2017 Highlight

Closure of WMAs
- A draft DOE O 435.1 Tier 2 Closure Plan for the 241-C-200 series tanks was prepared.
- The draft DOE O 435.1 Tier 1 Closure Plan for Waste Management Area (WMA) C and the draft Waste Incidental to Reprocessing evaluation document for WMA C were updated based on DOE review.
- A draft Resource Conservation and Recovery Act of 1976 (RCRA) Tier 2 Closure Plan for WMA C and a draft RCRA Tier 3 Closure Plan for the 241-C-200 series tanks were submitted to the Washington State Department of Ecology for review.
- A grout testing program to develop grouts for closure of the C-200 Series Tanks and associated pipe encasements began.
- Characterization activities for the 241-C-301 Catch Tank began.
- An evaluation for the removal of remaining equipment in WMA C began.
- A data quality objectives process and the associated summary report for the focus area around tanks 241-A-104 and 241-A-105 in WMA A-AX were completed.

Performance Assessments
- The Integrated Disposal Facility Performance Assessment documentation was completed and the review by the Low-Level Waste Federal Review Group was initiated.

Interim Surface Barriers
- Construction of two interim surface barriers in SX Farm began.
- Design of a third interim surface barrier for SX farm was developed.

5.0 Environmental Restoration and Waste Management

Environmental restoration and waste management activities continued on the Hanford Site during 2017. The following sections describe ongoing Hanford Site River Corridor closure, cleanup, remediation, facility decommissioning, waste management operations, underground waste storage tank status, construction of the Hanford Tank Waste Treatment and Immobilization Plant (WTP) and its associated facilities, and research activities related to waste cleanup.

5.1 Cleanup and Remediation Activities

The following sections describe ongoing cleanup and remediation activities at the Hanford Site.
5.1.1 River Corridor Closure

JA Lerch

The 220-mi² (570-km²) River Corridor includes the Hanford Site’s 100, 300, and 400 Areas that border the Columbia River. The River Corridor includes nine deactivated plutonium production reactors, numerous support facilities, and liquid and solid waste disposal sites. The U.S. Department of Energy’s (DOE) focus was to complete source cleanup actions in the 100 and 300 Areas with the following principal goals:

- Deactivate, decommission, decontaminate, and demolish (D4) excess facilities
- Place former production reactors in an interim safe and stable condition
- RemEDIATE liquid and solid waste disposal sites
- Meet all regulatory requirements
- Determine the adequacy of current cleanup criteria in protecting human health and the environment
- Prepare the River Corridor for transition to the U.S. Department of Energy, Richland Operations Office (DOE-RL) Long-Term Stewardship Program (surveillance and maintenance [S&M]).

In 1991, the Tri Parties agreed to the Hanford Federal Facility Agreement and Consent Order Action Plan (Tri-Party Agreement [TPA] Action Plan) (Ecology et al. 1989c) strategy to apply available funding to actual cleanup rather than spending available resources on extensive characterization and risk assessment activities. Waste site cleanup under interim action records of decision (RODs) were initiated in the 100 and 300 Areas during the mid-1990s. The 100 Area interim ROD continues today within the River Corridor, while the 300 Area ROD is final. As the interim actions are completed, associated geographical areas are transitioned into the DOE-RL Long-Term Stewardship Program. In 2017, transitions for the River Corridor have been completed with the exception of a portion of the 100-K Reactor Area.

In parallel with continued cleanup activities, the remedial investigation/feasibility study process is being implemented for six decision areas of the River Corridor (100-B/C, 100-K, 100-N, 100-D/H, 100-F/IU-2/IU-6, and 300 Area) to integrate the interim actions and establish final cleanup decisions for source and groundwater operable units. Final action RODs were issued in November 2013 (DOE and EPA 2013) for the 300 decision area and in September 2014 (DOE and EPA 2014) for the 100-F/IU-2/IU-6 decision area. Completion of remedial investigation/feasibility study reports, public review of proposed actions, and development of RODs for the remaining four decision areas are anticipated to be completed between 2018 and 2019.

