CHPRC-03348
Revision 1

Performance Assessment Maintenance 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

P.O. Box 1600
Richland, Washington 99352

CHPRC-03348
Revision 1

Performance Assessment Maintenance Plan for the Integrated Disposal Facility

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

J. L. Westcott
CH2M HILL Plateau Remediation Company

W. A. Borlaug
CH2M HILL Plateau Remediation Company

B. Sun
INTERA, Inc.

M. Rahman
INTERA, Inc.

R. Andrews
INTERA, Inc.

R. Arthur
INTERA, Inc.

R. Senger
INTERA, Inc.

Date Published
October 2019

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
P.O. Box 1600
Richland, Washington 99352

APPROVED
By Julia Raymer at 10:30 am, Oct 24, 2019

Release Approval Date

Executive Summary

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

This maintenance plan summarizes the major activities DOE plans to conduct to maintain the IDF PA, namely monitoring, research and development (R&D), planned reviews and analyses, and revisions of the PA.

The planned monitoring activities include both air and groundwater monitoring prior to and during operations. It is recommended that air and groundwater monitoring be excluded from the IDF post-closure performance monitoring requirements because of the following:

- The long time before any contamination resulting from the disposal of wastes in the IDF is expected to reach the compliance boundary of the IDF via the groundwater pathway
- The low concentrations of constituents of potential concern expected via the air pathway
- The existing and projected groundwater contamination resulting from other contaminant sources upgradient of the IDF

[1] 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.

[2] RPP-RPT-59958, 2019, *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.

However, if groundwater and air monitoring are deemed necessary, the existing site-wide operational air and groundwater monitoring programs are considered adequate to meet the IDF PA monitoring needs.

The planned R&D activities relate to evaluating the key assumptions, including evaluating conceptual model assumptions and parameter value assumptions used in the IDF PA (RPP-RPT-59958). The planned R&D activities include those that are designed to track the ongoing evolution of the waste form design and fabrication studies, as well as continued characterization and related modeling of the natural environment in the Central Plateau of the Hanford Site. In addition, the planned R&D activities include focused testing and evaluation of engineered and natural materials to reduce the uncertainty in the conceptual models and parameter values used in the IDF PA.

The planned reviews and analysis include reviews by DOE's Low-Level Waste Federal Review Group, Washington State Department of Ecology, the U.S. Nuclear Regulatory Commission, and additional analyses, including the Hanford Site Composite Analysis expected to be completed in 2019.

The planned revisions of the PA include any necessary supplemental analyses performed as part of the Unreviewed Disposal Question Evaluation process.

Contents

Figures

Tables

Appendix

Terms

AEA	*Atomic Energy Act of 1954*
BBI	Best-Basis Inventory
CA	composite analysis
CDN	composite drainage net
COPC	constituent of potential concern
DAS	Disposal Authorization Statement
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ETF	Effluent Treatment Facility
FY	fiscal year
GAC	granular activated carbon
GCL	geosynthetic clay liner
HDPE	high-density polyethylene
HEPA	high-efficiency particulate air
HTWOS	Hanford Tank Waste Operations Simulator
IDF	Integrated Disposal Facility
ILAW	immobilized low-activity waste
K_d	distribution coefficient
LAW	low-activity waste
LCRS	leachate collection and recovery system
LFRG	Low-Level Waste Disposal Facility Federal Review Group
LDS	leak detection system
LLW	low-level waste
LSW	liquid secondary waste
MLLW	mixed low-level waste
NEPA	*National Environmental Policy Act of 1969*
ODAS	Operational Disposal Authorization Statement
PA	performance assessment
PCT	product consistency test

PUREX	Plutonium Uranium Extraction
R&D	research and development
RCRA	*Resource Conservation and Recovery Act of 1976*
ROD	record of decision
SLDS	secondary leak detection system
SPFT	single pass flow-through
SST	single-shell tank
SSW	secondary solid waste
TC&WM	Tank Closure and Waste Management
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TST	transition state theory
TWINS	Tank Waste Inventory Network System
UDQE	unreviewed disposal question evaluation
UWMQ	Unreviewed Waste Management Question
VHT	vapor hydration test
WTP	Hanford Tank Waste Treatment and Immobilization Plant

1 Introduction

As required by the U.S. Department of Energy (DOE) in DOE O 435.1, *Radioactive Waste Management*, and implemented by DOE M 435.1-1, *Radioactive Waste Management Manual,* DOE Richland Operations Office and DOE Office of River Protection have been conducting performance assessment (PA) maintenance activities for the approved Integrated Disposal Facility (IDF)-relevant PAs: DOE/RL-97-69, *Hanford Immobilized Low-Activity Tank Waste Performance Assessment,* and DOE/ORP-2000-24, *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version*.

These immobilized low-activity waste (ILAW) PAs permitted construction of the IDF and evaluated the performance of the facility, assuming disposal of a vitrified (i.e., glass) waste material. Both analyses determined that adequate performance could be achieved with the planned waste form and, after acceptance by DOE, a Disposal Authorization Statement (DAS) was issued (Scott, 2001, "Disposal Authorization for the Hanford Site Low-Level Radioactive Waste Disposal Facilities – Revision 2").

Since the issuance of the ILAW DAS (Scott, 2001), the maintenance of the ILAW PA has been performed under the requirements specified in DOE/ORP-2000-01, *Maintenance Plan for the Hanford Immobilized Low-Activity Tank Waste Performance Assessment,* Rev. 0 and Rev. 1. The results of these maintenance activities have been summarized in annual summary reports identified in Table 1-1.

Table 1-1. Annual Summary Reports for the ILAW and IDF PA

Report Identification	Annual Summary Report Title
DOE/ORP-2000-19, Rev. 0	*Annual Summary of ILAW Performance Assessment*
DOE/ORP-2000-19, Rev. 2	*Annual Summary of ILAW Performance Assessment for 2002*
DOE/ORP-2000-19, Rev. 3	*Annual Summary of the Immobilized Low-Activity Waste Performance Assessment for 2003, Incorporating the Integrated Disposal Facility Concept*
DOE/ORP-2000-19, Rev. 4	*Annual Summary of the Integrated Disposal Facility Performance Assessment for 2004*
DOE/ORP-2000-19, Rev. 5	*Annual Summary of the Integrated Disposal Facility Performance Assessment for 2006*
DOE/ORP-2000-19, Rev. 6	*Annual Summary of the Integrated Disposal Facility Performance Assessment for 2007*
DOE/RL-2009-47	*Annual Summary of the Integrated Disposal Facility Performance Assessment for 2008*
DOE/RL-2009-131	*Annual Summary of the Integrated Disposal Facility Performance Assessment 2009*
DOE/RL-2010-121	*Annual Summary of the Integrated Disposal Facility Performance Assessment for 2010*
DOE/RL-2011-109	*Annual Summary of the Integrated Disposal Facility Performance Assessment for 2011*
DOE/RL-2012-57	*Annual Summary of the Integrated Disposal Facility Performance Assessment for 2012*
DOE/ORP-2019-01	*FY18 Annual Summary Report for the Integrated Disposal Facility Performance Assessment*

IDF = Integrated Disposal Facility
ILAW = immobilized low-activity waste
PA = performance assessment

The annual summaries through fiscal year (FY) 2007 and for 2018 were approved by the DOE Office of River Protection Field Manager (e.g., 05-TPD-016, "The U.S. Department of Energy (DOE), Office of River Protection (ORP) Submittal of the Annual Summary of the Integrated Disposal Facility (IDF) Performance Assessment for 2004 and Supporting Documents"). The annual summaries for FY 2008 through 2012 were approved by the DOE Richland Operations Office Field Manager (e.g., 10-AMCP-0071, "Contract No. DE-AC06-08RL14788 – Annual Reporting for the Hanford Site Composite Analysis, the Integrated Disposal Facility Performance Assessment, and the 200 West And 200 East Performance Assessments for 2009").

Annual summary reports were suspended from 2013 through 2017 due to the completion of 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 2012. The associated Record of Decision (ROD) for the TC&WM EIS (78 FR 240, "Record of Decision for the Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington") was issued December 2013. Most of the data collected since FY 2012 pertained to groundwater monitoring or to research on the characteristics of the waste forms planned for disposal in the IDF. This included studies of glass dissolution rates, evaluation of supplemental treatment technologies, and testing of secondary liquid waste treatment options, including cast stone.

The results of the maintenance and monitoring activities and related research and development activities have been documented in different data reports that have been summarized in the data packages used in support RPP-RPT-59958, *Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington*, hereinafter called the IDF PA, notably the following:

- RPP-20691, *Facility Data for the Hanford Integrated Disposal Facility Performance Assessment*
- PNNL-20781, *Integrated Disposal Facility FY 2011 Glass Testing Summary Report*
- PNNL-21812, *Integrated Disposal Facility FY 2012 Glass Testing Summary Report*
- PNNL-22747/SRNL-STI-2013-00465, *Supplemental Immobilization of Hanford Low-Activity Waste: Cast Stone Screening Tests*
- RPP-ENV-58562, *Inventory Data Summary for the Integrated Disposal Facility Performance Assessment*
- PNNL-24615, *Immobilized Low-Activity Waste Glass Release Data Package for the Integrated Disposal Facility Performance Assessment*
- PNNL-25194, *Secondary Waste Cementitious Waste Form Data Package for the Integrated Disposal Facility Performance Assessment*
- PNNL-24297, *Extended Leach Testing of Simulated LAW Cast Stone Monoliths*
- RPP-RPT-55960, *Supplemental Immobilization of Hanford Low-Activity Waste: Cast Stone Screening Tests*
- SRNL-STI-2015-00685, *Liquid Secondary Waste: Waste Form Formulation and Qualification*
- PNNL-23711, *Physical, Hydraulic, and Transport Properties of Sediments and Engineered Materials Associated with Hanford Immobilized Low-Activity Waste*

In addition to the above data packages that were used as the principal basis for the IDF PA conceptual models and parameter values, other studies have been conducted to support the design evolution of the waste forms planned for disposal in the IDF. These studies also identify potential future testing that could be performed to support the waste form material characterization in support of the design optimization. Reports summarizing the results and conclusion of these studies include the following:

- PNNL-25577, *Getter Incorporation into Cast Stone and Solid-State Characterizations*
- PNNL-25129, *Liquid Secondary Waste Grout Formulation and Waste Form Qualification*
- SRNL-STI-2015-00685, *Liquid Secondary Waste: Waste Form Formulation and Qualification*
- PNNL-23503, *A Strategy for Maintenance of the Long-Term Performance Assessment of Immobilized Low-Activity Waste Glass*

1.1 Facility Description

The IDF is an expandable lined landfill designated for permanent disposal of low-level waste (LLW) and mixed low-level waste (MLLW). 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. The current dangerous waste permit for the IDF (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste,* Part III, Operating Unit 11, hereinafter called the Hanford 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 Waste Treatment Plant, the Demonstration Bulk Vitrification System, and IDF operational waste. Future expansion of the *Resource Conservation and Recovery Act of 1976* (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, Part III, Operating Unit 11, Condition II.11.B.3).

The IDF consists of an expandable lined landfill (Figure 1-1) that is currently divided lengthwise (north-south orientation) into two distinct cells. Although the landfill was designed to accommodate six cells, based on the planned waste inventory volumes and waste container loading efficiencies evaluated in the IDF PA (RPP-RPT-59958), only four cells were used in the PA analyses. The designed final facility waste footprint may have a north-south length of 501 m (1,645 ft) and an east-west width of 422 m (1,385 ft) (drawing H-2-830827, *IDF Overall Site Development Plan*). 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. 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 (GCL) and composite drainage net (CDN) representing the leak detection system (LDS). The CDN drainage layer and geomembrane liner extend under the entire base and side slopes area of the IDF, whereas the drain gravel and GCL 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 material. Details of the IDF RCRA-compliant liner system are described in the PA (RPP-RPT-59958).

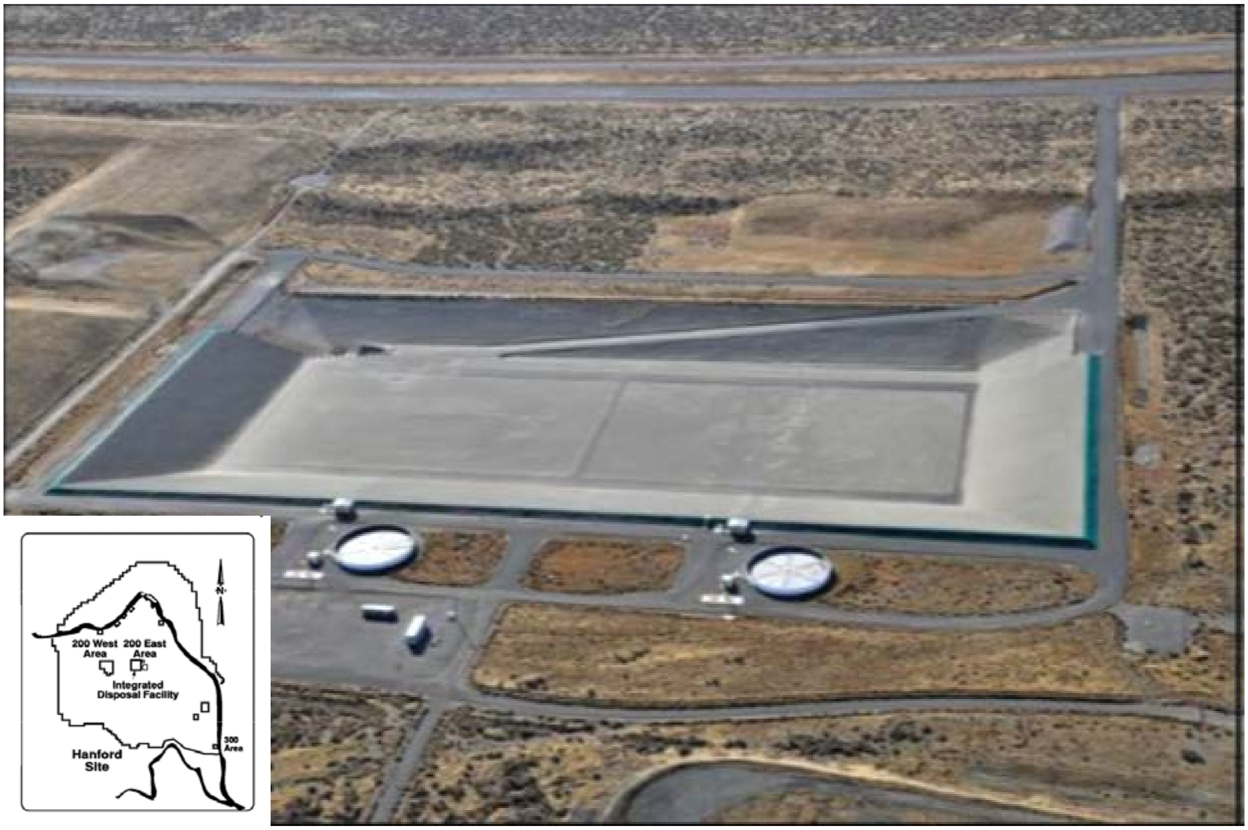
The landfill cells contain sumps for the leachate collection and recovery system (LCRS) and LDS. The LCRS is a system of liners, drainage layers, and collection piping that collects any liquids captured on the primary liner and routes these liquids to a sump location at the northern edge of Cell 1 and 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 CHPRC-03347, *Performance Assessment Monitoring Plan for the Integrated Disposal Facility*.

The safety concept for the IDF disposal 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, so that the loss of one or some of the safety functions continues to result in adequate performance of the overall system. A schematic depiction of these safety functions for the IDF is provided in Figure 1-2. The key engineered design features of the system that influence contaminant migration include the following:

- A closure surface barrier
- Placement of waste containers to limit infiltration and provide structural support
- Engineered backfill between and above waste containers
- ILAW and cementitious waste forms to limit radionuclide release
- Liner and LDS to limit water from entering the natural system beneath the facility

The natural components of the system that influence contaminant migration include the hydrological and geochemical features and processes in the vadose zone and unconfined aquifer that act to decrease contaminant mobility and reduce contaminant concentrations in the unconfined aquifer downgradient of the facility.



