m (328 ft) buffer zone (and thus has less distance for dispersive mixing that tends to lower the concentration) and is characterized by a thinner sequence of the saturated Hanford formation (and thus has a lower Darcy flux and less dilution) than other locations in the disposal footprint. The base case waste placement configuration was purposely selected with the rationale that if performance objectives could be met with the worst configuration and location, then they would be met with more optimum waste loading configuration scenarios and no operating constraints on where waste could be placed within the disposal zone would be warranted. Additional modeling was performed to show that other placement configurations can be used to reduce the peak drinking water dose to about 2.4 mrem/yr if the SSW wastes are placed in a north-south orientation in the eastern disposal cells or about 1.8 mrem/yr if the SSW wastes are placed in a north-south orientation in the western disposal cells; designated as SSW3 and SSW2, respectively in Figure 7-4. Other mitigation options include the following:

- More rigorous modeling of the encapsulated HEPA filter waste stream
- An alternate disposal approach for the HEPA filter waste stream
- A waste placement strategy that places constraints on the placement of encapsulated HEPA filters

7.1.4 Hypothetical Inadvertent Intruder Performance Measure

In addition to evaluating exposures via the air and groundwater pathways, a hypothetical inadvertent intruder scenario analysis was performed to calculate the total effective dose equivalent for a future member of the public that inadvertently intrudes into the facility. The stylized analysis assumes a well-driller drills a well in search of groundwater but intercepts waste disposed in the IDF. The robustness of the waste forms is assumed to be sufficiently degraded and unrecognizable as non-native material when it is brought to the surface and spread out over the land with the rest of the drill cuttings. Subsequently different exposures to the exhumed waste occur and the resulting doses are compared to the performance measure of 500 mrem for acute exposure and 100 mrem/yr for chronic exposures. For the chronic exposure pathway, three possible exposure routes were considered: (1) a rural pasture exposure route, (2) a suburban gardener exposure route, and (3) a commercial farmer exposure route, consistent with previous Hanford tank farm closure performance assessments.

Since the primary purpose of an inadvertent intruder scenario is to establish limits on concentrations of radionuclides for disposal, the likelihood of inadvertent intruder scenario needs to be considered. This is important because the concentration limits are affected by radionuclide decay and ingrowth. This is especially relevant for strontium-90 and cesium-137.

No inadvertent intrusion would occur during institutional controls 100 years following closure. The likelihood of an inadvertent intrusion at the IDF at the end of the 100-year institutional control period is very small because of access restrictions to the site due to following reasons:

1. Groundwater remediation in the 200 Area would be ongoing and DOE will be retaining control of the Central Plateau portion of the Hanford Site for a period beyond 100 years.

2. Land around the disposal facility is expected to remain under federal control for the next 150 years or longer (DOE/EIS-0222-F; DOE/EIS-0391).

3. The ROD for operable units located in the 200 Area, specifically for the 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units (EPA et al, 2011, *Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*), requires land-use controls to be maintained so long as residual contamination remains at levels that do not allow for unrestricted use.

For establishing concentration limits for waste acceptance and disposal at the facility, the dose following a 100-year intrusion is calculated for all waste streams. In the evaluation, concentration of each radionuclide in the disposed waste that results in an exceedance of the performance measure is determined, and the product of the concentration and disposed volume is used to set an acceptance limit on the quantity of curies of that radionuclide that can be accepted at the facility and still maintain compliance with the performance measures. In this analysis, the concentration limit represents the average concentration in waste packages contained in four lifts that are intersected by a single intrusion. Waste packages with higher concentrations can be accommodated, provided that waste packages with lower concentrations are disposed above or below the higher-concentration waste package resulting in an average concentration that is below the tabulated limit. However, because multiple radionuclides will be disposed in the facility, the facility must account for other radionuclides that are received and will not likely be able to accept waste up to each established limit using this approach. Accounting for other radionuclides in the received waste is done by a sum-of-fractions approach. In the sum-of-fractions approach, the accepted curies of all radionuclides received is divided by the limit of each radionuclide and the fractions are summed. The facility may be able to accept waste that does not result in a sum of fractions exceeding 1.0. The facility is considered full, with respect to curie content, when the sum of fractions is 1.0. Disposal limits can also be set as concentration limits. Expressed as a concentration limit, the limiting concentration for a waste stream can be calculated as the product of the initial concentration (Ci/m^3) in a waste stream and the ratio of the performance measure and the observed dose to the intruder from that radionuclide. Table 7-2 provides the representative concentration limits.