5.1.2 100 Area

This section describes ongoing cleanup and remediation activities in the 100 Area.
5.1.2.1 100-K Basins

SA McMahand

The 100-K Area remediation activities included facility demolition, waste site remediation, cleanout of the 105-K West Basin, and groundwater pump-and-treat operations. The K-West Basin is the only remaining operating nuclear facility, as explained below. The K-West Basin is undergoing cleanout that involves removing radioactive contaminated sludge and debris as a precursor to facility deactivation and demolition. For nearly 30 years, the basins stored 2,300 tons (2,100 metric tons) of N Reactor spent fuel and a small quantity of slightly irradiated single-pass reactor fuel from other Hanford Site reactors. In October 2004, the major cleanup effort to remove the fuel from the K-East and K-West Basins was completed.

This fuel corroded during storage and the fuel washing and packaging process left behind approximately 989 ft³ (28 m³) of sludge. Currently, the sludge is stored in underwater engineered containers in the K-West Basin for subsequent removal and disposition. The project’s Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) remedial design/remedial action work plan (RD/RAWP) documentation will describe the means of sludge treatment activities, including transferring sludge from KW-Basin engineered containers (ECs) into sludge transfer and storage containers (STSCs) and transporting the STSCs to T-Plant for storage as remote-handled transuranic (RH-TRU) prior to treatment and disposal. The STSCs will eventually be disposed of at the Waste Isolation Pilot Plant (WIPP). The basin floor and pit sludge is a non-homogenous mixture of debris that includes windblown sand and environmental particulates, concrete fragments from the basin walls, corrosion products from fuel canisters and fuel racks, fuel cladding pieces, tiny pieces of corroded uranium (i.e., uranium oxides, hydrates, and hydrides), ion-exchange resin beads, polychlorinated biphenyls (PCBs), and fission products. Sludge has been defined as any material that is less than or equal to 0.25 in. (0.64 cm) in size.

100-K Area Remediation Progress and Accomplishments (2017)

- Completed installing the Engineered Container Retrieval & Transfer System hardware in both the 105-K West Basin and Annex.
- Completed the K-Basin Preoperational Acceptance Testing.
- Continued groundwater pump-and-treat operations.
- Started removal of asbestos from the 165-KE Building in preparation for demolition forecast to start in 2019.
- Continued remediation of waste sites to protect human health and the environment.
- Waste sites 100-K-103, 100-K-79.9, 1607-K1, and 1607-K5 are interim closed and scheduled to be backfilled in 2018.
K-Basins Progress on Defense Nuclear Facilities Safety Board Recommendations

RA Quintero

In the 27th Annual Report to Congress (DNFSB 2017a), the Defense Nuclear Facilities Safety Board (DNFSB) identified an unresolved issue with the Hanford Site K-Basin Closure Sludge Treatment Project concerning control of Columbia River access during slurry transfers to protect the public. In a July 6, 2017 letter, the DNFSB concurred with DOE that the control set for spray release accidents, as documented in the Engineered Container Retrieval and Transfer System Preliminary Documented Safety Analysis, provided adequate protection for the public on the river. With the letter, the Board provided technical report DNFSB/TECH-41, Spray Release Accidents at the Hanford Sludge Treatment Project, (DNFSB 2017b) to DOE for information.

5.1.3 200 Areas – Central Plateau

MJ Hickey

The Central Plateau is a 75-mi² (194 km²) region near the center of the Hanford Site and includes the area designated in the Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (DOE/EIS-0222-F) and ROD (64 FR 61615) as the Industrial-Exclusive Area, a rectangular area of about 20 mi² (52 km²) in the center of the Central Plateau. The Industrial-Exclusive Area contains the 200-East and 200-West Areas, used in the past primarily for Hanford Site nuclear fuel processing and currently used for waste management and disposal activities. The Central Plateau also encompasses the CERCLA 200-Area National Priorities List site. The Central Plateau has a large physical inventory of chemical processing and support facilities, tank systems, liquid and solid waste disposal and storage facilities, utility systems, administrative facilities, and groundwater monitoring wells.

The Hanford Site Cleanup Completion Framework (DOE/RL-2009-10) defines the path forward for cleanup at the Hanford Site. The framework document defines the main components of cleanup in two main geographic areas — the River Corridor and Central Plateau. As a result of the goals established in DOE/RL-2009-10, the TPA agencies developed changes to the TPA that reflect the path forward for Central Plateau cleanup. The Central Plateau includes two principal cleanup locations: the Inner and Outer Areas. Table 5-1 shows the crosswalk from 23 source operable units on the central plateau to the 10 source operable units.

5.1.3.1 Inner Area. The Inner Area is the projected final footprint region of the Hanford Site. Dedicated to waste management and residual contamination containment, it will remain under federal ownership and control as long as potential hazards exist. Operable units within the Inner Area include those described in the sections below.