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 1-1. Integrated Disposal Facility Location Current Configuration on the Hanford Site

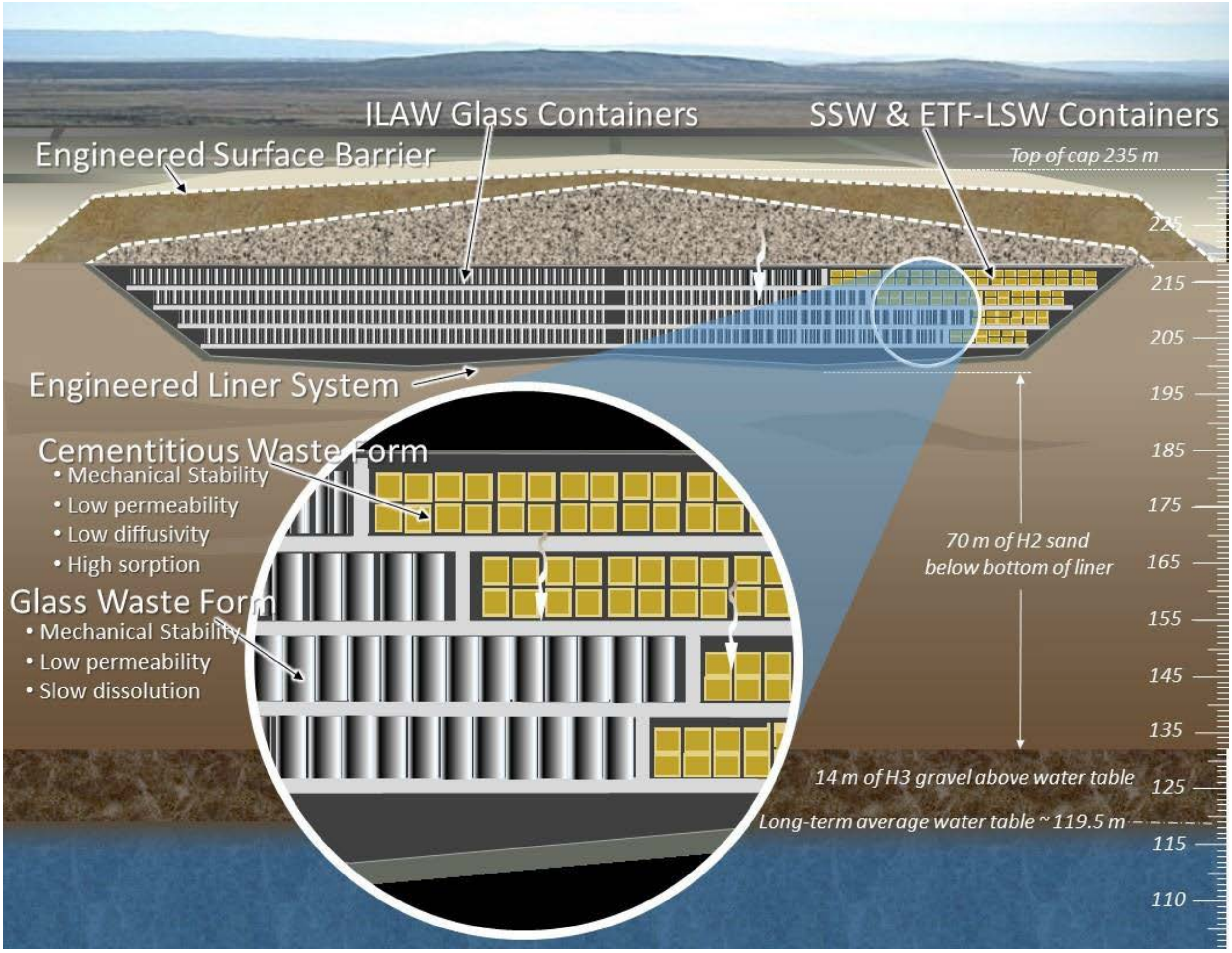


Figure 1-2. Schematic Depiction of the Safety Functions for the Integrated Disposal Facility

1.2 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, DOE, Washington State Department of Ecology (Ecology), and Environmental Protection Agency (EPA). The primary laws and regulations which govern closure processes include the following:

- *National Environmental Policy Act of 1969* (NEPA)
- *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement; Ecology et al., 1989a)
- *RCRA/Hazardous Waste Management Act* (RCW 70.105, "Hazardous Waste Management")
- *Atomic Energy Act of 1954* (AEA)

In concert, these laws and regulations provide the overarching guidelines for the 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/*Hazardous Waste Management Act* as implemented through WAC 173-303, "Dangerous Waste Regulations," regulating the nonradioactive dangerous portion of mixed waste. It should be noted that the various laws and regulations for closure create redundant and possibly conflicting administrative requirements. The Tri-Party Agreement, in part, was established to address these issues and to ensure the actions taken for IDF closure are protective of human health for all contaminants of concern, both radiological and nonradiological.

1.2.1 *National Environmental Policy Act of 1969*

The IDF was analyzed in detail during the NEPA process that resulted in the TC&WM EIS (DOE/EIS-0391). 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 SST closure waste that is not highly contaminated, such as rubble, soils, and ancillary equipment, in the proposed River Protection Project Disposal Facility (RPPDF) is also included under this alternative. After completion of disposal activities, IDF-East and the proposed RPPDF 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 ROD in December 2013 (78 FR 240). 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 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.

1.2.2 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.

The *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b, hereinafter called the Tri-Party Agreement Action Plan;) ensures the actions taken for IDF closure will be protective of human health for all contaminants of concern, both radiological and nonradiological. The part of the PA documentation being developed to meet the analysis requirements in DOE O 435.1 will also undergo extensive internal DOE review and be reviewed by the U.S. Nuclear Regulatory Commission under a consultation agreement.

1.2.3 *Resource Conservation and Recovery Act of 1976/Hazardous Waste Management Act*

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 (78 FR 240) for the TC&M EIS is that the IDF will be landfill closed under Washington Administrative Code regulations. Following the ROD, and in accordance with WAC 173-303-610, “Closure and Post-Closure,” 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.”

1.2.4 *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 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 Sitewide RCRA Permit (WA7890008967), it is not incorporated for the purpose of regulating the radiation hazards of such components under the authority of RCW 70.105.

1.2.5 Maintenance Plan Review Criteria

Appendix A provides a crosswalk to document compliance with the PA/composite analysis (CA) maintenance plan guidance in DOE-STD-5002-2017, *Disposal Authorization Statement and Tank Closure Documentation*, Table 7-3.

2 Key Assumptions

The key assumptions that have a potential to affect the IDF PA were summarized in Tables 2-12 and 2-13 of the IDF PA document (RPP-RPT-59958). These key assumptions were presented as two groups; the first group related to facility design or operations assumptions, and the second group related to conceptual model or parameter value assumptions used in the PA. The first group of assumptions, related to facility design and operations, are generally amenable to evaluation by PA maintenance activities while the second group of assumptions, related to conceptual model and parameter values, are generally amenable to evaluation by PA maintenance and monitoring activities. This was noted in RPP-RPT-59958, Section 8.0, where the significance of the key assumptions to the PA results and conclusions was identified and the potential maintenance and monitoring activities to address the key assumptions were mapped to the key assumptions. This mapping is reproduced here in Table 2-1 and Table 2-2.

In addition to the key assumptions potentially affecting the IDF PA, there are additional assumptions related to the conceptual models as well as the data and parameter values developed in support of the PA. These additional conceptual model assumptions and related uncertainties were presented in RPP-RPT-59958, Table 4-2, and are reproduced herein.

2.1 Sensitivity and Uncertainty Analyses Used to Prioritize Significance of Key Assumptions

As summarized in Tables 2-1 to 2-3, there are many assumptions that have the potential to affect the predicted post-closure performance of the IDF. The impact of these assumptions, and the related uncertainties in conceptual models and parameters, on the predicted performance were evaluated using sensitivity and uncertainty analyses summarized in the IDF PA document (RPP-RPT-59958). Sensitivity analysis results using the detailed deterministic process models are summarized in the IDF PA, Section 5.0 and the sensitivity analysis results using the integrated system model are summarized in Section 6.2. Uncertainty analysis results developed using the probabilistic integrated system model are summarized in Section 6.3.

The key conceptual model and parameter assumptions and related uncertainties evaluated in these sensitivity and uncertainty analyses include the following:

- Near-field environment sensitivity analyses (RPP-RPT-59958, Section 5.1.1)
  - Long-term average net infiltration rate
  - Hydraulic properties of surface barrier
  - Hydraulic properties of liner system
  - Hydraulic properties of backfill
  - Saturation of backfill
- Cementitious release sensitivity analyses (RPP-RPT-59958, Section 5.1.3)
  - Long-term average net infiltration rate
  - Diffusive properties of cementitious waste forms
  - Retardation properties of cementitious waste forms
  - Geometry of cementitious waste forms
  - Initial saturation of cementitious waste forms
  - Diffusive properties of backfill

- ILAW glass release sensitivity analyses (RPP-RPT-59958, Section 5.1.2)
  - Long-term average net infiltration rate
  - Hydraulic properties of ILAW glass
  - Diffusive properties of ILAW glass
  - Differences in ILAW glass composition
  - Na+-H+ exchange rate constant effect on ILAW glass corrosion
  - Kinetic parameters of ILAW glass dissolution
  - Secondary mineral reaction networks that affect ILAW glass corrosion
  - Reactive surface area of ILAW glass
  - Hydraulic properties of backfill
  - Chemistry of pore fluids in backfill
- Vadose and saturated zone sensitivity analyses (RPP-RPT-59958, Section 5.2)
  - Long-term average net infiltration rate
  - Focusing of recharge through liner system to vadose zone
  - Conceptual model of anisotropy in vadose zone
  - Hydraulic properties (including vanGenuchten-Mualem properties) of vadose zone
  - Effect of clastic dike in vadose zone
  - Constituent of potential concern (COPC) sorption in vadose zone
  - Dispersive properties in vadose zone
  - Location and distribution of COPC releases to vadose zone/saturated zone
  - Hydraulic properties in saturated zone
  - Dispersive properties in saturated zone
- Integrated system model sensitivity and uncertainty analyses (RPP-RPT-59958, Sections 6.2 and 6.3):
  - COPC inventory and inventory allocation among waste streams
  - Wind speed for air pathway release
  - Distance to receptor for air pathway release
  - Net infiltration through surface barrier
  - Long-term average net infiltration rate
  - Na^+-H^+ exchange rate constant effect on ILAW glass corrosion
  - Kinetic parameters of ILAW glass-matrix dissolution
  - Model for ILAW glass corrosion
  - Alternative ILAW glass formulations
  - Diffusive properties of cementitious waste forms
  - Sorptive properties of cementitious waste forms
  - Weathering/aging of cementitious waste forms
  - Diffusive properties of backfill
  - Moisture content in vadose zone
  - COPC sorption in vadose zone
  - Groundwater flow rate in saturated zone

2.2 Identification of Key Assumptions to Evaluate in Maintenance Program

The IDF PA used the sensitivity and uncertainty analyses to identify the key assumptions that were most significant to meeting the performance objective. The significant assumptions are presented in RPP-RPT-59958, Table 8-6, and 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 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

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. These conclusions and the associated assumptions that warrant being the focus of IDF PA maintenance activities are as follows:

- 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: (1) no releases would occur during the operational and institutional control period because it was assumed the waste containers are airtight, and (2) 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 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 $<1.0\times10^{-4}$ 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. PA maintenance activities, primarily research and development activities summarized in Chapter 4, have been identified that address these assumptions.

- 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 a bounding 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. PA maintenance activities, primarily research and development (R&D) activities summarized in Chapter 4, have been identified that address the inventory loading assumptions.

- For the post-1,000-year period, the expected performance results in predicted COPC concentrations that have a sum of fractions that exceeds the 4 mrem/yr drinking water standard based on the U.S. EPA *Safe Drinking Water Act* maximum contaminant levels (900 pCi/L for technetium-99 and 1.0 pCi/L for iodine-129). 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 the northwest quadrant of the IDF footprint rather than concentrating them in the most pessimistic location as assumed in the base case analyzed in the IDF PA (RPP-RPT-59958). PA maintenance activities have been identified that address these assumptions.

2.3 Mapping Key Assumptions to Maintenance Activities

In general, IDF maintenance activities can be subdivided into two main categories, those maintenance activities that are evaluated using monitoring activities as identified in the IDF PA monitoring program summarized in Chapter 3 of this document and those maintenance activities that are evaluated using R&D activities that are summarized in Chapter 4 of this document. The R&D activities fall into two groups: those activities related to the review and evaluation of the evolution of scientific studies and waste form designs, and 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.

As noted in the IDF PA monitoring plan (CHPRC-03347), performance-based monitoring relates to monitoring of environmental constituents that may be present in the leachate, vadose zone, groundwater, or air near the IDF. Because of the preponderance of other sources of air and groundwater contamination near the IDF, it is very unlikely that any monitoring would detect the presence of contamination that may emanate from releases from the IDF. Therefore, traditional performance monitoring is of limited use at the IDF. Other monitoring-like activities, such as monitoring waste form characteristics or waste form loading, are addressed under the R&D activities discussed in Chapter 4 of this report.

Table 2-1. Key Design and Operations Assumptions Approaches

Design Feature	Design Assumption	Operations Assumption	Impact of Assumption	Potential PA Maintenance Approach
Period of operational and institutional control	Disposal operations are assumed to commence in 2021 and be completed in 2051. There is assumed to be a 100-year period of institutional control during which time the performance of the liner may be evaluated.	During the institutional control period, the performance of the RCRA Subtitle C barrier cap will be maintained.	The period of operational and institutional control does not directly affect the PA other than defining the time when receptor may be assumed to be present.	Review Hanford Site operations and control documents that are expected to specify the operations and institutional control period.
Modified RCRA Subtitle C barrier	Design specified in preliminary closure plan and analogous to ERDF cap.	Specified nominal values of hydraulic properties can be achieved during operations.	Hydraulic properties and geometry allow ET and capillary processes to limit infiltration to about 0.5 mm/yr for the first 500 years and about 3.5 mm/yr afterwards	Modified RCRA Subtitle C barriers are expected to be used for other Hanford Site closure operations, including ERDF, prior to IDF closure. Review as-constructed information from these other closed facilities.
High density backfill	Backfill is used between waste lifts and above last lift to comply with design requirement for the operation of operational equipment and to provide redistribution of load of individual waste container.	Emplacement of backfill meets performance specifications for even compaction at optimum moisture content allowing free drainage of water and maintaining layer stability. Backfill is comprised of natural materials.	Hydraulic properties allow drainage of water which infiltrates the RCRA surface barrier. Chemical properties do not impact the fate and transport of COPCs.	Develop and implement methods to test backfill during operations period.
Low density backfill	Backfill is used between adjacent waste containers to avoid soil arching that may create voids between adjacent containers	Backfill fully fills the void space between adjacent containers and allows for free drainage of water between waste containers.	Water freely drains between the waste containers and does not focus flow.	Develop and implement methods to test backfill during operations period.