Table 7-2. Representative Radionuclide Concentration Limits Determined from the Inadvertent Intruder Scenario

Radionuclide	100-year Basis (Ci/m^3)
H-3	2.30
Sr-90	2.26
Tc-99	0.906
I-129	0.120
Cs-137	4.57
U-238	4.03

Source: RPP-RPT-59958, *Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington*, Table 1-4.

7.2 Compliance with Other Requirements

This section briefly describes the requirements imposed by the PA, RCRA regulations, and DOE O 458.1.

7.2.1 Requirements from Performance Assessment

The IDF PA imposes no specific constraints on the waste loading or configuration of the closed disposal facility.

7.2.2 RCRA-Based Requirements

The proposed IDF will be permitted for closure. The current permit conditions that are summarized in the IDF PA (RPP-RPT-59958) include the development of a risk-budget tool.

7.2.3 DOE O 458.1 Requirements

Institutional control shall continue until the facility can be released (DOE O 435.1) pursuant to DOE O 458.1.

7.2.4 Long-Term Site Stewardship

After trench loading and backfilling are completed, the top of the trench will receive a modified RCRA Subtitle C barrier to provide appropriate protection from the weather and other types of intrusion. The IDF will be closed as a landfill with waste remaining in place. Post-closure activities will be initiated on completion of closure cap construction. The length of time required for post-closure care will depend on the results of post-closure monitoring. The need and duration of monitoring will be assessed at each permit review and renewal.

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8 Institutional Controls

An engineered barrier cover will be installed in accordance with RCRA regulatory requirements to minimize infiltration of precipitation into the trench and hinder the inadvertent intruder from accessing the waste packages. Once the IDF is closed, operations are reduced to the continuance of monitoring and maintenance of security systems for this facility; the waste is safeguarded and monitored by institutional control. Institutional control shall continue until the facility can be released (DOE O 435.1) pursuant to DOE O 458.1.

During the first 100 years after the closure of the IDF, there is expected to be a period of institutional controls during which time the sumps are maintained and any COPCs released from the waste forms and transported to the base of the IDF would be removed by the operating sumps. The monitoring of the sumps would detect any contaminants released from the waste forms during this time and there would be no release to the vadose zone. In addition, during this time the containers are expected to be largely intact. Even after the institutional control period, it is likely the liner system would not degrade instantaneously as assumed in the IDF PA and COPCs released from the waste forms would be retained in the IDF for some time after the period of institutional controls has ceased.

The modified RCRA Subtitle C barrier has been designed to deter the inadvertent intrusion of humans into the waste. Additionally, to further decrease the possibility of inadvertent intrusion into the waste, a marker system will be used to warn future generations of the dangers of the buried waste. Permanent markers that identify the potential exposure hazards will be installed at all corner boundaries of the closed facility. DOE is expected to maintain active control of the Hanford Site (using fences, patrols, alarms, and monitoring instruments). Site information will be provided on an Internet website, U.S. Geological Survey maps, libraries, and other information repositories that would be readily available to the public. Land-use restrictions and institutional controls will be placed on the closed IDF facility and its adjacent buffer zone to permanently preclude development until unacceptable risk no longer remains at the site.

The closed IDF facility will clearly delineate the boundaries of the surface barrier by providing a distinct contrast with the surrounding terrain. The side slopes are engineered structures that will point to an obvious anthropogenic origin. These distinct side slopes in combination with warning signs are intended to minimize the risk of human intrusion.