200-PW-1, 200-PW-3, 200-PW-6, and 200-CW-5 Operable Units. This operable unit group includes 22 waste sites located in the 200-East and 200-West Areas that are contaminated with plutonium or cesium from processing activities at the Plutonium Finishing Plant (PFP) and the Plutonium Uranium Extraction (PUREX) Plant. Specific sites are listed in TPA Action Plan (Ecology et al. 1989c). At the U.S. Environmental Protection Agency’s (EPA) request, the TPA agencies agreed to retain the 200-PW-1, 200-PW-3, 200-PW-6 Operable Unit group and the 200-CW-5 Operable Unit and consolidate them into a single decision.
Table 5-1. Central Plateau Operable Unit Structure.

<table>
<thead>
<tr>
<th>New Operable Unit Group</th>
<th>Description</th>
<th>Predecessor Operable Units</th>
<th>Lead Regulatory Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inner Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200-PW-1/3/6 200-CW-5</td>
<td>Plutonium-contaminated soil sites located near the PFP and cesium-contaminated sites near the Plutonium Uranium Extraction Plant</td>
<td>No change</td>
<td>EPA</td>
</tr>
<tr>
<td>200-WA-1 200-BC-1</td>
<td>Soil waste sites located in the 200-West Inner Area not included in the 200-SW-2, 200-CR-1, 200-PW-1, 200-PW-6, 200-CW-5, and 200-IS-1 Operable Units; Soil waste sites in the BC Cribs and Trenches</td>
<td>200-BC-1 200-LW-1/2 200-MG-1/2 200-MW-1 200-PW-2/4</td>
<td>EPA</td>
</tr>
<tr>
<td>200-EA-1</td>
<td>200-East Inner Area not included in the 200-SW-2, 200-CB-1, 200-CP-1, and 200-PW-3 Operable Units</td>
<td>200-CS-1 200-IS-1 200-LW-1/2 200-MG-1/2</td>
<td>Ecology</td>
</tr>
<tr>
<td>200-IS-1</td>
<td>Selected pipelines, diversion boxes, etc. in the Inner Area</td>
<td></td>
<td>Ecology</td>
</tr>
<tr>
<td>200-SW-2</td>
<td>Solid waste burial grounds and waste sites in the footprint of the burial grounds</td>
<td>200-CW-1 200-MG-1/2</td>
<td>Ecology</td>
</tr>
<tr>
<td>200-DV-1</td>
<td>Selected soil waste sites in the Inner Area with deep vadose zone contamination</td>
<td>200-TW-1/2</td>
<td>Ecology</td>
</tr>
<tr>
<td>200-CB-1</td>
<td>B-Plant Canyon; associated waste sites</td>
<td>200-IS-1 200-MG-1/2 200-MW-1</td>
<td>Ecology</td>
</tr>
<tr>
<td>200-CP-1</td>
<td>PUREX Canyon; associated waste sites</td>
<td>200-IS-1 200-MG-1/2</td>
<td>Ecology</td>
</tr>
<tr>
<td>200-CR-1</td>
<td>REDOX Canyon; associated waste sites</td>
<td>200-IS-1 200-MG-1/2</td>
<td>EPA</td>
</tr>
<tr>
<td>200-CU-1</td>
<td>U-Plant Canyon; associated waste sites</td>
<td>No change</td>
<td>EPA</td>
</tr>
<tr>
<td><strong>Outer Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200-OA-1 200-CW-1 200-CW-3</td>
<td>Sites located in the Outer Area 200-OA-1 contains soils sites not in 200-CW-3 that were in the previous OUs 200-CW-1 contains ponds not in 200-CW-3 200-CW-3 contains sites associated with the 200 North Areas.</td>
<td>200-CS-1 200-CW-1 200-CW-3 200-IS-1 200-MG-1/2</td>
<td>EPA</td>
</tr>
</tbody>
</table>


The selected remedy in the ROD addresses soils and subsurface disposal structures contaminated primarily with plutonium and cesium, two settling tanks, and associated pipelines. The remove, treat, and dispose approach for contaminated soil and debris will be used to address plutonium contaminated soils and subsurface structures, and consists of removing a portion of contaminated soil, structures,
settling tanks, and associated debris; treating these removed wastes as required to meet disposal requirements at ERDF (Section 5.4.3.7) or waste acceptance criteria for offsite disposal at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico; and disposing at ERDF or WIPP. The 200-CW-5 Operable Unit (also known as the U Pond and Z-Ditches) will use the remove, treat, and dispose approach to excavate contaminated soils and dispose at ERDF or the WIPP, as appropriate.