Table 2-1. Key Design and Operations Assumptions Approaches

Design Feature	Design Assumption	Operations Assumption	Impact of Assumption	Potential PA Maintenance Approach
Waste loading	Like waste forms are collocated; i.e., ILAW glass waste containers are collocated with other ILAW glass containers, ETF-generated LSW waste containers are collocated with other ETF-generated LSW waste containers and all other wastes are collocated. The container volumes occupy about 40% of the total volume.	Current waste container volume can be placed in Phases 1 and 2 of facility. SSW waste containers are assumed to be placed in southeast corner of Phase 1 and northeast corner of Phase 2. ETF-generated LSW waste containers are assumed to be placed in northern portion of Phase 1 or northeast corner of Phase 1 and southeast corner of Phase 2. ILAW glass containers occupy the largest volume of the IDF and thus the largest footprint.	The waste containers can be spaced closer or further apart. Generally closer spacing yields a higher release rate per unit area of the IDF and a corresponding higher COPC concentration in the saturated zone. Locating the SSW waste in the eastern portion of the IDF footprint tends to maximize COPC concentration in the saturated zone.	Develop loading plan in concert with facility operator using the IDF PA results on the impact of alternative loading strategies.
Waste receipt	ILAW and ETF-generated waste containers are expected to be received weekly at the IDF. SSW containers are expected to be received on an as-needed basis.	Waste is loaded annually starting with the bottom lift in Cells 1 and 2 and continuing with subsequent lifts in until there is a demonstrated need to expand Cells 1 and 2.	The timing of waste receipt does not impact the PA.	None.
Container	Containers for ILAW glass are stainless steel and containers for all other wastes are mild carbon steel. SSW and ETF-generated LSW containers may be either boxes or drums.	Containers are handled during curing, cooling, transportation, storage, and disposal in such a way as to not induce degradation or cracking of the waste form other than the cooling cracks that are expected for vitrified waste.	No performance credit is taken for waste containers even though the time to corrode stainless steel under IDF relevant conditions may be hundreds to thousands of years. ILAW glass corrosion could be affected by sorption of silica on container corrosion products, and/or by changes in secondary mineralogy affected by steel corrosion (e.g., precipitation of Fe(III)-bearing clay minerals).	Evaluate ongoing studies of glass-steel corrosion interactions.

Table 2-1. Key Design and Operations Assumptions Approaches

Design Feature	Design Assumption	Operations Assumption	Impact of Assumption	Potential PA Maintenance Approach
Glass waste form	Glass formulations are based on LAWA44, LAWB45, or LAWC22 designs.	Glass can be formulated and poured resulting in matrix properties consistent with the laboratory-tested specimens.	Laboratory-derived properties are applicable to as formulated and as cured conditions.	Monitor glass properties during operations. Develop surrogates to glass corrosion properties that can be readily tested during operations. Test alternative glass formulations developed as WTP glass envelopes mature.
ETF LSW cementitious waste form	ETF-generated LSW grout may be either fly ash or hydrated lime based.	ETF LSW grouts are formulated, poured and cured in a manner analogous to the processes used to derive samples for laboratory testing.	Laboratory-derived properties are applicable to as formulated and as cured conditions.	Test alternative ETF-LSW formulations as ETF design matures. Monitor ETF-LSW properties during operations. Develop surrogates to ETF-LSW diffusion and sorption properties that can be readily tested during operations.
SSW cementitious waste form	Cementitious grouts are used for debris and nondebris SSW as well as FFTF waste, onsite non-CERCLA nontank waste and other solid waste.	SSW cementitious grouts are either paste-like for encapsulated debris waste or mortar-like for nondebris waste. GAC, Ag mordenite, and IX nondebris wastes are assumed to be mixed with grout creating mortar-like properties.	Laboratory-derived properties are applicable to as formulated and as cured conditions.	Test alternative SSW grout mortar and paste formulations to be used with debris and nondebris waste. Monitor SSW grout properties during operations. Develop surrogates to SSW diffusion and sorption properties that can be readily tested during operations.

Table 2-1. Key Design and Operations Assumptions Approaches

Design Feature	Design Assumption	Operations Assumption	Impact of Assumption	Potential PA Maintenance Approach
Facility liner	Facility liner for expansion of the IDF footprint uses the same design employed for Phase 1 consisting of a drain gravel layer above a geomembrane and low permeable GCL above an admix layer.	Operations do not impact the as-emplaced properties of the liner materials. As-emplaced properties of liner materials, especially the GCL and admix layer are equivalent to the as-designed properties.	During operations and the assumed period of institutional controls, the geomembrane layer of the liner collects all precipitation that infiltrates through the operational layers and backfill. Once the geomembrane/GCL layer degrade, the drainage layer, acting as a capillary barrier, may cause infiltrating water to flow laterally and collect in the low points of the liner resulting in focused recharge to the vadose zone.	During construction of southern extension of IDF (i.e., Phase 2), evaluate moisture content beneath liner emplaced in Phase 1.
Sumps	Sumps are designed to withdraw all infiltrating water that may collect during operational and institutional control periods (LCRS and LDS) and potential leakage through the liner (SLDS).	Sumps remove all water that infiltrates through backfill during operations.	No releases to vadose zone occur	Continue to monitor sump performance as required in permit condition.

Source: RPP-RPT-59958, *Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington*, Table 8-7.

COPC = constituent of potential concern
ERDF = Environmental Restoration Disposal Facility
ET = evapotranspiration
ETF = Effluent Treatment Facility
FFTF = Fast Flux Test Facility
GAC = granular activated carbon
GCL = geosynthetic clay liner
IDF = Integrated Disposal Facility
ILAW = immobilized low-activity waste
IX = ion exchange
LCRS = leachate collection and recovery system
LDS = leak detection system
LSW = liquid secondary waste
PA = performance assessment
RCRA = *Resource Conservation and Recovery Act of 1976*
SLDS = secondary leak detection system
SSW = secondary solid waste

Table 2-2. Key Conceptual Model and Parameter Assumptions

Natural System Feature	Conceptual Model Assumption	Parameter Assumption	Impact of Assumption	Potential Monitoring Approach
Climate/ meteorology	Semi-arid conditions	Precipitation, wind, ET conditions are based on IDF-specific or analogous conditions.	Observed present-day conditions are applicable for the next 1,000 years and longer.	Continue Hanford sitewide monitoring of atmospheric conditions.
Natural net infiltration	Long-term average net infiltration through natural and engineered soils above and around IDF are equivalent to present-day conditions.	Steady state ambient and long-term infiltration rate is conservatively assumed to be 3.5 mm/yr.	Net infiltration rate directly controls the time for contaminants released from the IDF to be transported to the water table.	Continue monitoring of chloride mass balance and other methods to determine in situ ambient net infiltration in Rupert sand with native vegetation. Continue monitoring effect of nonnative vegetation on net infiltration.
Hydrostratigraphy	The hydrostratigraphic units have different flow and transport properties, which can affect the flow of water and transport of COPCs.	The vadose and saturated zone hydrostratigraphy is based on observations from boreholes drilled to the water table around the IDF boundary. These observations have allowed for the development of a hydrostratigraphic framework model of both the vadose zone near the IDF and the saturated zone beneath and downgradient of the IDF.	The vertical and lateral distribution of hydrostratigraphic units at the IDF affect the flow of water and COPCs released from the IDF waste forms.	Monitor detailed hydrostratigraphy in any boreholes drilled near IDF.
Vadose zone – Hanford formation sand (H2)	Hanford sand may be represented as homogeneous and anisotropic unit.	Observed laboratory test information and in situ observations at Sisson and Lu site are analogous to those under the IDF. Laboratory-scale hydraulic and transport properties are representative of the scale of the model.	The natural net infiltration rate near the IDF is inferred from analog locations, including the nearby Sisson and Lu site, with analog moisture retention relationships.	Conduct moisture profile measurements from any boreholes drilled near IDF.
Vadose zone – Hanford formation – silt layers and paleosols	Hanford sand locally contains lenses and layers of silts, loess, and other finer grained materials.	Hydraulic properties of silt lenses are generally higher moisture content, thus reducing the pore velocity through these materials.	Including the silt lenses and paleosols in the model would increase the transport time of COPCs to the water table.	None.

Table 2-2. Key Conceptual Model and Parameter Assumptions

Natural System Feature	Conceptual Model Assumption	Parameter Assumption	Impact of Assumption	Potential Monitoring Approach
Vadose zone – Hanford formation clastic dike	Clastic dikes are semi vertical and spaced based on observed conditions in IDF trench.	Clastic dike properties in other clastic dikes observed at Hanford are analogous to those in clastic dikes under IDF	The presence of clastic dikes under the IDF does not affect the transport of COPCs in the vadose zone as these features are finer grained and therefore have a higher moisture content and lower pore water velocity.	None.
Vadose zone – Hanford formation gravel (H3)	Hanford gravel (H3) exists below the Hanford sand (H2). The Hanford gravel has a lower moisture content hence higher pore velocity as well as generally is less sorptive than the overlying H2 unit.	Direct testing of the H3 unit at IDF has not been conducted. Other locations with Hanford gravel (H3) or similar gravels are assumed to be analogous to the H3 unit at IDF. Observed laboratory test information from the other Hanford gravel locations is assumed to be analogous to the H3 gravel properties at the IDF	The H3 unit is not as significant as the H2 unit in delaying the transport of COPCs in the vadose zone because the H3 is thinner than the H2, the H3 has a lower moisture content and therefore a higher pore velocity for the same infiltration rate, and the H3 has a lower K_d than the overlying H2 sands.	None.
Saturated zone – Hanford formation	Extent and characteristics of Hanford gravel are based on interpolating hydrostratigraphic information from boreholes near the IDF.	Model calibrated values of hydraulic conductivity for the Hanford gravel are derived from site-wide models and are applicable to the area around the IDF.	The boreholes drilled into the saturated Hanford gravel under the IDF have measure minimum saturated hydraulic conductivities of about 80 m/day. The hydraulic properties inferred from site-scale models is orders of magnitude greater (about 4,000 m/day in the TC&WM EIS flow model and 17,000 m/day for the Central Plateau flow model). Uncertainty in these models and the calibrated hydraulic conductivity has not been quantified. The hydraulic conductivity directly affects the dispersive dilution of COPCs downgradient of the IDF.	Monitor Hanford formation test information from analog sites. Conduct hydraulic testing in nearby boreholes drilled into the Hanford formation.

Table 2-2. Key Conceptual Model and Parameter Assumptions

Natural System Feature	Conceptual Model Assumption	Parameter Assumption	Impact of Assumption	Potential Monitoring Approach
Saturated zone – Ringold unit E	Extent and characteristics of Ringold unit E are based on interpolating hydrostratigraphic information from boreholes near the IDF.	Model calibrated values of hydraulic conductivity for the Ringold unit E are derived from sitewide models and are applicable to the area around the IDF.	The thinning of the saturated Hanford formation to the east of the IDF causes the water table to be in the less conductive Ringold unit E to the east of the IDF which causes the modeled flow in the higher conductivity Hanford formation to be towards the northeast.	Monitor extent of Ringold unit E with any future drilling campaign near IDF.

Source: Modified from RPP-RPT-59958, *Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington*, Table 8-8.

COPC = constituent of potential concern

ET = evapotranspiration

IDF = Integrated Disposal Facility

K_d = distribution coefficient

Ringold unit E = Ringold Formation member of Wooded Island – unit E

TC&WM EIS = DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*

This page intentionally left blank.

3 Monitoring

Monitoring activities are planned for the IDF both prior to operations and during operations. The activities planned for monitoring of the IDF are presented in CHPRC-03347.

The monitoring activities may be divided into the following groups:

- Pre-operational monitoring of liquids collected in LCRS and LDS
- Meteorological monitoring
- Air monitoring
- Groundwater level monitoring
- Groundwater monitoring
- Monitoring of leachate collected in LCRS and LDS
- Monitoring of leakage collected in SLDS

Note that other monitoring that is expected to occur during WTP and ETF operations and related site operations at the IDF are not explicitly addressed in the IDF PA monitoring plan (CHPRC-03347). This includes monitoring of waste form loading, waste form characteristics, waste inventory, waste volumes, and backfill properties, among others.

This page intentionally left blank.

4 Research and Development

There are two broad classes of R&D activities that support the IDF PA maintenance plan. First are those activities that relate to evaluating updated design and operations information and ongoing scientific studies to determine if the updated information is consistent with assumptions made in the IDF PA or is reasonably bounded by the assumptions made in the IDF PA. Second are those R&D activities that are specific to the IDF facility and associated waste forms as modeled in the IDF PA. The second group of R&D activities is focused on addressing specific assumptions and related uncertainties that are important to the IDF PA results and conclusions.

The first group of R&D activities represent ongoing studies that are not explicitly required to support the IDF PA. It represents information collected for other Hanford Site reclamation, closure, and design purposes as well as related ongoing national and international R&D that may be relevant for IDF models and parameters. The updated information needs to be compared to the information used as a basis for the IDF PA. Examples of the types of studies that fall into this first group of R&D activities include the following:

- Evolution of inventory allocation based on updated WTP process flow sheets and decisions made in ORP-11242, *River Protection Project System Plan*, Rev. 8
- Evolution of ILAW glass formulations as well as SSW grout formulations as the WTP design matures
- U.S. and international research, testing, and modeling on glass corrosion
- U.S. and international research, testing, and modeling on cementitious waste forms
- Hanford Site and U.S. research, testing, and modeling of surface barrier characteristics
- Hanford Site research, testing, and modeling of vadose zone characteristics
- Hanford Site research, testing, and modeling of saturated zone characteristics

The second group of R&D activities focuses on specific assumptions that can affect the IDF PA results. The second group also includes questions that have been raised by researchers studying the characteristics of the waste forms planned for disposal in the IDF. Examples of the types of studies that fall into this second group of R&D activities include the following:

- Laboratory testing of ILAW glass to confirm the low likelihood of Stage III glass corrosion under IDF-relevant environmental conditions
- Laboratory testing of nondebris waste streams solidified in mortar to confirm the sorptive properties of the substrate materials are not affected by the treatment method
- Field testing of saturated zone hydraulic properties near the IDF

4.1 Summary of R&D Activities

The R&D activities that are appropriate to support the IDF PA maintenance are summarized here to provide an overall perspective of the depth and breadth of the activities. The activities are arranged by the component models of the IDF PA, as follows:

- Waste inventory and inventory allocation
- Near-field chemistry

- Near-field hydrology
- Glass corrosion and COPC release
- Cementitious waste form COPC release
- Vadose zone and saturated zone flow and COPC transport

In the following list, the italicized activities are presumed to be R&D that directly address an assumption in the IDF PA while all other activities are for other purposes and the commitment is to evaluate the consistency of the new information developed from ongoing Hanford Site, national, or international studies with the conceptual models and parameter assumptions used in the IDF PA.