The IDF engineered surface cover system also contains a bio-intrusion layer consisting of gravel. The function of this layer is to prevent small burrowing animals and rodents from penetrating the underlying cover components and the waste material. Barrier studies at the Hanford Site have shown that a thin layer of gravel is effective in preventing animals and rodents from penetrating underlying waste materials (WHC-EP-0673, *Permanent Isolation Surface Barrier Development Plan*). The bio-intrusion material will consist of gravel screened from the local available alluvium at the Hanford Site. The alluvium gravels at the Hanford Site are composed of granite, quartz, and other durable minerals that make it ideally suited for long-term applications.

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9 References

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title10-vol2/xml/CFR-2010-title10-vol2-part61.xml.

61.7, "Concepts."

61.51, "Disposal Site design for Land Disposal."

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=15c56aeaa1e8ea2a2fb3914f862177e0&mc=true&node=pt10.4.835&rgn=div5.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol8/xml/CFR-2010-title40-vol8-part61-subpartH.xml.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart Q, "National Emission Standards for Radon Emissions From Department of Energy Facilities," Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol8/xml/CFR-2010-title40-vol8-part61-subpartQ.xml.

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol22/xml/CFR-2010-title40-vol22-part141.xml.

141.66, "Maximum Contaminant Levels for Radionuclides."

40 CFR 143, "National Secondary Drinking Water Regulations," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol22/xml/CFR-2010-title40-vol22-part143.xml.

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol25/xml/CFR-2010-title40-vol25-part264.xml.

264.310, "Closure and Post-Closure Care."

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol25/xml/CFR-2010-title40-vol25-part265.xml.

40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol26/xml/CFR-2010-title40-vol26-part268.xml.

64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)," *Federal Register*, Vol. 64, No. 218, pp. 61615-61625, November 12, 1999. Available at: http://www.gpo.gov/fdsys/pkg/FR-1999-11-12/pdf/99-29325.pdf.

65 FR 37253, “Establishment of the Hanford Reach National Monument,” *Federal Register*, Vol. 65, No. 114, pp. 37253-37257, June 13, 2000. Available at: http://www.gpo.gov/fdsys/pkg/FR-2000-06-13/pdf/00-15111.pdf.

78 FR 240, “Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington,” Federal Register, Vol. 79, No. 240, pp. 75913-75919, December 13, 2013. Available at: http://www.hanford.gov/files.cfm/TCWM_ROD_FR_pub_12_13_13.pdf.

Atomic Energy Act of 1954, Pub. L. 83-703, as amended, 42 USC 2011, et seq., 68 Stat. 919. Available at: https://science.energy.gov/~/media/bes/pdf/nureg_0980_v1_no7_june2005.pdf.

BNI, 2017, *Hanford Vit Plant Low-Activity Waste Vitrification Facility*, U.S. Department of Energy Office of River Protection. Richland, Washington, Available at: https://www.hanfordvitplant.com/sites/default/files/page/3LAW%20Fact%20Sheet.pdf.

CHPRC-03347, 2019, *Performance Assessment Monitoring Plan for the Integrated Disposal Facility*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington.

CHPRC-03348, 2019, *Performance Assessment Maintenance Plan for the Integrated Disposal Facility*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Pub. L. 107-377 as amended, 42 USC 9601 et seq., December 31, 2002. Available at: https://www.csu.edu/cerc/researchreports/documents/CERCLASummary1980.pdf.

DOE, 1992, *Considerations for Closure of Low-Level Radioactive Waste Engineered Disposal Facilities*, DOE/LLW-133, National Low-Level Waste Management Program, Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho.

DOE, 1999, “Conditional Acceptance of the Immobilized Low-Activity Tank Waste Disposal Facility Performance Assessment and the Hanford Site 200 Plateau Composite Analysis,” Memorandum from James J. Fiore and Mark W. Frei to R. T. French and K. A. Klein, U.S. Department of Energy, Washington, D.C., October 20, 1999.