Three of the six 200-PW-1 waste sites will use the remove, treat, and dispose approach to excavate the highest concentrations of contaminated soils located up to 2 ft (0.6 m) below the bottom of the structure and dispose at ERDF or the WIPP, as appropriate. An evapotranspiration barrier will be constructed over the remaining waste in these waste sites.

- **200-PW-3 Operable Unit.** Also known as the Cesium-137 Waste Group, this operable unit will require additional backfill for three of the five waste sites to achieve coverage of a depth of at least 15 ft (4.57 m). Contamination at the other two waste sites is deeper than 15 ft (4.57 m) from the ground surface and will not require additional backfill.

- **200-PW-6 Operable Unit.** This operable unit and three of the six 200-PW-1 waste sites will use the remove, treat, and dispose approach to excavate a significant portion (~90%) of the contaminated soils to a depth of 33 ft (10 m) below ground surface and dispose at ERDF or WIPP, as appropriate. An evapotranspiration barrier will be constructed over the remaining waste at these sites. A soil vapor extraction (SVE) system was used to remove and treat carbon tetrachloride contamination at waste sites in the High-Salt Waste Group. During SVE operations, vapor-phase carbon tetrachloride was extracted through multiple vadose zone wells and adsorbed onto granular activated carbon before the treated, clean vapor was released to the atmosphere. Between 1992 and 2012, the last year of SVE operation, 88.3 tons (80,107 kg) of carbon tetrachloride were removed from the vadose zone. This remedy was evaluated using the process outlined in PNBNL-21843, Soil Vapor Extraction System Optimization, Transition, and Closure Guidance, and DOE/RL-2014-18, Path Forward for Future 200-PW-1 Operable Unit Soil Vapor Extraction Operations. In November 2015, EPA concurred that the SVE remedy met the remedial action objectives in the ROD and that SVE activities could be ended. EPA concurrence with the response action report (DOE/RL-2014-48, Response Action Report for the 200-PW-1 Operable Unit Soil Vapor Extraction Remediation) in August 2016 closed out the SVE portion of the 200-PW-1 Operable Unit remedy in the ROD and initiated activities to terminate SVE operations and vadose zone monitoring. Institutional controls and long-term monitoring will be required for waste sites in the 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units where waste is left in place and unrestricted land use is precluded.

**200-WA-1/200-BC-1 Operable Unit (200-West Inner Area).** This operable unit group includes source waste sites located in the BC Cribs and Trenches and soil waste sites in the Inner Area portion of the 200-West Area not included in the 200-CR-1, 200-CW-5, 200-IS-1, 200-PW-1, 200-PW-6, and 200-SW-2 Operable Units. Specific sites are listed in the TPA Action Plan (Ecology et al. 1989c); additional sites may be added to the 200-WA-1/200-BC-1 Operable Unit as new waste sites in the geographic area are discovered or created (e.g., soil that is determined to require additional evaluation or remediation following demolition of a structure). DOE/RL-2010-49, Remedial Investigation/Feasibility Study Work Plan 200-WA-1 and 200-BC-1 Operable Units was issued in January 2017. In addition, DOE obtained approval of DOE/RL-2009-94, 216-U-8 Crib and 216-U-12 Crib Vadose Zone Characterization Sampling and Analysis Plan, which supports the 200-WA-1 Operable Unit remedial investigation.
200-EA-1 Operable Unit (200-East Inner Area). This operable unit consolidates the remaining Inner Area source sites in the 200-East Area except for the environmental media underlying tank farm waste management areas (WMA), landfills in the 200-SW-2 Operable Unit, 200-IS-1 waste sites, PUREX, B-Plant Canyon, and several waste sites with deep vadose zone contamination that are adjacent to WMA environmental media sites. Specific sites are listed in Appendix C to the TPA Action Plan (Ecology et al. 1989c); additional sites may be added to the 200-EA-1 Operable Unit as new waste sites in the geographic area are discovered or created (e.g., soil that is determined to require additional evaluation or remediation following demolition of a structure). The 200-EA-1 Operable Unit will use a comprehensive application of the technical cleanup principles for the Inner Area developed for the 200-WA-1 Operable Unit.