- Waste inventory and inventory allocation (Section 4.2)
  - Evaluate the evolution of COPC inventory based on revision to Tank Waste Inventory Network System (TWINS) (RPP-RPT-39487, *TWINS Software Description*)
  - Evaluate the evolution of COPC inventory allocation among different waste forms based on revisions to Hanford Tank Waste Operations Simulator (HTWOS) (RPP-RPT-39908, *Hanford Tank Waste Operations Simulator Model (HTWOS) Version 3.0 Verification and Validation Report*) or the River Protection Project System Plan (ORP-11242, Rev. 6)
  - Evaluate the evolution of COPC inventory allocation among different SSW streams based on revisions to HTWOS and 24590-WTP-RPT-ENS-10-010, *WTP Estimate of Secondary Radioactive Solid Waste Generation*
  - Evaluate the evolution of plans, including designs, for treatment and disposal of SSW waste streams
  - Evaluate the evolution of information related to the waste stream loading efficiency in ILAW, ETF-LSW, and SSW
- Near-field chemistry (and effect on ILAW glass dissolution) (Section 4.3)
  - Evaluate ongoing studies of pH-buffering controls on ILAW glass corrosion
  - Evaluate ongoing studies on effects of steel corrosion on glass corrosion
- Evaluate ongoing studies on microbial effects on glass corrosion
- Near-field hydrology (Section 4.4)
  - Evaluate ongoing studies of Hanford Site closure cap designs and other closure cap studies in semi-arid environments
  - Evaluate ongoing engineering studies supporting the evolution of design and properties of backfill materials
  - Evaluate ongoing studies of the properties of the different materials used in liner system
  - Evaluate ongoing development of conceptual plans for backfill emplacement
- Glass corrosion and COPC release (Section 4.5)
  - Evaluate ongoing national and international research on glass corrosion mechanisms and rates
  - Evaluate ongoing national and international research on secondary mineral reaction networks

- Evaluate the potential for Stage III corrosion of ILAW glass under IDF-relevant environmental conditions
- Evaluate the evolution of glass compositions and loading with enhanced glass formulations
- Develop metrics to compare contractual durability test results to data used in glass corrosion models

- Cementitious waste forms COPC release (Section 4.6)
  - Evaluate ongoing national and international research on grout properties and release models
  - Evaluate ongoing international research on natural analogs of cementitious and glass materials
  - Evaluate ongoing research on transport characteristics of cementitious materials using accelerated tests to approximate the effects of aging/alteration/weathering
  - Evaluate ongoing research on the effects of getters to enhance retention of key COPCs on cementitious materials
  - Evaluate ongoing research on corrosion in highly alkaline environment surrounded by dry backfill
  - Evaluate ongoing research on microbial effects on transport processes in cementitious materials
  - Evaluate transport characteristics (sorption and diffusion) of cementitious materials exposed to partially saturated conditions for both LSW formulations (e.g., hydrated lime, fly ash) and SSW formulations (paste, mortar)
  - Evaluate bulk (i.e., average) transport properties (notably distribution coefficient [K_d]) of solidified nondebris waste streams, with special focus on the retention of iodine-129 on the granular activated carbon (GAC) and silver mordenite substrate materials
  - Evaluate scale dependency of diffusive properties of paste materials used to encapsulate debris waste, with special focus on the diffusivity of iodine-129 and technetium-99 in the encapsulating grout used for the high-efficiency particulate air (HEPA) filter waste stream

- Vadose zone and saturated zone flow and COPC transport (Section 4.7)
  - Evaluate vadose zone model results and parameter values used in ongoing Central Plateau remediation or related activities
  - Evaluate undisturbed present-day soil moisture profiles determined from ongoing studies of other Central Plateau areas near the IDF
  - Evaluate ongoing research and testing related to characterization of present-day natural infiltration, with focus on the Central Plateau area
  - Evaluate saturated zone flow model results and parameter values used in ongoing Central Plateau remediation or related activities
  - Evaluate assumptions and analyses used in the ongoing Hanford Site CA and other ongoing PAs (including the A/AX tank farm PA)
  - Evaluate saturated zone flow properties and hydrostratigraphy at the IDF

- Human receptor exposure pathways and routes (Section 4.8)
  - Evaluate ongoing national and international research and guidance on models and parameters used to evaluate human receptor exposure pathways and routes
  - Evaluate ongoing Hanford Site risk and other related analyses that include models and parameters used to evaluate human receptor exposure pathways and routes
  - Evaluate potential effects of COPC accumulation in soil due to irrigation

4.2 R&D Activities Related to Waste Inventory and Inventory Allocation

1. **Evaluate the evolution of COPC inventory based on updates to TWINS** – As the characterization of the wastes in the tanks continues and the WTP design and construction matures resulting in updates to the WTP process flowsheet, additional updates on the COPC inventory anticipated to be disposed in the IDF are possible. As noted in the inventory data package (RPP-ENV-58562) there are uncertainties related to tank waste composition and inventory uncertainties, WTP process and operational uncertainties, and model partitioning uncertainties. Additional measurements or process definition may reduce these sources of uncertainty. The Best-Basis Inventory (BBI) provides the official tank waste inventory estimates for 177 SSTs and double-shell tanks at the Hanford Site (RPP-7625, *Guidelines for Updating Best-Basis Inventory*). The BBI is included in the TWINS database that stores and provides all official tank sample/characterization data and other information related to the SSTs and double-shell tanks at the Hanford Site. Planned tank sampling events are identified in RPP-26781, *Tank Operations Contractor Sampling Projections for FY2016 through FY2020*. These events are updated on an annual basis and the BBI is maintained through quarterly updates in accordance with BBI protocols. Therefore, the IDF PA maintenance includes annual reviews of updates of the BBI and TWINS to ensure the range of analyzed conditions is still valid.

2. **Evaluate the evolution of COPC inventory allocation among different waste forms based on updates to HTWOS** – As noted in the inventory data package (RPP-ENV-58562), there is significant uncertainty into which waste form the key COPCs (notably iodine-129 and technetium-99) are allocated. This allocation is based on RPP-17152, *Hanford Tank Waste Operations Simulator (HTWOS) Version 8.1 Model Design Document*. HTWOS provides a “mass balance” of the inventory for each waste stream in the WTP process flowsheet based on projections of the expected performance of numerous processes including waste retrieval from tanks, waste partitioning during pretreatment, and waste form generation. Because many of these processes are still undergoing development and testing, it is possible that updates of inventory allocation will result from enhancements of HTWOS. Therefore, the IDF PA maintenance includes annual review of updates of HTWOS to ensure the range of analyzed conditions is still valid.

3. **Evaluate the evolution of COPC inventory allocation among different SSW waste streams based on updates to HTWOS and related WTP flow sheet models (i.e., 24590-WTP-RPT-ENS-10-010)** – As noted in the inventory data package (RPP-ENV-58562), there is significant uncertainty into which waste stream of the SSW the key COPCs (notably technetium-99 and iodine-129) are allocated. As the WTP process flow sheet matures and decisions regarding waste allocation are made, as well as evaluations of process efficiencies are completed, it is possible that the waste allocation assumed in the IDF PA will be updated. The inventory allocation represents the low-activity waste (LAW) flowsheet as of October 2014, which is based on ORP-11242, Rev. 7. The System Plan was revised in September 2017 (ORP-11242, Rev. 8) based in part on recommendation provided in GAO-17-206, *Opportunities Exist to Reduce Risks and Costs by Evaluating Different Waste Treatment Approaches at Hanford*) prior to the Low-Level Waste Disposal Facility Federal Review

Group (LFRG) review of the IDF PA (RPP-RPT-59958). Therefore, the IDF PA maintenance includes annual review of updates to HTWOS and the WTP flow sheet model as well as the River Protection Project System Plan (ORP-11242) to ensure the range of analyzed conditions is still valid.

4. **Evaluate plans for treatment and disposal of SSW waste streams** – As noted in the inventory data package (RPP-ENV-58562) there is uncertainty on how the SSW waste streams will be treated prior to disposal. The range of options is also noted in 24590-WTP-RPT-ENV-14-006, "Updated Evaluation of WTP Secondary Dangerous Waste Treatment and Disposal for 2015 DWP submittal," which address the Hanford RCRA Permit (WA7890008967) Condition III.10.C.2.n.v. In addition, as noted in SRNL-STI-2016-00175, *Solid Secondary Waste Data Package Supporting Hanford Integrated Disposal Facility Performance Assessment*, there is uncertainty in whether these waste streams will be encapsulated or solidified and what type of grout will be used for the encapsulation or solidification. As the plans for treatment and disposal of the SSW waste streams mature, the IDF PA maintenance will evaluate whether the designs deviate from the assumptions used in the IDF PA (RPP-RPT-59958).

5. **Evaluate waste stream loading efficiency –** As noted in the inventory data package (RPP-ENV-58562) there is uncertainty in the COPC inventory loading efficiency within the different waste forms. This is particularly relevant for the iodine-129 and technetium-99 loading in ILAW glass, which controls the amount of ILAW glass required as well as the inventory of these COPCs on other waste forms (notably ETF-LSW for technetium-99 and the GAC and silver mordenite for iodine-129). As the WTP design matures and the LAW glass formulation is refined, estimates of the loading efficiency are expected to be refined and the IDF PA maintenance will evaluate whether the resulting loading deviates from the assumptions used in the IDF PA. In addition, implementation of the permit requirements included in DOE/ORP-2015-01, *Immobilized Low-Activity Waste Form Technical Requirements Document*, may result in changes in the ILAW glass loading or characteristics that need to be considered during the IDF PA maintenance.

4.3 R&D Activities Related to Near-Field Chemistry

1. **Evaluate ongoing studies of pH-buffering controls on ILAW glass corrosion behavior** – ILAW glass corrosion and COPC release models assume that the partial pressure (p) of the reactive gas species $CO_2(g)$ is fixed in the IDF near field at the atmospheric value of $10^{-3.5}$ bar (RPP-CALC-61031, *Low-Activity Waste Glass Release Calculations for the Integrated Disposal Facility Performance Assessment*). This assumption is based in part on measurements of gas partial pressures in natural vadose-zone environments that are like that expected at the IDF. A fixed $p_{CO2(g)}$ value provides an important buffering constraint on pH, which is a key determinant of the glass corrosion rate, and implies that the advective/diffusive transport rate of $CO_2(g)$ through the unsaturated cover, backfill, and waste form is fast enough to maintain $p_{CO2(g)}$ at a constant value. This assumption may not be valid if the rate at which $CO_2(g)$ is consumed locally by glass corrosion reactions is faster than the rate at which $CO_2(g)$ can be transported to the reaction site, however. This could be important from a PA perspective because sensitivity analyses have indicated that fractional release rates are likely to increase if $p_{CO2(g)}$ is reduced. Ongoing studies of the chemistry of pore fluids (gas and aqueous) in materials that may be analogous to backfill (e.g., in undisturbed regions of the Hanford Formation vadose zone) will be evaluated to gain insights concerning reactive-gas transport mechanisms and rates in the IDF near field. If necessary, a reactive-transport modeling approach that explicitly couples the overall rate of glass corrosion with the transport rate of $CO_2(g)$ will be used to address this topic quantitatively.

2. **Evaluate ongoing studies on effects of steel corrosion on glass dissolution and COPC releases** – Glass corrosion rates could be accelerated by reactions involving corrosion products of steel containers. Such reactions could involve sorption of silica by ferric oxide/oxyhydroxide corrosion products, or precipitation of secondary iron-bearing silicate minerals. Ongoing national and international studies of the effects of steel corrosion products and processes on glass corrosion rates and COPC releases will be evaluated.

3. **Evaluate ongoing studies on microbial effects on glass corrosion** – Although numerous investigations have shown that the corrosion rate of natural and archaeological glasses can be accelerated by the metabolic byproducts of microbial activity, similar investigations appear to be limited for ILAW glass. Experiments with LAWA44 glass in contact with an aqueous solution containing microbes extracted from a composite sample of Hanford soils representing the IDF backfill showed a significant increase in the corrosion rate (PNNL-14805). However, it is uncertain if this increased rate is due to microbial effects or to the presence of very fine-grained mineral particles that were not removed from the soil solution prior to contact with the glass. Ongoing national and international investigations of microbial effects on glass corrosion will be evaluated to determine their potential relevance to IDF performance.

4.4 R&D Activities Related to Near-Field Hydrology

1. **Evaluate ongoing studies of Hanford Site closure cap designs and other closure cap studies in semi-arid environments** – The modified RCRA Subtitle C closure cap for the IDF is expected to be analogous to a similar surface barrier planned for use at the Environmental Restoration Disposal Facility and may potentially be used for closure of other surface burial grounds at the Hanford Site. As the designs of these closure caps mature, it is relevant to evaluate the extent to which the modified designs impact any recharge assumptions used in the IDF PA. It is also relevant to compare the results of ongoing research on surface barriers being conducted in other remediation applications around the United States, especially those in semi-arid conditions such as exist at the Hanford Site.

2. **Evaluate ongoing studies of properties of backfill materials** – The selection of the materials to be used include the low density backfill for infill between adjacent waste containers and high-density backfill for the operations layer between the different lifts of the IDF has not been finalized. As the design matures, the material properties can be compared to the assumed properties used in the IDF PA.

3. **Evaluate ongoing studies of properties of the different materials used in liner system** – The as-emplaced hydraulic properties of the different materials of the liner system, which include the drain gravels, geomembrane, GCL, and admix layer, are assumed to be as good as the material properties defined in the design specifications. Opportunities may exist to test the as-emplaced material properties.

4. **Evaluate ongoing development of conceptual plans for backfill emplacement** – The IDF Operations and Maintenance Philosophy, described in RPP-18516, *Integrated Disposal Facility (IDF) Operations and Management Philosophy,* outlined the proposed operational plans for the backfilling of the IDF. Because these plans were largely conceptual in nature and have not been demonstrated in the field, a full-scale field test program was proposed for waste placement, backfilling, and equipment loading. The conceptual field test program, described in detail in RPP-18516, Section 5.1.6.5, includes the following:

   - Crane operator practicing placement of waste container and backfilling with hopper and placing cover soil

- Using test pads to evaluate filling and compaction techniques of cover soil and placement of ecology block walls to determine if adequate tolerances on block placement, stability, and differential settlement can be met
- Assess compaction operation of cover soil and its effect on mechanical integrity of the different waste containers
- Evaluation of controlled low strength material backfilling technique as an alternative to soil filling

4.5 R&D Activities Related to Glass Corrosion

1. **Evaluate ongoing national and international research on glass corrosion mechanisms and rates** – This topic includes: (1) an evaluation of whether the range of parameters used in kinetic (specifically transition state-theory [TST]-based) models of glass dissolution are appropriate for the range of glass compositions that will be disposed of in the IDF; (2) characterization or refinement of uncertainty ranges in TST parameters at the IDF temperature of 15°C (41°F); (3) refinement of uncertainty ranges in the reactive surface area of glass waste forms that account for cooling-induced fracturing during production, and possible stress-induced fracturing after emplacement; (4) an evaluation of improvements to kinetic models of the alkali-H^+ exchange reaction; and (5) an evaluation of uncertainties in kinetic parameters for the precipitation of secondary reaction products of glass corrosion (e.g., chalcedony/amorphous silica).
2. **Evaluate ongoing national and international research on secondary mineral reaction networks** – Scoping models indicate that fractional release rates may not be significantly affected by differences in the mineralogy of secondary mineral reaction networks that form as ILAW glass reacts with water (RPP-CALC-61031). This observation will be further evaluated based on a review of ongoing national and international R&D investigations aimed at characterizing the mineralogy, mineral chemistry, paragenesis, and crystallinity of secondary solids that form during the corrosion of analogs to ILAW glass. Based on these characterization data, it may be necessary to either estimate or measure relevant thermodynamic properties (e.g., equilibrium constants for hydrolysis reactions) for the key minerals identified so the impact of these observations can be evaluated in ILAW corrosion and COPC release models. The evaluation will determine whether differences in the secondary mineral reaction networks significantly affect fractional release rates.
3. **Evaluate the potential for Stage III corrosion in the IDF** – Stage III behavior, which causes the glass corrosion rate to increase after Stage II is achieved, appears to be caused by the precipitation of secondary minerals, specifically zeolites. If the precipitation rate reduces the concentrations of certain aqueous constituents (silicon, aluminium) faster than the dissolution rate adds these constituents to the solution during Stage II, then corrosion can occur at the accelerated Stage III rate. Because such behavior has typically been observed only in closed experimental systems at elevated temperatures (e.g., 90°C [194°F]), it may be unlikely at the low temperatures (15°C [41°F]) and open-system conditions expected in the IDF (PNNL-24615), but this possibility cannot be ruled out completely. This topic will review ongoing national and international investigations of Stage III effects on glass corrosion and will assess the extent to which the R&D results may be relevant to IDF performance. Numerical geochemical models of the nucleation, growth, and precipitation kinetics of glass alteration phases in open versus closed aqueous systems as a function of temperature will be used to support the assessments.
4. **Evaluate the evolution of glass compositions and loading with enhanced glass formulations** – It is recognized that advanced glass formulations are being developed by DOE to increase waste

loadings. To provide a basis for comparing the alternative glasses to the baseline ILAW glasses (LAWA44, LAWB45, and LAWC22) evaluated in the IDF PA (RPP-RPT-59958), additional TST-relevant data need to be collected and analyzed using single-pass flow-through (SPFT) tests. Examples of this have recently been completed by Pacific Northwest National Laboratory (PNNL-26169, *FY2016 ILAW Glass Corrosion Testing with the Single-Pass Flow-Through Method*, and PNNL-27098, *FY2017 ILAW Glass Corrosion Testing with the Single-Pass Flow-Through Method*) where the results of testing IDF18-A161, ORPLG9, and other glasses are presented. The IDF18-A161 glass was chosen for SPFT testing in order to increase the understanding of glasses that have a somewhat marginal response to vapor hydration test (VHT) and product consistency test (PCT) and to increase the amount of corrosion data available on glasses with intermediate, but higher than baseline glasses, sodium concentrations. The ORPLG9 glass was selected for SPFT testing due to its high sodium concentration and it allows for comparison of SPFT results with another high-alkali glass, ORPLB2, the only high waste-loaded glass where a complete set of SPFT testing has been performed. Prior to making a design decision, it is necessary to confirm that the alternative glass performs adequately to meet the performance objectives analyzed in the IDF PA.