DOE/EIS-0222-F, 1999, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158842.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158843.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158844.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158845.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158846.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158847.

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.

DOE M 435.1-1, Chg 2 (Admin Chg), 2011, *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-chg2-AdmChg.

DOE O 435.1 Chg 1 (PgChg), 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-PgChg/@@images/file.

DOE O 458.1, Chg 3 (Admin Chg), 2013, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives-documents/400-series/0458-1-border-admc3.

DOE/RL-91-50, 2015, *Hanford Site Environmental Monitoring Plan*, Rev. 7, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/DOE-RL-91-50-Rev-7.pdf.

DOE/RL-93-33, 1996, *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197226618.

DOE/RL-96-109, 1999, *The Hanford Site Radiological Control Manual*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2003-04, 2005, *Sampling and Analysis. Plan for the 200-PO-1. Groundwater Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D3818675.

As modified by:

TPA-CN-205, 2008, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: DOE/RL-2003-4, Revision 1, Sampling and Analysis Plan for the 200-PO-1 Operable Unit*, dated June 18, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0905200814.

DOE/RL-2007-31, 2008, *Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit*, Rev. 0, Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA07159571.

DOE/RL-2009-10, 2013, *Hanford Site Cleanup Completion Framework*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/Comp_Framework_Jan_%201-23-13-lfm.pdf.

DOE/RL-2016-09, 2016, *Hanford Site Groundwater Monitoring Report for 2015*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0075314H.

DOE/RL-2016-10, 2016, *Radionuclide Air Emissions Report for the Hanford Site Calendar Year 2015*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0075774H.

DOE/RL-2016-33, 2016, *Hanford Site Environmental Report for Calendar Year 2015*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://msa.hanford.gov/files.cfm/DOE-RL-2016-33_FULL-with-Appdxs.pdf.

DOE/RL-2016-66, 2017, *Hanford Site RCRA Groundwater Monitoring Report for 2016*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0072146H.

DOE-STD-1196-2011, 2011, *Derived Concentration Technical Standard*, U.S. Department of Energy, Washington, DC. Available at: https://www.standards.doe.gov/standards-documents/1100/1196-astd-2011/@@images/file.

DOE-STD-5002-2017, 2017, *Disposal Authorization Statement and Tank Closure Documentation*, U.S. Department of Energy, Washington, D.C. Available at: https://www.standards.doe.gov/standards-documents/5000/5002-astd-2017/@@images/file.

Drummond, M.E., 1992, *The Future for Hanford: Uses and Cleanup: The Final Report of the Hanford Future Site Uses Working Group*, prepared by the Hanford Future Site Uses Working Group for the U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196123428.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

EPA, 1989, *Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments*, EPA 530-SW-89-047, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://nepis.epa.gov/Exe/ZyPDF.cgi/100019HC.PDF?Dockey=100019HC.PDF.

EPA, Ecology, and DOE, 2011, *Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093644.

H-2-830827 (drawing), 2006, *IDF Overall Site Development Plan*, Sheet 1, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

H-2-830835 (drawing), 2006, *IDF Grading and Drainage Sections and Details*, Sheet 1, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

H-2-830838 (drawing), 2006, *IDF Geosynthetics Sections and Details*, Sheet 1, Rev. 1, U.S. Department of Energy, Office of River Protection, Richland, Washington.

H-2-830839 (drawing), 2006, *IDF Geosynthetics Sections and Details*, Sheet 1, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

HNF-2211, 1998, *Design Requirements Document for Project W-520, Immobilized Low-Activity Waste Disposal*, Revision 0, prepared by COGEMA Engineering Corporation for Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-EP-0063, 2017, *Hanford Site Solid Waste Acceptance Criteria*, Rev. 17, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://www.hanford.gov/files.cfm/HNF-EP-0063_Rev_17_Hanford_Site_Solid_Waste_Accpetance_Criteria.pdf.