Analysis for the 200-EA-1 Operable Unit will follow the same pattern as the 200-WA-1 Operable Unit and will utilize the same technical basis documents and comprehensive alternatives evaluation to clearly demonstrate how selected remedies for each fit within the framework of impacts from the entire Inner Area. The 200-EA-1 work plan has been initiated.

200-IS-1 Operable Unit. This operable unit includes select inactive waste transfer pipelines and pipeline components in the 200-IS-1 Operable Unit and soil waste sites in the Inner Area that are not included in the canyon area operable units (i.e., 200-EA-1, 200-WA-1, 200-SW-2) or in the tank farm WMAs. Specific sites are listed in the TPA Action Plan (Ecology et al. 1989c).

The TPA agencies agreed to use a coordinated CERCLA remedial action and Resource Conservation and Recovery Act of 1976 (RCRA) corrective action process for cleanup decisions in the pipelines operable unit group. The 200-IS-1 Operable Unit Pipeline System Waste Sites RFI/CMS/RI/FS Work Plan (DOE/RL-2010-114) was issued in September 2011. The work plan is undergoing revision and finalization.

200-SW-2 Operable Unit (Burial Grounds). This operable unit includes 24 landfills located in the 200-East and 200-West Areas. Three soil waste sites located within the boundary of one of the burial grounds were added to the 200-SW-2 Operable Unit during restructuring. Specific sites are listed in the TPA Action Plan (Ecology et al. 1989c). Portions of the burial grounds listed in the RCRA Permit (WA7890008967) include treatment, storage, and disposal (TSD) facilities. DOE is working with the Washington State Department of Ecology (Ecology) to remove unused areas from the permit scope.

The TPA agencies agreed to use a coordinated CERCLA remedial action and RCRA corrective action process for cleanup decisions in the 200-SW-2 Operable Unit. DOE/RL-2004-60, 200-SW-2 Radioactive Landfills Group Operable Unit RCRA Facility Investigation/Corrective Measures Study/Remedial Investigation/Feasibility Study Work Plan, was issued in June 2016 and mobilization of field activities to conduct the remedial investigation was initiated. A helicopter radiological survey was completed over the majority of the inner area and a summary report to present the findings of the survey was issued in March 2018.

200-DV-1 Operable Unit (Deep Vadose Zone). This operable unit includes 43 soil waste sites located in the Inner Area that were previously located in the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units. Specific sites are listed in the TPA Action Plan (Ecology et al. 1989c). The Remedial Investigation/Feasibility Study and RCRA Facility Investigation/Corrective Measures Study Work Plan for the 200-DV-1 Operable Unit (DOE/RL-2011-102) was approved by Ecology on September 13, 2016. The Long-Range Deep Vadose Zone Program Plan (DOE/RL-2010-89), issued in October 2010, summarizes
the state of knowledge about contaminant cleanup challenges faced by the deep vadose zone beneath the Central Plateau and the approach to solving those challenges. Field activities associated with the remedial investigation will be completed in 2018.

**200-CB-1 Operable Unit (B-Plant Canyon).** This operable unit includes the B-Plant Canyon Building (221-B) and the Waste Encapsulation and Storage Facility (WESF), along with exterior ventilation system components for each structure (e.g., high-efficiency particulate air [HEPA] filters and sand filter) and 17 soil waste sites within the vicinity. Specific sites are listed in the TPA Action Plan (Ecology et al. 1989c); additional sites may be added to the 200-CB-1 Operable Unit as new waste sites in the geographic area are discovered or created (e.g., soil that is determined to require additional evaluation or remediation following demolition of a structure). Sites near the B-Plant Canyon currently assigned to the 200-IS-1 Operable Unit are in the process of being reassigned to the 200-CB-1. Additionally, sites currently assigned to the 200-IS-1 Operable Unit may be reassigned to the 200-CB-1 Operable Unit pending the outcome of discussions among the TPA agencies. Cesium and strontium capsules located in the WESF are not included in the scope of the 200-CB-1 Operable Unit.

**200-CU-1 Operable Unit (U-Plant Canyon).** This operable unit includes the U-Plant Canyon Building (221-U) and other structures included in the ROD for the U-Plant Canyon (DOE et al. 2005). The U-Plant Canyon Disposition Initiative is a pilot project for disposition of the five canyon buildings in the 200-East and West Areas. Implementation of the selected remedial action (close in place – partially demolished structure) began in 2009. Additionally, sites currently assigned to the 200-IS-1 Operable Unit may be reassigned to the 200-CP-1 Operable Unit pending the outcome of discussions among the TPA agencies.