5. **Develop metrics to compare contractual durability test results to data used in glass dissolution models** – Short duration high-temperature accelerated tests are contractually required for the potential ILAW glasses. These tests include the pressurized unsaturated flow test (McGrail et al., 1996, "The Pressurized Unsaturated Flow (PUF) Test: A New Method for Engineered-Barrier Materials Evaluation"), the PCT (ASTM C1285-14, *Standard Test Methods for Determining Chemical Durability of Nuclear, Hazardous, and Mixed Waste Glasses and Multiphase Glass Ceramics: The Product Consistency Test (PCT)*), the VHT (ASTM C1663-09, *Standard Test Method for Measuring Waste Glass or Glass Ceramic Durability by Vapor Hydration Test*), and Method 1311, "Toxicity Characteristic Leach Procedure" (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*). These tests are also used to obtain information on secondary mineral alteration phases that can form as the glass dissolves. These required tests do not provide the necessary kinetic rate law input parameters used as input to the reactive transport models used in the IDF PA, however. The kinetic rate law information is derived from expensive testing, notably the SPFT test. As it is expected that short duration tests will continue to be required, determining the nexus between the short duration tests (pressurized unsaturated flow, PCT, and VHT) and the more complex SPFT tests is desirable, so the short duration tests may be used to monitor glasses formulated during operations.

4.6 R&D Activities Related to Characteristics of Cementitious Waste Forms

1. **Evaluate ongoing national and international research on grout properties and release models** – A range of other national programs as well as international studies are conducting active research on the properties of cementitious materials that may be used as analogs to those being considered for use at IDF (i.e., grouts used for solidification of nondebris SSW or encapsulation of debris SSW as well as hydrated lime or fly-ash based grouts being considered for use with LSW). The national research includes ongoing research being performed by the Cement Barriers Partnership as well as Saltstone studies conducted at SRNL. There are useful insights to be gained by this related research that can be used to compare with conceptual and numerical model assumptions and parameter values used in the IDF PA.

2. **Evaluate ongoing international research on natural analogs of cementitious and glass materials** – International programs use research on natural analogs to support and corroborate the release models and parameters used in long-term performance projections. Although natural analogs have a disadvantage in that the details of the environmental conditions and materials are not directly

analogous to the conditions at the IDF, they have an advantage of being able to replicate the long times of concern for the performance assessment. Extrapolating short duration accelerated laboratory tests to the time frames of interest to the PA is uncertain and the natural analogs may be used to support the assumptions made in the PA. The natural analogs may be used to evaluate aging/weathering effects of cementitious materials.

3. **Evaluate ongoing national and international research on transport characteristics of cementitious materials using accelerated tests to approximate the effects of aging/alteration/ weathering** – The IDF PA assumes that as the cementitious waste forms age, the hydraulic properties will change, but in the unsaturated environment at IDF these property changes do not negatively affect the diffusive or advective release characteristics. This is a significantly different assumption than used in the TC&WM EIS (DOE/EIS-0391) where it was assumed the tortuosity (and hence diffusion coefficient) increased by a factor of 60 when the cementitious materials were assumed to degrade. Although sensitivity analyses results conducted in the IDF PA indicate that this assumption does not significantly affect the results, better understanding on the effects of aging/alteration/weathering on transport properties is warranted.

4. **Evaluate ongoing research on the effects of getters to enhance retention of key COPCs on cementitious materials** – Research has been conducted to evaluate the potential benefit of different getters on COPC sorption in IDF-relevant grouts (refer to PNNL-25577 for example). As the grout formulations mature, the actual grouts planned for use, with or without the inclusion of additional getters, should be evaluated.

5. **Evaluate ongoing research on corrosion in highly alkaline environment surrounded by dry backfill** – The IDF-PA did not take credit for the container based on many corrosion studies performed under Hanford Site relevant disposal environments like that expected at IDF. In addition, there was no information that steel corrosion would negatively impact the release of COPCs from cementitious waste forms or the transport of COPCs in the IDF. However, ongoing research on both steel corrosion and the interaction of steel corrosion products and cementitious materials will be monitored to track potential deleterious effects that might impact this assumption.

6. **Evaluate ongoing research on microbial effects on transport processes in cementitious materials** – Microbial processes may alter transport properties of the disposal facility and surrounding host rock. In addition, microorganism may affect the redox state of COPCs affecting its mobility. Analogue studies provide insights into the viability and consequences of biogeochemical processes that could occur as the infiltration of surficial water leads to the formation of hyper-alkaline conditions and potential microbial effects may need to be part of assessing near- and long-term transport and redox properties of near-surface, cementitious disposal systems.

7. **Evaluate transport characteristics (sorption and diffusion) of cementitious materials exposed to partially saturated conditions** – The IDF PA makes assumptions on whether the properties of cementitious materials are affected by possible changes in saturation as the materials age and interact with the partially saturated backfill in the IDF. Preliminary studies by Langton, 2014, *Technetium Oxidation in Slag-based Sodium Salt Waste Forms Exposed to Water and Moist Hanford Soil,* were used to justify the assumption of oxidizing conditions in the cementitious waste forms as the base case for sorption of key COPCs (notably iodine-129 and technetium-99) which contrasts with the reducing environment used in the laboratory testing programs completed to date. As noted in the laboratory testing, there is a marked difference in sorption characteristics for both technetium-99 and iodine-129 depending on whether oxidizing or reducing conditions are assumed. The reported transport characteristics for LSW formulations indicated inconsistencies between laboratory-determined

diffusion and sorption coefficient for different COPCs. The laboratory testing results have been used to develop the parameter values for effective diffusion coefficients and K_d values used in the IDF PA. For the ETF-LSW waste form, assumptions were made using the diffusion coefficients for nonsorbing species as effective diffusion and the sorption coefficient was based on those from SSW formulations under oxidizing and reducing conditions. Even though the LSW inventory is relatively low for the recommended inventory case (Case 7) and shows little contribution to total release, alternatives were examined in the PA with much greater inventory loading (mainly iodine-129). Additional studies would be useful to confirm the actual transport characteristic in terms for consistency between diffusion and sorption coefficients.

8. **Evaluate bulk (i.e., average) transport properties (notably K_d) of solidified nondebris waste streams, with special focus on the retention of iodine-129 on the GAC and silver mordenite substrate materials** – The IDF PA assumes that it is appropriate to average the K_d of substrate and grout for solidified nondebris waste streams. As the grout formulations mature the effect of grouts on the K_d of substrate materials (for example, the K_d of iodine-129 on GAC and silver mordenite) is expected to be studied to determine if the grout properties affect the average waste form properties for solidified nondebris wastes.

9. **Evaluate scale dependency of diffusive properties of paste materials used to encapsulate debris waste, with special focus on the diffusivity of iodine-129 and technetium-99 in the encapsulating grout used for the HEPA filter waste stream** – Laboratory test specimens have been used to develop the diffusive characteristics of cementitious grouts, both mortar and paste. It has been assumed that the laboratory test results for mortar can be used to represent solidified waste forms and the laboratory test results for paste can be used for encapsulated waste forms. It is assumed that 10 cm (4 in.) of paste is used to encapsulate compacted HEPA filters; however, there has been no testing to determine whether the treatment process affects the diffusive properties. This research would focus on determining if the diffusive properties are dependent on the scale or treatment method. Although this research may also be relevant for other waste streams, the HEPA filter waste stream has been identified as the most significant cementitious waste stream in the IDF PA.

4.7 R&D Activities Related to Vadose Zone and Saturated Zone Flow and Transport

1. **Evaluate vadose zone models and parameter values developed for use in other Central Plateau remediation or related activities** – The Hanford Site is an area of ongoing characterization and modeling of shallow (<15 m [49 ft]) and deep vadose zone contamination and evaluation of alternative remediation technologies. In addition, fate and transport modeling of vadose zone contamination associated with past waste disposal practices at the Hanford Site is actively being pursued for several Central Plateau waste locations. While there are important differences between the other Central Plateau locations and the IDF that result in differences in anticipated or observed COPC fate and transport, these other studies provide useful analogs for the models and parameters used in the IDF PA, similar to the way in which the IDF PA took advantage of previous modeling and analyses for other Central Plateau facilities (including the 2012 TC&WM EIS [DOE/EIS-0391], the 2013 Environmental Restoration Disposal Facility PA [CP-60089, *Performance Assessment for the Environmental Restoration Disposal Facility, Hanford Site, Washington, formerly WCH-520 Rev. 1*], and the 2016 Waste Management Area C PA [RPP-ENV-58782, *Performance Assessment of Waste Management Area C, Hanford Site, Washington*]). These reviews should be conducted annually and summarized in the annual summary of related activities.

2. **Evaluate undisturbed present-day soil moisture profiles for areas near the IDF** – There are limited data on the existing undisturbed moisture contents in the shallow or deep vadose zone at IDF.

One of the few locations with ambient moisture information is at well 299-E17-21 (PNNL-11957, *Immobilized Low Activity Waste Site Borehole 299-E17-21*). While existing waste sites and tank farms in the Central Plateau area of the Hanford Site have been the focus of detailed characterization efforts of the vadose zone, in large part to evaluate the potential consequences associated with past waste disposal practices or unplanned tank leaks, there is limited information on the ambient moisture profile or other observations that may be able to constrain the vadose zone hydraulic properties or flow rates under IDF. Future boreholes in the Central Plateau should be monitored for soil moisture. This is especially relevant in areas underlain by the Hanford Site sands and gravels where the net infiltration rate is expected to approximate conditions that are undisturbed by Hanford Site operations.

3. **Evaluate measurements of natural infiltration** – This may include direct measurements using field lysimeter test facilities, such as the one that used to exist at the IDF dune site. In addition, indirect measurements may be used to infer present-day infiltration rates such as using chloride mass balance and bomb-pulse chlorine-36 measurements. It is noted that monitoring activities have been completed in the past (PNNL-19945, *Soil Water Balance and Recharge Monitoring at the Hanford Site – FY 2010 Status Report*). These measurements were used to support the development of the range of likely post-closure net infiltration rates. It is recognized that the monitoring of net infiltration will be a long process because for many years there will be no observed net infiltration, however in wetter years, there is expected to be some observable net infiltration that should be monitored to reduce the uncertainty in this key parameter value.

4. **Evaluate saturated zone flow models and parameter values developed for use in other Central Plateau remediation or related activities** – The Hanford Site is an area of ongoing characterization and modeling of the groundwater flow domain in the Central Plateau area. These groundwater investigations and models could extend and include the 200 East Area and other areas around the IDF. These studies are expected to be of relevance to IDF, specifically with respect to analyses of the present trends in the water table surface in the 200 East Area as well as the hydraulic conductivity of the Hanford formation. Although the IDF groundwater flow model uses a projected groundwater flow field after the end of Hanford Site operations (calendar year 2200), understanding the transient behavior of the groundwater flow system near the IDF supports the development of the groundwater flow rates used in the IDF PA.

5. **Evaluate assumptions and analyses used in the Hanford Site CA and other planned and ongoing PAs (including the A/AX tank farm PA)** – The Hanford Site CA is expected to be completed in 2019 after which it will be reviewed by the LFRG. Until the DOE O 435.1 compliant CA is complete, the TC&WM EIS (DOE/EIS-0391, Section 6.0 and Appendix U) serves as the Hanford site-wide assessment of cumulative impacts. These impacts include impacts from sources immediately upgradient of the IDF, notably the US Ecology site and the BC cribs and trenches. Analyses of COPCs released from these facilities significantly affects the forecast concentration of technetium-99 and iodine-129 beneath the IDF; therefore, these results should be evaluated to determine their impact on the IDF PA monitoring program.

6. **Evaluate saturated zone flow properties and hydrostratigraphy at the IDF** – The magnitude of dilution for COPCs which reach the saturated zone beneath the IDF is dependent on the hydraulic properties and hydraulic gradient of the hydrostratigraphic units beneath the IDF. While the current site characterization indicates that the present-day and long-term average water table is in the Hanford formation beneath the IDF, this unit is mapped as thinning to the east and south of the IDF and the contact with the Ringold Formation member of Wooded Island – unit E is uncertain. In addition, the single-hole slug tests conducted in the observation wells near the IDF provide only a minimum

estimate of the hydraulic properties of the Hanford formation in the small volume stressed around the test wells and are not believed representative of the average hydraulic properties of the Hanford formation at the IDF. Although the properties and extent of the Hanford formation do not affect the PA results during the 1,000-year compliance period, they significantly affect the concentrations in the 1,000-year to 10,000-year sensitivity analysis period. Therefore, opportunities will be explored to conduct larger scale pump tests in the Hanford formation near the IDF.

4.8 R&D Activities Related to Human Receptor Exposure Pathways and Routes

1. **Evaluate ongoing national and international research and guidance on models and parameters used to evaluate human receptor exposure pathways and routes** – The definition of the receptor and biosphere characteristics relevant for calculating the dose a receptor may receive by all relevant exposure routes has been based on guidance provided by federal agencies. Ongoing research is underway to enhance the scientific basis of the dose models and the guidance has changed with time to reflect the ongoing research. This ongoing research relates to the dose that may be received when the receptor inhales a certain concentration of contaminated air or ingests a certain amount of contaminated water or food grown from contaminated soil. A case in point is the estimated dose which the receptor may receive if s/he drinks a liter of water containing 1.0 pCi/L of a COPC, such as iodine-129. This ongoing research is vetted in the scientific community and is ultimately reflected in updated guidance provided by federal agencies. As the guidance is promulgated, it is relevant to track the updates to determine their potential impact on the IDF PA results.

2. **Evaluate ongoing Hanford Site risk and other related analyses that include models and parameters used to evaluate human receptor exposure pathways and routes** – Assumptions are made in the IDF PA (RPP-RPT-59958) regarding the characteristics of the receptor for which the groundwater or air pathway dose is calculated. These characteristics include assumptions about the eating and drinking habits of the individual; the amount of locally grown fruits, vegetables and animal products (meat, eggs, milk, poultry) consumed by the individual; and the amount of locally grown fodder the animals eat, among other factors. Although there exists guidance on parameter values that are recommended to quantify these characteristics, alternative assumptions can be made, resulting in alternative results. As noted in Section 4.5.1 of the IDF PA, although different models and parameter assumptions have been used for Hanford Site assessments over the past 20 years to evaluate the dose a receptor may receive by using contaminated groundwater, the unit concentration dose factors (i.e., dose per 1.0 pCi/L of groundwater) for iodine-129 and technetium-99 have remained virtually unchanged.

   The range of unit concentration dose factors used in Hanford Site assessments for iodine-129 is between 0.36 and 0.69 mrem/yr per pCi/L with the low value from the TC&WM EIS (DOE/EIS-0391) and the high value from the IDF PA (RPP-RPT-59958). The range of unit concentration dose factors for technetium-99 is between 1.7E-03 and 4.5E-03 mrem/yr per pCi/L with the low value from the data package used to support the noncompleted 2005 IDF PA (HNF-SD-WM-TI-707, *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment*) and the high value from the TC&WM EIS (DOE/EIS-0391). For comparison, the unit concentration dose factor for technetium-99 used in the IDF PA is 3.76E-03 mrem/yr per pCi/L. Because it is possible that different receptor characteristics may be recommended, it is relevant to continue to evaluate the evolution of the recommendations to determine what impact the different values may have on the IDF PA results.

3. **Evaluate potential effects of COPC accumulation in soil due to irrigation** – The unit concentration dose factors for both the groundwater and air pathway can be affected by the potential

accumulation of COPCs in the soil horizon due to irrigation using contaminated groundwater or long-term deposition of air-borne COPCs. Section 4.5.1 in the IDF PA (RPP-RPT-59958) noted that alternative assumptions could be made on the potential accumulation (e.g., buildup) of COPCs in the soil horizon resulting from irrigation practices. The impact of these alternative assumptions on the dose is uncertain, but bounding assumptions discussed in RPP-RPT-59958 indicate that soil accumulation could lead to a buildup of technetium-99 in the soil that leads to a factor of 7 increase in the dose attributed to technetium-99 groundwater contamination (HNF-SD-WM-TI-707, Appendix C).