HNF-SD-WM-MAR-008, 1998, *Tank Waste Remediation System Mission Analysis Report*, Rev. 3. prepared by Lockheed Martin Hanford Corporation for Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-SD-WM-SP-012, 2002, *Tank Farm Contractor Operation and Utilization Plan*, Rev. 4, Office of River Protection, Richland, Washington.

NCRP Report No. 22, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure / NBS Handbook 69 (1959)*, National Council on Radiation Protection and Measurements, Bethesda, Maryland. Available at: https://ncrponline.org/shop/reports/report-no-022-maximum-permissible-body-burdens-and-maximum-permissible-concentrations-of-radionuclides-in-air-and-in-water-for-occupational-exposure-nbs-handbook-69-1959/.

National Environmental Policy Act of 1969, 42 USC 4321, et seq. Available at: https://www.gpo.gov/fdsys/pkg/USCODE-2010-title42/pdf/USCODE-2010-title42-chap55-sec4321.pdf.

PNNL-6415, 2007, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, Rev. 18, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-6415Rev18.pdf.

PNNL-13033, 1999, *Recharge Data Package for the Immobilized Low-Activity Waste 2001 Performance Assessment*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/13033.pdf.

PNNL-14586, 2005, *Geologic Data Package for 2005 Integrated Disposal Facility Waste Performance Assessment*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14586Rev1.pdf.

PNNL-14700, 2004, *Near-Field Hydrology Data Package For the Integrated Disposal Facility 2005 Performance Assessment*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-14700.pdf.

PNNL-14744, 2004, *Recharge Data Package for the 2005 Integrated Disposal Facility Performance Assessment*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14744.pdf.

PNNL-15160, 2005, *Hanford Site, Climatological Summary 2004 with Historical Data*. Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15160.pdf.

PNNL-20631, 2011, *Hanford Site Regional Population – 2010 Census*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20631.pdf.

PNNL-23711, 2015, *Physical, Hydraulic, and Transport Properties of Sediments and Engineered Materials Associated with Hanford Immobilized Low-Activity Waste*, RPT-IGTP-004, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23711.pdf.

RCW 70.105, “Hazardous Waste Management,” *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: https://www.gpo.gov/fdsys/pkg/STATUTE-90/pdf/STATUTE-90-Pg2795.pdf.

RPP-7625, 2015, *Guidelines for Updating Best-Basis Inventory*, Rev. 12, Washington River Protection Solutions, LLC, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0068329H.

RPP-8402, 2002, *Waste Acceptance Criteria for the Immobilized Low Activity Waste (ILAW) Disposal Facility*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: https://www.osti.gov/biblio/807982/.

RPP-17152, 2015, *Hanford Tank Waste Operations Simulator (HTWOS) Version 8.1 Model Design Document*, Rev. 12, Washington River Protection Solutions, LLC/AEM Consulting, LLC, Richland, Washington. Available at: https://www.osti.gov/biblio/816321-hanford-tank-waste-operations-simulator-version-description-document.

RPP-18489, 2014, *Integrated Disposal Facility (IDF), Detailed Design: Specifications*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-19941, 2004, *200 East Area Integrated Disposal Facility (IDF) Detailed Design Drawings*, H-2-830828 (drawing), 2004, IDF Cells 1 and 2- Site and Access Plan, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-20691, 2015, *Facility Data for the Hanford Integrated Disposal Facility Performance Assessment*, Rev. 1, Hanford Group, Inc., Richland, Washington.

RPP-21633, 2004, *Preliminary Closure Plan for the Integrated Disposal Facility*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-60058, 2017, *Low-Activity Waste Melter Replacement and Disposition Logistics Alternatives Analysis*,” Rev. 00, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-CALC-61029, *Two-Dimensional, Two-Phase Flow Model Calculations for the Integrated Disposal Facility Performance Assessment*, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-CALC-61194, 2018, *System Model Calculations for the Integrated Disposal Facility Performance Assessment*, Rev. 2, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-ENV-58562, 2016, *Inventory Data Summary for the Integrated Disposal Facility Performance Assessment*, Rev. 3, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-PLAN-26534, 2005, *Integrated Disposal Facility Operational Monitoring Plan to Meet DOE Order 435.1*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081138H.