**200-CP-1 Operable Unit (PUREX Canyon).** This operable unit includes the PUREX Canyon Building (202-A), PUREX Storage Tunnels (218-E-15 and 218-E-16), exterior components of the ventilation system for each structure (e.g., deep bed filters), and 20 soil waste sites in the vicinity. Specific sites are listed in the TPA Action Plan (Ecology et al. 1989c); additional sites may be added to the 200-CP-1 Operable Unit as new waste sites in the geographic area are discovered or created (e.g., soil determined to require additional evaluation or remediation following demolition of a structure). Sites near PUREX currently assigned to the 200-EA-1 Operable Unit are in the process of being reassigned to the 200-CP-1 Operable Unit. Additionally, sites currently assigned to the 200-IS-1 Operable Unit may be reassigned to the 200-CP-1 Operable Unit pending the outcome of discussions among the TPA agencies. The 200-CP-1 work plan has not been initiated.

**200-CR-1 Operable Unit (REDOX Canyon).** This operable unit includes the Reduction-oxidation (REDOX) Canyon Building (202-S), exterior components of the ventilation system (e.g., filters), and 12 soil waste sites located in the vicinity. Specific sites are listed in the TPA Action Plan (Ecology et al. 1989c); additional sites may be added to the 200-CR-1 Operable Unit as new waste sites in the geographic area are discovered or created (e.g., soil that is determined to require additional evaluation or remediation following demolition of a structure). Sites near the REDOX Canyon Building currently assigned to the 200-IS-1 Operable Unit may be reassigned to the 200-CR-1 Operable Unit pending the outcome of discussions among the TPA agencies. The 200-CR-1 work plan has not been initiated. Additionally, sites currently assigned to the 200-IS-1 Operable Unit may be reassigned to the 200-CR-1 Operable Unit pending the outcome of discussions among the TPA agencies.

**5.1.3.2 Outer Area.** The Outer Area is defined as all areas of the Central Plateau beyond the boundary of the Inner Area. The Outer Area covers approximately 65 mi² (168 km²) and contains more than
90 waste sites and structures scattered throughout the largely undisturbed sagebrush-steppe habitat. Most of the waste sites in the Outer Area are small near-surface sites that will be removed for treatment as needed for onsite disposal or sampled to confirm that no additional action is required apart from implementing appropriate institutional controls. The largest components of Outer Area remediation are ponds where cooling water and chemical sewer effluents were discharged and the BC Control Area where surface contamination was spread through animal intrusion.

**200-CW-1, 200-CW-3, and 200-OA-1 Operable Units (Outer Area).** Soil waste sites in the Outer Area requiring cleanup are assigned to one of the following three operable units.

- **200-CW-1 Operable Unit** – Contains ponds used for discharging large volumes of cooling water and other effluents with low levels of contamination or that were only potentially contaminated. There are 14 sites in the 200-CW-1 Operable Unit, including eight ponds and associated sewer lines, control structures, and unplanned releases.

- **200-CW-3 Operable Unit** – Contains 16 sites that were associated with operating the 200-North Area, a small complex initially used for temporary storage of spent nuclear fuel and later for storing miscellaneous materials and rail cars. The soil waste sites (e.g., trenches, small ponds, septic tanks, and sewer lines) were cleaned up as part of interim actions conducted from 2005 through 2010.

- **200-OA-1, Operable Unit** – Incorporates soil waste sites from several previous operable units (Table 5-1).

DOE/RL-2011-58, **200-CW-3 Operable Unit Interim Remedial Action Report**, was issued in September 2011. The summary of waste site remediation activities, cleanup processes, and cost information will support developing a final remedial action for the Outer Area of the Hanford 200 Areas’ National Priorities List site.

**Nonradioactive Dangerous Waste Landfill and Solid Waste Landfill.** The Nonradioactive Dangerous Waste Landfill (NRDWL) and Solid Waste Landfill (SWL) are located in the Outer Area and are not included in the operable units described above. The NRDWL is a RCRA-permitted disposal facility for dangerous waste generated at the Hanford Site that was not contaminated with radioactive materials. The NRDWL received dangerous waste from 1975 through 1985, asbestos waste through 1988, and sanitary solid waste in 1976. The SWL is a non-RCRA solid waste landfill south of the NRDWL. The SWL received non-dangerous and nonradioactive solid waste including paper, construction debris, asbestos, and lunchroom waste from 1973 to early 1996. The SWL also received up to 1.3 million gal (5 million L) of sewage and 100,000 gal (380,000 L) of garage wash water. Because the NRDWL is a RCRA-permitted TSD site, closure is being managed in accordance with WAC 173-303, “Dangerous Waste Regulations”; the SWL is regulated under WAC 173-350, “Solid Waste Handling Standards.”