The buildup of contamination in the soil is a function of several uncertain processes and properties including (1) the sorptive properties of the COPC in the soil, (2) the amount of irrigation, (3) the loss of irrigation water due to evaporation, transpiration and soil drainage, (4) the loss of soil by erosion, and (5) the loss of contaminant mass by plant uptake. To quantify the effects of the potential accumulation of COPCs in irrigated soil, a process-based quantification of the effects of these mechanisms using Hanford Site-specific soil characteristics and common irrigation practices is planned. This process-based modeling will use Hanford Site-specific soil properties developed from ongoing Hanford Site remediation activities of existing contaminated sites as well as other Hanford Site-specific properties. If the process-based quantitative modeling indicates that the accumulation of COPCs in the soil horizon is potentially significant, then additional R&D activities may be developed to better characterize the soil properties and soil accumulation/loss parameters. This may include laboratory-scale soil column experiments to assess the potential accumulation of COPCs by passing contaminated synthetic groundwater through various soil types.

4.9 Potential Future R&D Activity – Field Lysimeter Test

The R&D activities identified in Sections 4.2 to 4.8 relate to current ongoing R&D activities or to R&D activities that are planned to be conducted to address specific assumptions or uncertainties identified as being significant to the IDF PA. In addition to these R&D activities, plans have been developed to perform a field lysimeter test to test the behavior of the ILAW glass and cementitious waste forms planned for disposal in the IDF under IDF-relevant near-field environment conditions. As the plan for this field lysimeter test does not address a specific IDF PA assumption or uncertainty, it is not presently included as an IDF PA maintenance activity. However, noting that such a test could enhance the confidence in the models and parameters used to calculate COPC release rates from ILAW glass and cementitious waste forms, it is identified as a test that could be included in future revisions of this maintenance plan. Therefore, this section summarizes the goals, objectives, and historical perspective on such a field lysimeter test. The details of the current implementation plan for this test are provided in PNNL-27394, *Field-Scale Lysimeter Studies of Low-Activity Waste Form Degradation Implementation Plan*.

The ILAW glass and cementitious waste form COPC release conceptual and numerical models as well as the parameter values used to calculate COPC source term release rates are principally based on laboratory testing performed over the last several decades on relevant ILAW glass and cementitious waste formulations. It is difficult to emulate the variably saturated conditions expected in the near-field environment at the IDF with the laboratory testing program. The laboratory testing information has been supplemented by information from natural analogs, but the extent to which these analogs are representative of IDF waste forms (both vitrified glass and cementitious grouts) or IDF near-field environmental conditions is difficult to ascertain. Therefore, there remains uncertainty on the transferability of the laboratory-derived information to the expected *in-situ* conditions at the IDF.

The uncertainty in extrapolating laboratory information to field conditions relevant to the IDF was recognized at the time of the 1998 ILAW PA (DOE/RL-97-69, Section 6.4). R&D activities related to conducting field-scale tests of ILAW glass release were identified in the maintenance plan for the 2001 ILAW PA (DOE/ORP-2000-01, Section 6.3, which references DOE/RL-97-69, Section 6.4, which in turn references DOE/RL-97-69, Appendix G, which is a draft of PNNL-11834, *A Strategy to Conduct an Analysis of the Long-Term Performance of Low Activity Waste Glass in a Shallow Subsurface Disposal System at Hanford*). A field lysimeter test was identified in DOE/RL-97-69, Appendix G (i.e., PNNL-11834), and a plan for this test was published in 2001 (PNNL-13670, *Test Plan for Field Experiments to Support the Immobilized Low Activity Waste Disposal Performance Assessment at the Hanford Site*). The specific objectives of the planned field experiments identified in PNNL-13670 include the following:

- Obtain a dataset that can be used to validate the models used in the near-field simulation of the ILAW PA
- Represent the important aspects of glass corrosion and the interaction of the glass corrosion products with the surrounding materials
- Determine whether field-scale flow and transport are represented by laboratory measurements of hydraulic and transport properties
- Provide data to validate models of the change in effective material properties over the life of the facility
- Provide information on potential monitoring strategies for evaluating the nearfield performance of the full-scale facility
- Reduce uncertainty in the ILAW PA predictions

The field lysimeter test was carried out over an 8-year period from 2002 to 2010. The focus of this test was on ILAW glass because this was the waste form of interest in the 2001 ILAW PA (DOE/ORP-2000-01). The results of the field lysimeter tests were presented and analyzed in PNNL-23693, *Geochemical Modeling of ILAW Lysimeter Water Extracts* and PNNL-21812. The test data developed in the field lysimeter tests were also used to benchmark the eSTOMP software as summarized in PNNL-25185, *Integrated Disposal Facility FY 2016: ILAW Evaluation of the eSTOMP Simulator.*

The test results from the field lysimeter experiment indicated elevated levels of rhenium, molybdenum, and boron (PNNL-21812 and PNNL-25185). The test results identified that the faster observed release of rhenium and molybdenum was due to a reduced metallic phase precipitated on the surface of the glass during the manufacturing of the glass specimens and that the LAWA44 glass experienced less corrosion of the glass matrix than the HAN28 glass. In both glasses tested, the alteration of the glass was slow and only small concentrations of boron, the key indicator of glass matrix dissolution, were detected. The observed boron concentrations may have been the result of normal downward leaching of pore waters and the subsequent precipitation in the unsaturated soil beneath the simulated waste forms.

The boron and molybdenum data sets were used to benchmark the eSTOMP simulator in PNNL-25185. The comparisons were favorable; however, the modeled conditions in the comparison made two assumptions that differ from the nominal conceptual model of ILAW glass alteration presented in PNNL-24615. First, the comparison assumed the carbon dioxide gas concentration was not fixed at the atmospheric carbon dioxide gas concentration but was instead allowed to vary. Second, the comparison assumed the ILAW glass surface area was fixed at the nominal external surface area rather than being enhanced by a factor of 10 due to assumed fractures of the glass monolith. The effect of these assumptions on the predicted results and comparison to the observed data has not been evaluated; however, as noted in PNNL-25185, there remain significant unquantified uncertainties that make interpreting the existing lysimeter experiments speculative, thus minimizing the utility of the existing lysimeter test data to enhance the confidence in the conceptual and numerical models and parameter values used in the IDF PA (RPP-RPT-59958).

Although the field lysimeter test performed as part of R&D activities for the 2001 ILAW PA (DOE/ORP-2000-01) maintenance yielded inconclusive results, there are merits of a redesigned field lysimeter test. Although the need for a field lysimeter test has not been identified in PNNL-23503, Rev. 0, *A Strategy to Conduct an Analysis of the Long-Term Performance of Low-Activity Waste Glass in a Shallow Subsurface Disposal System at Hanford*, or PNNL-23503, Rev. 1, a plan for such a test that includes both ILAW glass and cementitious waste forms is under development. The intent is for this test plan to use pre-test modeling to aid in the selection of appropriate boundary conditions, sample conditions and sampling sizes, approaches and frequency to provide a high-resolution data set representative of expected in-situ conditions. Once the test plan is reviewed, accepted, and implemented, it will be included in an update of this IDF PA maintenance plan to enhance the confidence in ILAW glass and cementitious waste form COPC release models used in the IDF PA (RPP-RPT-59958).

This page intentionally left blank.

5 Planned Review and Analysis

DOE M 435.1-1 requires the ongoing maintenance of the PA to evaluate changes that could affect the performance, design, and operating bases for the facility. The maintenance includes a series of activities that are performed on an annual basis. A determination of continued adequacy of the PA is required on an annual basis and it includes consideration of the results of data collection and analysis from any research, field studies, and monitoring needed to address uncertainties or gaps in existing data. The results of the annual review will be reported in the Annual Summary Report.

5.1 Periodic Review

Periodic reviews are needed to evaluate any information that may become available that was not evaluated during the PA preparation, including information gained from retrieval, post-retrieval sampling, and R&D activities that may be relevant to the PA. Periodic reviews can focus on reducing conservatisms and uncertainties in the PA results.

5.1.1 Requirements

Specifically, the objectives of annual reviews can be summarized as the following:

- Confirmation of existing controls being effective in ensuring that PA conclusions are valid
- Consideration of expected future events in terms of their significance to facility closure and the adequacy of the PA
- Review of new information and determining the significance of this new information to the PA through special analysis, if found necessary
- Identification of R&D needs that have been met during the past year, new needs that have arisen because of changes in actual or expected future conditions, and revised R&D priorities

Any data derived from monitoring, tests, or research activities during the review period must be evaluated relative to the current PA assumptions to determine if such assumptions remain credible. Finally, any other information or changes in the waste management area decontamination, decommissioning, and/or closure practices that are relevant to PA assumptions and conclusions must be reviewed to determine if the current PA still adequately describes the closure condition, and PA results still predict compliance with the performance objectives. The assessment of any significant changes identified to the input parameters or conceptual model or assumptions (of the original PA) through annual monitoring, R&D, or new data or information will be conducted as part of the Unreviewed Disposal Question Evaluation (UDQE) process. The results of implementing the UDQE process will be summarized in the Annual Summary Report.

5.1.2 Status

Annual reviews of the IDF PA will be provided to DOE starting with FY 2018. DOE will evaluate the information provided in the review and make the annual determination to document the continued adequacy of the PA or to identify those areas requiring revisions.

5.1.3 Plans

The purpose of the PA maintenance program is to confirm the continued adequacy of the current IDF PA and to maintain and increase confidence in the results of the PA. A requirement of the maintenance program is to conduct an annual review of the facility closure-related activities. The annual PA review is conducted in a systematic manner that incorporates the following considerations:

1. Changes in estimates of radionuclide inventories, waste volumes, and waste types
2. Testing and research activities performed during the year and planned for the out years
3. Results of PA monitoring conducted in accordance with the PA Monitoring Plan (CHPRC-03347) for the IDF

The above factors are reviewed annually to confirm the adequacy of the current facility PA, and to evaluate the need to conduct special analyses under the UDQE process (IDF-PRO-EN-54165, *IDF Unreviewed Disposal Question*) or to prepare a revision to that PA. The results of the review will be documented in the annual review summary report for the IDF PA.

5.2 Status of DAS Conditions/Limits

The issuance of a DAS, which serves as the DOE federal authorization for the design, construction, operation, monitoring, and closure of a LLW disposal facility, is a requirement under DOE O 435.1. DOE-STD-5002-2017 provides consolidated guidance for implementation of DOE O 435.1, including a consistent approach for federal and contractor personnel responsible for developing and/or reviewing documents that support the issuance of a DAS. This standard states that prior to operating the disposal facility, an Operational DAS (ODAS) should be approved.

5.2.1 IDF DAS Background

The original IDF PA (RPP-RPT-59958) and DAS (DOE-STD-5002-2017) were issued in 1999 to allow the construction of the disposal facility. The IDF PA was updated in 2001 to resolve issues with the PA which also closed the associated DAS conditions. The IDF PA was again revised in 2018 to update the analysis and associated technical basis documents required to obtain an ODAS. The IDF ODAS was issued June 2018 (*Operating Disposal Authorization Statement for the Integrated Disposal Facility, Hanford Site, Washington* [DOE, 2018]) based on the LFRG recommendation that the facility's current PA and associated technical basis documentation meet the DOE O 435.1 requirements for an ODAS.

5.2.2 IDF DAS Conditions

The IDF ODAS listed three conditions that required resolution prior to accepting waste at the IDF:

1. Condition 1 (Key Issue IDF-K02-W01): The waste acceptance criteria must be revised to align with the radionuclide limits and critical assumptions identified in the PA prior to accepting waste for disposal at the facility.
    - Added to Table 6-2 for tracking until closed
2. Condition 2 (Key Issue IDF-K01-PA18): The inadvertent intruder analysis must be revised to ensure the DOE M 435.1-1 performance measure of 100 mrem in a year for the chronic exposure can be met prior to accepting waste for disposal at the facility.
    - Completed and closed in Rev. 1 of the IDF PA (RPP-RPT-59958) as documented in the IDF 2018 Annual Summary Report (DOE/ORP-2019-01, *FY18 Annual Summary Report for the Integrated Disposal Facility Performance Assessment*).

3. Condition 3: The maintenance program and maintenance plan shall include activities to resolve each of the secondary issues identified in the LFRG report on the ODAS documentation for the IDF at the Hanford Site (dated June 2018) that were not completely addressed in post-review PA revisions.

    - Added to Table 6-2 for tracking until closed

The status of the ODAS conditions will be included in the Annual Summary Report.

5.3 LFRG Key and Secondary Issues

The LFRG completed their review of the IDF PA (RPP-RPT-59958, Rev. 0). Tables 6-2 and 6-3 list the open key and secondary issues remaining to be closed. The status of the resolution of the open issues will be documented in the IDF annual summary reports.

This page intentionally left blank.

6 Planned Maintenance Activities and Schedule

The maintenance of the IDF PA consists of four inter-related activities: (1) monitoring, (2) research and development, (3) planned reviews and analyses, and (4) revisions to the IDF PA and the related Hanford Site CA.

The details of the planned monitoring activities are presented in CHPRC-03347 and are summarized in Chapter 3.

The planned R&D activities, including both (1) activities planned to continue the evaluation of assumptions related to the design basis used for the IDF PA and the related scientific studies of waste form and site characteristics, and (2) activities planned to conduct focused testing on key assumptions related to the conceptual models and parameter values used in the forecasts of the IDF performance, are summarized in Chapter 4.

The planned reviews and analyses are summarized in Chapter 5. These reviews support the integrated and iterative development of the technical basis document supporting disposal of wastes at the IDF as illustrated in Figure 6-1.

Based on the additional information garnered from these sources, revisions to the IDF PA and related IDF PA and Hanford Site CA documents are possible.

The schedules for the planned R&D activities are presented in the following tables:

- Table 6-1 presents the schedule for R&D activities related to IDF-specific testing to address conceptual model and parameter assumptions
- Table 6-2 presents the DAS Conditions and Key Issues
- Table 6-3 presents the Open Secondary Issues for the IDF PA

These schedules are contingent on available funding. It is expected that the schedules will be revisited as the WTP construction and operations mature and as waste form and facility design and operations decisions are made.

The Annual Summary Report will include a summary of the monitoring results completed that fiscal year, in particular the monitoring results related to addressing the two secondary issues identified in the LFRG review of the IDF PA (RPP-RPT-59958). In addition, the Annual Summary Report includes a summary of any UDQEs completed that fiscal year.