RPP-PLAN-60324, 2015, *2017 Integrated Disposal Facility (IDF) Performance Assessment Project Execution Plan*, Rev. 0, AREVA Federal Services, LLC, Richland, Washington.

RPP-RPT-59958, 2019, *Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington*, Rev. 1A, Washington River Protection Solutions, LLC, Richland, Washington.

Safe Drinking Water Act of 1974, 42 USC 300f et seq., Pub. L. 93-523 as amended, December 16, 1974. Available at: https://www.gpo.gov/fdsys/pkg/STATUTE-88/pdf/STATUTE-88-Pg1660-2.pdf.

SGW-58828, 2015, *Water Table Maps for the Hanford Site 200 East Area, 2013 and 2014*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0079727H.

SRNL-STI-2016-00175, 2016, *Solid Secondary Waste Data Package Supporting Hanford Integrated Disposal Facility Performance Assessment*, Rev. 0, Savannah River National Laboratory, Aiken, South Carolina. Available at: http://sti.srs.gov/fulltext/SRNL-STI-2016-00175.pdf.

TFC-ENG-STD-06, *Design Loads for Tank Farm Facilities*, as amended, Washington River Protection Solutions, Richland, Washington. Available at: https://www.hanford.gov/tocpmm/files.cfm/TFC-ENG-STD-06.pdf.

WDOT, 2002, *Standard Specifications for Road, Bridge and Municipal Construction, 2002 Edition*, M 41-10, Washington State Department of Transportation, Olympia, Washington. Available at: http://www.wsdot.wa.gov/publications/manuals/fulltext/M41-10/SS2002.pdf.

WA7890008967, 2007, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion Revision 8C for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended, Washington State Department of Ecology, Richland, Washington. Available at: https://fortress.wa.gov/ecy/nwp/permitting/HDWP/Rev/8c/IDF/IDF.html.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303.

173-303-610, "Closure and Post-Closure."

173-303-665, "Landfills."

173-303-801, "Types of Dangerous Waste Management Facility Permits."

173-303-806, "Final Facility Permits."

WAC 246-247, "Radiation Protection—Air Emissions," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=246-247.

WHC-EP-0673, 1994, *Permanent Isolation Surface Barrier Development Plan*, Westinghouse Hanford Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=E0035087.

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ADMINISTRATIVE DOCUMENT PROCESSING AND APPROVAL

DOCUMENT TITLE: Assessment lma/wab 10/22/2019 Performance ~~Acceptance~~ Closure Plan for the Integrated Disposal Facility	**OWNING ORGANIZATION/FACILITY:** RRMP / IDF
Document Number: CHPRC-03407	**Revision/Change Number:** 1

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

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

RESPONSIBLE CONTACTS

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DOCUMENT CONTROL

Is the document intended to be controlled within the Document Management Control System (DMCS)?	[X] Yes ~~[x] No~~ lma/wab 10/10/2019
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NOTE: Provide a brief description or summary of the changes for the document listed.

Issue Rev. 1 to incorporate minor reference updates and corrections.

REVIEWERS

Others

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G. Pyles	DOE/RL
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K. P. Lee	WRPS

APPROVAL SIGNATURES

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Responsible Manager:

Print Name	Signature	Date
C. H. Larson	Craig Larson	10/8/2019

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J. Comments

Information Clearance Approval

APPROVED
By Lynn M. Ayers at 7:46 am, Nov 04, 2019

Approved for Public Release;
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If Additional Comments, Please Attach Separate Sheet

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        Lynn Ayers Information Clearance</comments>
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