### 5.1.4 300 Area

*LM Dittmer and RL Cathel*

#### 5.1.4.1 618-10, 316-4, and 600-63 Waste Sites.** The 618-10, 316-4, and 600-63 are co-located in the 600 Area of the Hanford Site, approximately 4 miles northwest of the 300 Area. (Figure 5-1)
When operational, the 5.7–ac (2.3-ha) 618-10 Burial Ground received a variety of waste from 300 Area operations, primarily waste material contaminated with fission products, disposed in 12 burial trenches and 94 vertical pipe units. Intrusive remediation of the 618-10 Burial Ground was initiated in 2011 and completed in 2017. At the completion of field remediation, the total excavation area was approximately 2,380,000 ft$^2$ (221,100 m$^2$) in area with a maximum depth of approximately 36 ft (11 m) below the surrounding grade. Final remediation resulted in a total of 526,700 tons (477,820 metric tons) of material being disposed at the Environmental Restoration Disposal Facility.

The 316-4 Liquid Waste Disposal Crib, located adjacent to the 618-10 Burial Ground, consisted of two 8 ft (2.4 m) diameter by 7 ft (2.1 m) tall bottomless tanks, buried 10 ft (3 m) below grade, resting on a gravel base. The crib was used for disposal of uranium-bearing organic waste from the 321 Building between 1948 and 1962. An initial remediation effort conducted in 2004 and 2005 removed the crib structure, as well as contaminated soil to a depth of 26 ft (7.9 m) below ground surface.

Although contamination extended to groundwater, the remediation of contaminated soil was not completed due to the proximity to the 618-10 Burial Ground, the boundary of which interfered with the required excavation layback for 316-4. The excavation was backfilled in 2005; final remediation to remove contamination to the soil/groundwater interface at a depth of 66 ft (20.1 m) began in November 2016 and was completed in May 2017. The total area of the excavation was approximately 404,700 ft$^2$ (37,600 m$^2$), resulting in a total 730,700 ft$^3$ (20,700 m$^3$) of material being disposed at the Environmental Restoration Disposal Facility. The clean overburden and layback material (5,907,600 ft$^3$ [167,300 m$^3$]) was stockpiled for use as backfill material.
The 600-63 Buried Waste Test Facility, also called the 300-N Lysimeter Area, was constructed in 1978 to investigate moisture recharge and radionuclide migration at the Hanford Site and was identified as a waste site requiring remediation in the 300 Area Final ROD (EPA 2013). Tracers, consisting of cobalt-60 and tritium, were placed in lysimeters, measured amounts of water were added, and migration of the contaminants was monitored. The original excavated depth of the site was 30 ft (9.1 m). Remediation of the 600-63 Buried Waste Test Facility was completed in July 2017 and resulted in 250,600 ft³ (7,100 m³) of material being disposed at the Environmental Restoration Disposal Facility.

Following backfill, the three waste site footprints and the supporting infrastructure (trailer areas, container transfer area, parking and roads) are being re-graded and re-contoured to return the area to a natural landscape. Revegetation will be completed between November 2018 and January 2019.

5.1.4.2 300-296 Waste Site. Today, the focus of the project is the remote excavation of the highly contaminated soil beneath the 324 Building B-Cell. The 300-296 Remote Soil Excavation Project is designing and procuring equipment and components that will be used to remove debris and grout from the B-Cell, cut and remove the B-Cell floor, and remotely excavate the highly contaminated soil to establish conditions for demolition in the future. In addition to facility modifications to support the installation of soil removal equipment, structural modifications will be performed to underpin the B-Cell to prevent settling during the removal of the underlying contaminated soil.

The first 324 Building Airlock entry took place on April 10, 2017, which represented an important transition from planning to execution for critical prerequisite actions to prepare for 324 Building modifications and, ultimately, B-Cell activities leading to soil removal. All debris has been removed from the airlock as of November 2017.