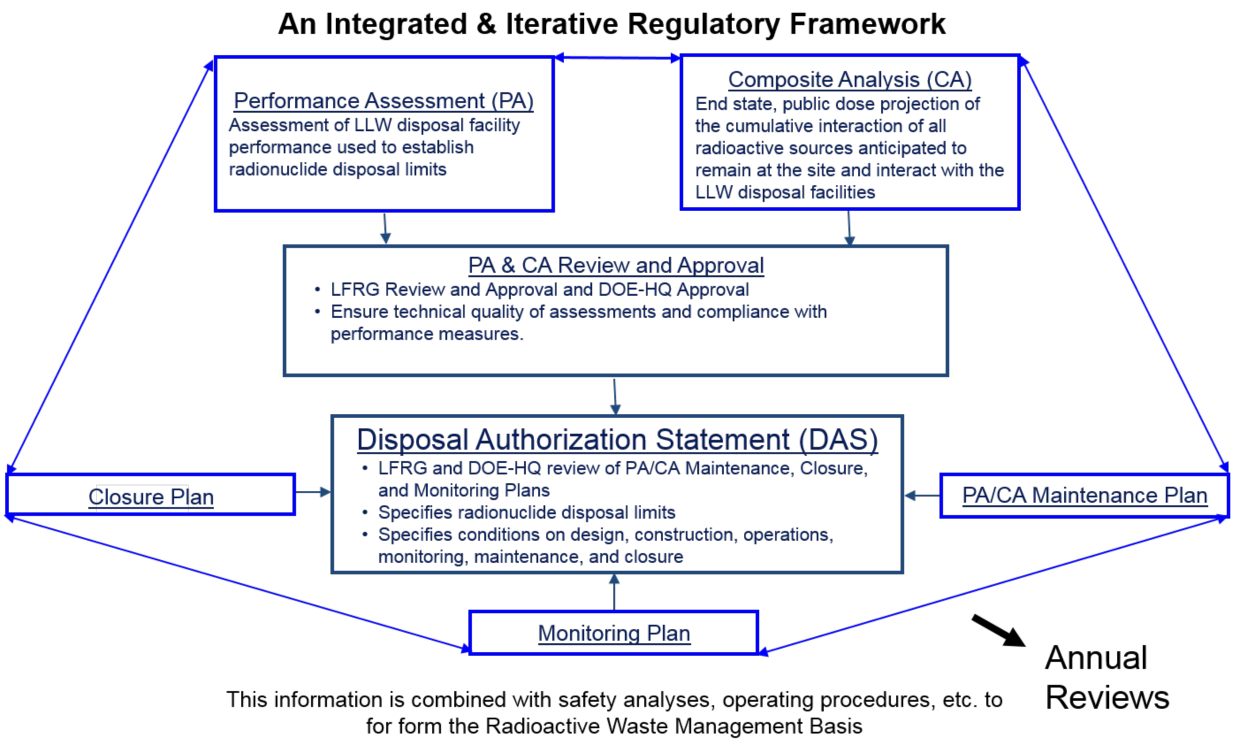


Figure 6-1. Planned Reviews of Technical Basis Documents for Low-Level Radioactive Waste Disposal at the IDF

Table 6-1. Schedule of R&D Activities

R&D Activity	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27
Glass Corrosion and COPC Release										
Evaluate the potential for Stage III corrosion of ILAW glass	X	X	X							
Evaluate the evolution of glass compositions and loading with enhanced glass formulations		X	X	X						
Develop metrics to compare contractual durability test results to data used in glass dissolution models			X	X	X	X				
Cementitious Waste Forms COPC Release										
Evaluate transport characteristics (sorption and diffusion) of cementitious materials exposed to partially saturated conditions for both LSW formulations (e.g., HL, FA) and SSW formulations (paste, mortar)	X	X	X							
Evaluate bulk (i.e., average) transport properties (notably K_d) of solidified nondebris waste streams, with special focus on the retention of I-129 on the GAC and Ag mordenite substrate materials.		X	X	X						
Evaluate scale dependency of diffusive properties of paste materials used to encapsulate debris waste, with special focus on the diffusivity of I-129 and Tc-99 in the encapsulating grout used for the HEPA filter waste stream			X	X	X					
Vadose Zone and Saturated Zone Flow and COPC Transport										
Evaluate saturated zone flow properties and hydrostratigraphy at the IDF			X	X	X					

Table 6-1. Schedule of R&D Activities

R&D Activity	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27
Human Receptor Exposure Pathways and Routes										
Evaluate potential effects of COPC accumulation in soil due to irrigation	X	X								

Note: The schedule of completion of R&D activities are based on current assumptions and are subject to available funding. The status of each of these activities is expected to be summarized in annual summary reports.

COPC = constituent of potential concern
FA = fly ash
FY = fiscal year
GAC = granular activated carbon
HEPA = high efficiency particulate air
HL = hydrated lime
IDF = Integrated Disposal Facility
ILAW = immobilized low-activity waste
K_d = distribution coefficient
LSW = liquid secondary waste
R&D = research and development
SSW = secondary solid waste

Table 6-2. DAS Conditions and Key Issues

DAS Condition and Associated Key Issue	Issue Description	Resolution Scheduled Date	Disposition Documentation	PA, CA, DAS Impact
DAS Condition #1, Key Issue IDF-K02-W01	The WAC must be revised to align with the radionuclide limits and critical assumptions identified in the PA.	FY 2019	Revised WAC (IDF-00002)	Required resolution to remove DAS condition prior to accepting waste for disposal at the facility.
DAS Condition #2, Key Issue IDF-K01-PA18	The inadvertent intruder analysis must be revised to ensure the performance measure of 100 mrem in a year for the chronic exposure can be met.	Completed August 2018	IDF PA Rev. 1 (RPP-RPT-59958)	Required resolution to remove DAS condition prior to accepting waste for disposal at the facility.
DAS Condition #3	The maintenance program and maintenance plan shall include activities to resolve each of the secondary issues that were not completely addressed in post-review PA revisions.	FY 2019	Revised maintenance plan (this document), monitoring plan (CHPRC-03347), change control process (IDF-PRO-EN-54165), and closure plan (CHPRC-03407)	Required resolution to remove DAS condition prior to accepting waste for disposal at the facility.

References: CHPRC-03347, *Performance Assessment Monitoring Plan for the Integrated Disposal Facility.*

CHPRC-03407, *Performance Assessment Closure Plan for the Integrated Disposal Facility.*

IDF-00002, *Waste Acceptance Criteria for the Integrated Disposal Facility.*

IDF-PRO-PM-53955, *Integrated Disposal Facility Data Collection Process.*

RPP-RPT-59958, *Performance Assessment for the Integrated Disposal Facility, Hanford Site, Washington.*

CA = composite analysis

DAS = disposal authorization statement

FY = fiscal year

PA = performance assessment

WAC = waste acceptance criteria

Table 6-3. Open Secondary Issues for the IDF PA

Secondary Issue	Issue Description	Resolution Schedule Date	Disposition Documentation	PA, CA, DAS Impact
IDF-S01-CC03	The change control procedure UDQE form does not contain the necessary screening criteria to determine if additional evaluation is necessary for a proposed activity, discovery or new information.	FY 2019	Revised change control procedure (IDF-PRO-EN-54165)	None
IDF-S02-CA01	The CA does not currently include an update of sources that could interact with the IDF.	September 2020	Hanford Site CA	CA revision underway
IDF-S03-CC05	The change control process procedure does not contain LFRG notification requirements.	FY 2019	Revised change control procedure (IDF-PRO-EN-54165)	None
IDF-S04-MO08	IDF-specific monitoring	FY 2019	Revised monitoring plan (CHPRC-03347)	None
IDF-S05-MO10	Air radionuclide monitoring	FY 2019	Revised monitoring plan (CHPRC-03347)	None
IDF-S06-MO17	Monitoring data evaluation, management, and reporting	FY 2019	Revised monitoring plan (CHPRC-03347)	None

References: CHPRC-03347, *Performance Assessment Monitoring Plan for the Integrated Disposal Facility.*

IDF-PRO-EN-54165, *IDF Unreviewed Disposal Question*.

CA = composite analysis

DAS = disposal authorization statement

FY = fiscal year

LFRG = Low-Level Waste Disposal Facility Federal Review Group

PA = performance assessment

UDQE = Unreviewed Disposal Question Evaluation

7 Revisions to DAS Documents

7.1 Requirements

The DOE M 435.1-1 requires that the PA be revised when significant new information alters the conclusions or conceptual models of the PA. The proposed revisions to the DAS, technical documents, and the radioactive waste management basis are used for planning purposes to identify the need for Headquarters/LFRG reviews.

The potential areas of revisions to the IDF DAS and PA are changes in:

- Waste forms or containers
- Radionuclide inventories
- Facility design and operations
- Closure concepts
- Conceptual model
- K_d value to a key radionuclide that significantly affects dose
- The location of the site boundary in land use plans
- DAS conditions (secondary issues verified complete)

In addition, any planned or ongoing revisions to the monitoring plan or closure plan must be described.

7.2 Status

The need for PA revision will be determined by DOE Office of River Protection or DOE Richland Operations Office based on the results of annual reviews and special analyses. The form of a revision will be an addendum or revised PA document. Report revisions will be submitted to DOE Headquarters for review and approval. At IDF facility closure, a final PA will be prepared and submitted to DOE Headquarters for approval together with the final monitoring and closure plans.

7.3 Plans

The IDF PA will be revised whenever new data or information is obtained that would change the conclusions of the PA. The process used to determine the need for a special analysis or a revision of the PA is defined in the UDQE procedure (IDF-PRO-EN-54165). Similarly, the IDF PA monitoring plan (CHPRC-03347) and preliminary closure plan (CHPRC-03407, *Performance Assessment Closure Plan for the Integrated Disposal Facility*) will be updated as more information becomes available. The following PA document revisions are planned at this stage.

1. Prior to closure, update CHPRC-03407 to address the closure cover design selected for construction
2. Update CHPRC-03347 after regulatory approval of the IDF groundwater monitoring program and the leachate monitoring program
3. Prior to closure, update CHPRC-03347 to address the air monitoring requirements (e.g., carbon-14, tritium, and iodine-129) after closure

This page intentionally left blank.

8 References

05-TPD-016, 2005, "The U.S. Department of Energy (DOE), Office of River Protection (ORP) Submittal of the Annual Summary of the Integrated Disposal Facility (IDF) Performance Assessment for 2004 and Supporting Documents" (letter to P.M. Golan from R.J. Schepens), U.S. Department of Energy, Office of River Protection, Richland, Washington, February 7.

10-AMCP-0071, 2010, "Contract No. DE-AC06-08RL14788 – Annual Reporting for the Hanford Site Composite Analysis, the Integrated Disposal Facility Performance Assessment, and the 200 West And 200 East Performance Assessments for 2009" (letter to J.G. Lehew III, CHPRC, from J.C. Connerly), U.S. Department of Energy, Richland Operations Office, Richland, Washington, February 1.

24590-WTP-RPT-ENS-10-010, 2010, *WTP Estimate of Secondary Radioactive Solid Waste Generation*, Rev. 0, Bechtel National, Inc., Richland, Washington.

24590-WTP-RPT-ENV-14-006, *Updated Evaluation of WTP Secondary Dangerous Waste Treatment and Disposal for 2015 DWP Submittal*," Rev. 0, Bechtel National, Inc., Richland, Washington.

78 FR 240, "Record of Decision for the 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.

ASTM C1285-14, 2014, *Standard Test Methods for Determining Chemical Durability of Nuclear, Hazardous, and Mixed Waste Glasses and Multiphase Glass Ceramics: The Product Consistency Test (PCT)*, ASTM International, West Conshohocken, Pennsylvania.

ASTM C1663-09, 2009, *Standard Test Method for Measuring Waste Glass or Glass Ceramic Durability by Vapor Hydration Test*, ASTM International, West Conshohocken, Pennsylvania.

CHPRC-03347, 2018, *Performance Assessment Monitoring Plan for the Integrated Disposal Facility*, Rev. 1, CH2M HILL Plateau Remediation Company, LLC, Richland, Washington.

CHPRC-03407, 2019, *Performance Assessment Closure Plan for the Integrated Disposal Facility*, Rev. 1, CH2M HILL Plateau Remediation Company, LLC, Richland, Washington.

CP-60089, 2013, *Performance Assessment for the Environmental Restoration Disposal Facility, Hanford Site, Washington, formerly WCH-520 Rev. 1*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

DOE, 2018, *Operating Disposal Authorization Statement for the Integrated Disposal Facility, Hanford Site, Washington*, Rev. 0, U.S. Department of Energy, Washington D.C.

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, Washington, D.C. Available at: http://energy.gov/nepa/downloads/eis-0391-final-environmental-impact-statement.

DOE M 435.1-1 Chg 1, 2007, *Radioactive Waste Management Manual*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives-documents/400-series/0435.1-DManual-1-chg1.

DOE O 435.1 Chg 1 (PgChg), 2007, *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.

DOE/ORP-2000-01, 2000, *Maintenance Plan for the Hanford Immobilized Low-Activity Tank Waste Performance Assessment*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/801303-8aa9bj/native/.

DOE/ORP-2000-01, 2004, *Maintenance Plan for the Hanford Integrated Disposal Facility Performance Assessment*, Rev. 1, U.S. Department of Energy, Office of River Protection, Richland, Washington.

DOE/ORP-2000-19, 2000, *Annual Summary of ILAW Performance Assessment*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: https://www.osti.gov/servlets/purl/803914.

DOE/ORP-2000-19, 2002, *Annual Summary of ILAW Performance Assessment for 2002*, Rev. 2, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: https://www.osti.gov/servlets/purl/808401.

DOE/ORP-2000-19, 2003, *Annual Summary of the Immobilized Low-Activity Waste Performance Assessment for 2003, Incorporating the Integrated Disposal Facility Concept*, Rev. 3, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: https://www.osti.gov/servlets/purl/816310.

DOE/ORP-2000-19, 2004, *Annual Summary of the Integrated Disposal Facility Performance Assessment for 2004*, Rev. 4, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: https://www.osti.gov/servlets/purl/837629.

DOE/ORP-2000-19, 2006, *Annual Summary of the Integrated Disposal Facility Performance Assessment for 2006*, Rev. 5, U.S. Department of Energy, Office of River Protection, Richland, Washington.

DOE/ORP-2000-19, 2007, *Annual Summary of the Integrated Disposal Facility Performance Assessment for 2007*, Rev. 6, U.S. Department of Energy, Office of River Protection, Richland, Washington.

DOE/ORP-2000-24, 2001, *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=D8862887. https://pdw.hanford.gov/arpir/pdf.cfm?accession=D8862892.

DOE/ORP-2015-01, 2015, *Immobilized Low-Activity Waste Form Technical Requirements Document*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

DOE/ORP-2019-01, *FY18 Annual Summary Report for the Integrated Disposal Facility Performance Assessment*, pending, U.S. Department of Energy, Office of River Protection, Richland, Washington.

DOE/RL-97-69, 1998, *Hanford Immobilized Low-Activity Tank Waste Performance Assessment*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://www.osti.gov/servlets/purl/10148305.

DOE/RL-2009-47, 2009, *Annual Summary of the Integrated Disposal Facility Performance Assessment 2008*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://www.osti.gov/servlets/purl/1363921.

DOE/RL-2009-131, 2010, *Annual Summary of the Integrated Disposal Facility Performance Assessment 2009*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://www.osti.gov/servlets/purl/1363938.

DOE/RL-2010-121, 2011, *Annual Summary of the Integrated Disposal Facility Performance Assessment 2010*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://www.osti.gov/servlets/purl/1363949.

DOE/RL-2011-109, 2012, *Annual Summary of the Integrated Disposal Facility Performance Assessment 2011*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://www.osti.gov/servlets/purl/1363959.

DOE/RL-2012-57, 2012, *Annual Summary of the Integrated Disposal Facility Performance Assessment 2012*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: https://www.osti.gov/servlets/purl/1363963.

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

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

GAO-17-206, 2017, *Opportunities Exist to Reduce Risks and Costs by Evaluating Different Waste Treatment Approaches at Hanford*, U.S. Government Accountability Office, Washington, D.C. Available at: https://www.gao.gov/assets/690/684468.pdf.

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.

HNF-SD-WM-TI-707, 2007, *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment*, Rev. 5, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0911240117.

IDF-00002, *Waste Acceptance Criteria for the Integrated Disposal Facility*, Rev. 1 pending, CH2M HILL Plateau Remediation Company, Richland, Washington.

IDF-PRO-EN-54165, *IDF Unreviewed Disposal Question*, CH2M HILL Plateau Remediation Company, Richland, Washington.

IDF-PRO-PM-53955, *Integrated Disposal Facility Data Collection Process*, CH2M HILL Plateau Remediation Company, Richland, Washington.

Langton, C.A., 2014, *Technetium Oxidation in Slag-based Sodium Salt Waste Forms Exposed to Water and Moist Hanford Soil*, Savannah River National Laboratory, Aiken, South Carolina. Available at: http://sti.srs.gov/fulltext/SRNL-STI-2014-00399.pdf.

McGrail, B.P., C.W. Lindenmeier, P.F.C. Martin, and G.W. Gee, 1996, "The Pressurized Unsaturated Flow (PUF) Test: A New Method for Engineered-Barrier Materials Evaluation." *Trans. Am. Ceram. Soc.*72:317–329.

ORP-11242, 2011, *River Protection Project System Plan*, Rev. 6, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: https://pdw.hanford.gov/document/0093553.

ORP-11242, 2014, *River Protection Project System Plan*, Rev. 7, U.S. Department of Energy, Office of River Protection, Richland, Washington.

ORP-11242, 2017, *River Protection Project System Plan*, Rev. 8, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: https://www.hanford.gov/files.cfm/ORP-11242_System_Plan_Rev._8.pdf.

PNNL-11834, 1998, *A Strategy to Conduct an Analysis of the Long-Term Performance of Low Activity Waste Glass in a Shallow Subsurface Disposal System at Hanford*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-11834.pdf.

PNNL-11957, 1998, *Immobilized Low Activity Waste Site Borehole 299-E17-21*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/665973-RqmZ2s/webviewable/665973.pdf.

PNNL-13670, 2001, *Test Plan for Field Experiments to Support the Immobilized Low Activity Waste Disposal Performance Assessment at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/pnnl-13670.pdf.

PNNL-19945, 2010, *Soil Water Balance and Recharge Monitoring at the Hanford Site – FY 2010 Status Report*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-19945.pdf.

PNNL-20781, 2011, *Integrated Disposal Facility FY 2011 Glass Testing Summary Report*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20781.pdf.

PNNL-21812, 2013, *Integrated Disposal Facility FY 2012 Glass Testing Summary Report*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-21812Rev1.pdf.

PNNL-22747/SRNL-STI-2013-00465, 2013, *Supplemental Immobilization of Hanford Low-Activity Waste: Cast Stone Screening Tests*, Pacific Northwest National Laboratory/Savannah River National Laboratory, Richland, Washington. Available at: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22747.pdf.

PNNL-23503, 2014, *A Strategy to Conduct an Analysis of the Long-Term Performance of Low-Activity Waste Glass in a Shallow Subsurface Disposal System at Hanford*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington, Available at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23503.pdf.

PNNL-23503, 2016, *A Strategy for Maintenance of the Long-Term Performance Assessment of Immobilized Low-Activity Waste Glass*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23503Rev1.pdf.

PNNL-23693, 2014, *Geochemical Modeling of ILAW Lysimeter Water Extracts*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23693.pdf.

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

PNNL-24297/RPT-SLAW-001, 2015, *Extended Leach Testing of Simulated LAW Cast Stone Monoliths*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-24297.pdf.

PNNL-24615/RPT-IGTP-005, 2015, *Immobilized Low Activity Waste Glass Release Data Package for the Integrated Disposal Facility Performance Assessment*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-24615.pdf.

PNNL-25129/RPT-SWCS-005, 2016, *Liquid Secondary Waste Grout Formulation and Preliminary Waste Form Qualification*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-25129.pdf.

PNNL-25185, 2016, *Integrated Disposal Facility FY 2016: ILAW Evaluation of the eSTOMP Simulator*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-25185.pdf.

PNNL-25194/RPT-SWCS-006, 2016, *Secondary Waste Cementitious Waste Form Data Package for the Integrated Disposal Facility Performance Assessment*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-25194.pdf.

PNNL-25577/RPT-SLAW-003, 2016, *Getter Incorporation into Cast Stone and Solid State Characterizations*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-25577REV0.pdf.

PNNL-26169/RPT-IGTP-013, 2017, *FY2016 ILAW Glass Corrosion Testing with the Single-Pass Flow-Through Method*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26169.pdf.

PNNL-27098/RPT-IGTP-015, 2018, *FY2017 ILAW Glass Corrosion Testing with the Single-Pass Flow-Through Method*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-27098.pdf.

PNNL-27394/RPT-IGTP-017, 2018, *Field-Scale Lysimeter Studies of Low-Activity Waste Form Degradation Implementation Plan,* Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.osti.gov/servlets/purl/1460055.

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.

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/index.cfm/viewDoc?accession=0068329H.

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-18516, 2004, *Integrated Disposal Facility (IDF) Operations and Management Philosophy*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-20691, 2015, *Facility Data for the Hanford Integrated Disposal Facility Performance Assessment*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington.

RPP-26781, 2015, *Tank Operations Contractor Sampling Projections for FY2016 through FY2020*, Rev. 11, CH2M HILL Plateau Remediation Company, Richland, Washington.

RPP-CALC-61031, 2018, *Low-Activity Waste Glass Release Calculations for the Integrated Disposal Facility Performance Assessment*, Rev. 0, INTERA, Inc. for 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-ENV-58782, 2016, *Performance Assessment of Waste Management Area C, Hanford Site, Washington*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-39487, 2008, *TWINS Software Description*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-39908, 2009, *Hanford Tank Waste Operations Simulator Model (HTWOS) Version 3.0 Verification and Validation Report*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-55960, 2013, *Supplemental Immobilization of Hanford Low-Activity Waste: Cast Stone Screening Tests*, Rev. 0, Pacific Northwest National Laboratory/Savannah River National Laboratory/Washington River Protection Solutions, 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.

Scott, R.S., 2001, "Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Revision 2" (memorandum to H.L. Boston, U.S. Department of Energy, Office of River Protection and K.A. Klein, U.S. Department of Energy, Richland Operations Office), Office of Environmental Management, U.S. Department of Energy, Washington, D.C., November 1.

SRNL-STI-2015-00685, 2016, *Liquid Secondary Waste: Waste Form Formulation and Qualification*, Rev. 0, Savannah River National Laboratory, Aiken, South Carolina. Available at: http://sti.srs.gov/fulltext/SRNL-STI-2015-00685.pdf.

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

SW-846, 2015, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Compendium methods available at: https://www.epa.gov/hw-sw846/sw-846-compendium.

WA7890008967, 2007, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Washington State Department of Ecology. Available at: https://fortress.wa.gov/ecy/nwp/permitting/hdwp/rev/8c/.

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."

This page intentionally left blank.

Appendix A

DOE-STD-5002-2017, Chapter 7 – Performance Assessment/ Composite Analysis Maintenance Guide

This page intentionally left blank.

A1 Introduction

This appendix provides a crosswalk to document compliance with the performance assessment/composite analysis maintenance plan guidance in DOE-STD-5002-2017[4], Table 7-3, "Maintenance Plan Review Criteria."

ID	Review Criteria	Maintenance Plan Section(s)
MA-1	Describe the purpose and scope of the PA/CA maintenance program and provide an overview of the approach, including the site-established priorities for maintenance activities for the PA/CA, MonP, and CP. Summarize the relationship of the PA/CA MP with other relevant documents associated with the disposal facility. The PA/CA MP should be reviewed annually by the site and updated as needed to address priorities based upon new information or proposed changes, the status of any disposal authorization statement (DAS) conditions/limitations and LFRG issues. (7.2.1 Introduction)	Section 1
MA-2	Describe key assumptions regarding major aspects of the disposal facility including design, operations, waste form/inventory, and closure, essential to the performance expectations and maintenance of the PA/CA and CP until the facility is released from DOE control. It should identify major assumptions such as land use(s), point of assessment (POA), and any interacting end-state facility/waste site configurations and inventories [including decontamination and decommissioning (D&D), Resource Conservation and Recovery Act (RCRA), and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) actions] not directly related to the disposal facility. (7.2.2 Key Assumptions)	Section 2
MA-3	Provide an overview of the monitoring program and describe any planned changes to the PA/CA MonP, special monitoring studies, or monitoring-related oversight activities (e.g., site-wide groundwater model consistency committee reviews). (7.2.3 Monitoring)	Section 3
MA-4	Describe any ongoing or planned research and development (R&D) activities associated with managing and/or reducing the uncertainty associated with the PA/CA/CP. Each activity should be linked to a specific need related to the PA/CA, change control, or resolution of LFRG conditions or review issues. (7.2.4 Research and Development)	Section 4 Table 6-1
MA-5	Describe all planned and/or ongoing reviews including the disposal facility annual summary report (ASR) (Chapter 9); review of PA, CA, and other DAS technical basis documents, UDQE/SA as well as reviews of radioactive waste management basis (RWMB), or by DOE and other regulatory authorities [U.S. Environmental Protection Agency (EPA)/state/ Nuclear Regulatory Commission (NRC)]. (7.2.5 Planned Review and Analysis)	Section 5.1

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

ID	Review Criteria	Maintenance Plan Section(s)
MA-6	Identify any conditions/limits identified in the DAS; including a proposed schedule for resolution/compliance for each. A description of other conditions imposed by the PSO that require the PA/CA MP to track should be included. A schedule should be developed for resolution of DAS Conditions/Limits (e.g., revision of the MonP within 1 year of issuance of the DAS). (7.2.5.1 Status of DAS Conditions/Limits)	Section 5.2 Table 6-2
MA-7	Identify the DAS conditions/limits most commonly linked to key or secondary issues identified in the LFRG Review Report for the PA/CA or other DAS technical basis documents. Additionally, this section should specify expectations regarding the actions necessary to resolve any outstanding LFRG review secondary issues. (7.2.5.2 LFRG Key and Secondary Issues)	Section 5.3 Table 6-2 Table 6-3
MA-8	Provide a listing of planned maintenance activities and their proposed schedule (funding estimates/expectations) for each of the four essential maintenance components (compliance and performance monitoring, R&D activities, periodic reviews and analyses, and revision of the PA/CA). (7.2.6 Planned Maintenance Activities and Schedules)	Section 6
MA-9	Describe any planned or ongoing revisions of the DAS, PA, CA, PA/CA MonP, WAC, UDQE, Unreviewed Composite Analysis Question Evaluation (UCAQE), CP, or RWMB. The annual review and assessment of the PA/CA MP should be scheduled in coordination with the ASR so than any revisions to the DAS technical basis documents and the results of those revisions are reported in the ASR. (7.2.7 Revisions to DAS Documents)	Section 7
MA-10	Identify references cited in the PA/CA MP. (7.2.8 References)	Section 8
MA-11	Include appendices as necessary to provide details supporting the PA/CA MP. (7.2.9 Appendices)	Appendix A

CA = composite analysis
CP = closure plan
LFRG = Low-Level Waste Disposal Facility Federal Review Group
MonP = monitoring plan
MP = maintenance plan
PA = performance assessment
SA = special analysis
UDQE = Unreviewed Disposal Question Evaluation

CH2M HILL Plateau Remediation Company

ADMINISTRATIVE DOCUMENT PROCESSING AND APPROVAL

DOCUMENT TITLE: Assessment JRR 10/24/19 per e-mail with B. Borlaug Performance ~~Acceptance~~ Maintenance Plan for the Integrated Disposal Facility	**OWNING ORGANIZATION/FACILITY:** RRMP / IDF
Document Number: CHPRC-03348	**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

	Name	Phone Number
Author:	W. A. Borlaug	509-373-1084
Manager:	C. H. Larson	509-373-4081

DOCUMENT CONTROL

JRR 10/10/2019 per e-mail with Borlaug

Is the document intended to be controlled within the Document Management Control System (DMCS)? [x] Yes [~~x~~] No

Does document contain Scientific and Technical Information (STI) intended for public use? [x] Yes [ ] No

Does document contain Controlled Unclassified Information (CUI)? [ ] Yes [x] No

DOCUMENT REVISION SUMMARY

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

Name *(print)*	Organization
G. Pyles	DOE/RL
R. Andrews, R. Senger	INTERA
K. P. Lee	WRPS

APPROVAL SIGNATURES

Author:

W. A. Borlaug	W.A. Borlaug	10/8/2019
Print Name	*Signature*	*Date*

Responsible Manager:

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

ADD ROW

Other:

		D
Print Name	*Signature*	*Date*

RELEASE / ISSUE

DATE: Oct 24, 2019 HANFORD RELEASE

A-6005-184 (REV 7)

INFORMATION CLEARANCE FORM

Date Received for Clearance Process (MM/DD/YYYY)
07/18/2019 10/24/2019 JRR

A. Information Category

- [ ] Abstract
- [ ] Summary
- [ ] Visual Aid
- [ ] Full Paper
- [ ] Journal Article
- [ ] Internet
- [ ] Software
- [x] Report
- [ ] Other ______

B. Document Number CHPRC-03348 Revision 1

C. Title
Performance Assessment Maintenance Plan for the Integrated Disposal Facility

D. Proposed Internet Address

E. Required Information (MANDATORY)

1. Is document potentially Classified? (●) No ( ) Yes

Larson, Craig H Approved via att. IDMS data file.
Manager Required (Print and Sign)

If Yes ______
ADC Required (Print and Sign) ( ) No ( ) Yes Classified

2. Official Use Only (●) No ( ) Yes Exemption No. ____
3. Export Controlled Information (●) No ( ) Yes OUO Exemption No. 3
4. UCNI (●) No ( ) Yes
5. Applied Technology (●) No ( ) Yes OUO Exemption No. 5
6. Other (Specify) ______

7. Does Information Contain the Following:
   a. New or Novel (Patentable) Subject Matter? (●) No ( ) Yes
      If "Yes", OUO Exemption No. 3
      If "Yes", Disclosure No.: ______
   b. Commercial Proprietary Information Received in Confidence, Such as Proprietary and/or Inventions?
      (●) No ( ) Yes If "Yes", OUO Exemption No. 4
   c. Corporate Privileged Information? (●) No ( ) Yes
      If "Yes", OUO Exemption No. 4
   d. Government Privileged Information? (●) No ( ) Yes
      If "Yes", Exemption No. 5
   e. Copyrights? (●) No ( ) Yes If "Yes", Attach Permission.
   f. Trademarks? (●) No ( ) Yes If "Yes", Identify in Document.
8. Is Information requiring submission to OSTI? (●) No ( ) Yes
9. Release Level? (●) Public ( ) Limited

F. Complete for a Journal Article

1. Title of Journal

G. Complete for a Presentation

1. Title for Conference or Meeting ______
2. Group Sponsoring ______
3. Date of Conference ______
4. City/State ______
5. Will Information be Published in Proceedings? (●) No ( ) Yes
6. Will Material be Handed Out? (●) No ( ) Yes

H. Information Owner/Author/Requestor
Borlaug, Bill A Approved via att. IDMS data file.
(Print and Sign)

Responsible Manager
Larson, Craig H Approved via att. IDMS data file.
(Print and Sign)

Approval by Direct Report to President (Speech/Articles Only) ______
(Print and Sign)

I. Reviewers

Reviewers	Yes	Print	Signature	Public Y/N (If N, complete J)
General Counsel	☐			Y / N
Office of External Affairs	☐			Y / N
DOE	☒	Pyles, Gary L	Approved via att. IDMS data file.	(Y) / N
Other	☒	Ruane, Tom J	Approved via att. IDMS data file.	(Y) / N
Other	☐			Y / N
Other	☐			Y / N

J. Comments

Information Clearance Approval

APPROVED
By Julia Raymer at 10:29 am, Oct 24, 2019

Approved for Public Release; Further Dissemination Unlimited

If Additional Comments, Please Attach Separate Sheet

A-6001-401 (REV 5)

- <workflow name="(JRR) CHPRC-03348-01" id="250833807">
- <task name="Clearance Process" id="0" date-initiated="20191010T1311" performer="Julia R Raymer" performer-id="164931488" username="h3310581">
<comments>Please approve CHPRC-03348, Rev. 1, for public release. POC: Bill Borlaug (509) 373-1084 Thank you, Julia Raymer (509) 373-0230</comments>
</task>
<task name="Add XML" id="1" date-done="20191010T1311" />
<task name="Manager Approval" id="41" date-due="20191015T1311" date-done="20191016T1556" performer="Craig H Larson" performer-id="8023870" username="h0015207" disposition="Approve" authentication="true" />
<task name="Document Reviewer2" id="53" date-due="20191021T1556" date-done="20191017T0709" performer="Thomas (Tom) J Ruane" performer-id="7146942" username="h0048833" disposition="Public Release" authentication="true" />
- <task name="Document Reviewer1" id="54" date-due="20191021T1556" date-done="20191017T0728" performer="Gary L Pyles" performer-id="147601648" username="h6400308" disposition="Public Release" authentication="true">
<comments>No Comments</comments>
</task>
<task name="Doc Owner Clearance Review" id="13" date-due="20191018T0728" date-done="20191017T0833" performer="Bill A Borlaug" performer-id="210527709" username="h3932535" disposition="Send On" authentication="true" />
<task name="Milestone 1" id="24" date-done="20191017T0833" />
<task name="Milestone 2" id="62" date-done="20191017T0834" />
<task name="Verify Doc Consistency" id="4" date-due="20191018T0833" date-done="20191024T1019" performer="Julia R Raymer" performer-id="164931488" username="h3310581" disposition="Cleared" authentication="true" />
</workflow>