History was made in December 2017 with the first person entry into 324 Building C-Cell in over 15 years, marking the initiation of C-Cell cleanout activities. Fifty percent of the C-Cell debris has been removed. During 2017, 33 manned entries were made into the airlock and/or C-Cell. In addition to 6,180 ft³ (175 m³) of waste and debris removed, the Televator was also removed.

The project scope also includes the utilization of a Mockup of the B-Cell and the Airlock for equipment performance validation, training, and proficiency development for operations planned for the 324 Building during soil removal. The Mockup will be maintained and operated throughout the project to support refresher training, contingency development and response planning, and provide spare equipment during operations for any unplanned occurrences or challenges.

Mockup modifications required to support remote soil removal system installations (including core drilling, master slave manipulator installation, and camera mount installation) were completed. The trailer to support the mockup training mission was reconfigured.

Full-scale floor saw testing was completed at the Maintenance and Storage Facility that demonstrated successful system performance. Floor break-up and removal with remote excavator arm tools was demonstrated.

5.1.4.3 300 Area Waste Sites. Planning was initiated in 2017 for the interim stabilization of three waste sites in the 300 Area, including the 300-5, 331-LSLT1 and 331-LSLT2 sites. The 300-5 site consists of fuel contaminated soil from previously removed buried fuel tanks and the 331-LSLT1 and 331-LSLT2 sites are
former waste trenches that accepted liquid animal waste. All three of these sites will be covered by impermeable barriers to prevent water intrusion into the contaminated soil. Activities completed in calendar year (CY) 2017 in preparation for installation of the barriers include preparation of an ecological/cultural assessment of the areas, completion of topographical surveys, and preparation of design sketches for barrier and water drainage construction.

5.2 Facility Decommissioning Activities

This section provides information regarding the transition of Hanford Site facilities from stabilization to S&M and eventual decommissioning. Decommissioning activities include the interim safe storage of plutonium production reactors and deactivation and decommissioning of facilities in the 100, 200, 300, and 400 Areas and ancillary reactor facilities.

5.2.1 100 Area

As of 2017, all D4 activities in the 100 Area have been completed with the exception of a portion of the 100-K Area.

5.2.2 200 Areas – Central Plateau

Central Plateau facilities include buildings and waste sites in the 200-East, 200-West, and 200-North Areas and those on the adjoining Rattlesnake Unit (Arid Lands Ecology Reserve). The transition toward decommissioning encompasses surveillance, maintenance, and deactivation activities.

5.2.2.1 Plutonium Finishing Plant Decommissioning Progress

WG Cox

The PFP began processing plutonium nitrate solutions into metallic plutonium during 1949 for shipment to nuclear weapons-production facilities. Operation of this plant continued into the late 1980s. The DOE issued a shutdown order for PFP in 1990. In 1996, DOE authorized the deactivation and transition of plutonium-processing portions of the facility in preparation for decommissioning.

All special nuclear materials and stored fuel elements have been removed from the plant; security was downgraded by the end of 2009. Preparations for demolition were completed and demolition of the four main PFP buildings commenced in 2017. Figure 5-2 was taken in February 2018 but provides an overview of the progress made in 2017.
Plutonium Finishing Plant Complex. The final demolition preparations were completed for 234-SZ and 291Z Buildings. Demolition activities continued on 236Z, demolition of 242Z/ZA and 291Z commenced and were completed, and demolition of 234-SZ was started in 2017. Work was stopped in December when contamination was found outside the radiologically controlled area.

A summary of activities completed in 2017 for each of the four remaining buildings in the PFP Complex is provided below:

- **234-SZ, Plutonium Finishing Plant**
  - Completed demolition preparations in September
  - Initiated demolition on the east side of the building.

- **236Z, Plutonium Reclamation Facility**
  - Completed removal and packaging of gallery gloveboxes in November
  - Completed removal and packaging of strongbacks in December
  - Completed 90% of demolition activities and remaining rubble was covered under soil.

- **242Z/ZA, Americium Facility**
  - Completed demolition in April.

- **291Z, Exhaust Fan House**
  - Completed demolition in July (only top few feet of building removed).

More than 1,500 roll-on/roll-off containers of rubble were shipped to the Environmental Restoration Disposal Facility in 2017.
5.2.2.2 Canyon Disposition Initiative

*D Singleton*

The Canyon Disposition Initiative was created to investigate the potential for using the five former chemical separations facilities (B-Plant, T-Plant, U-Plant, PUREX Plant, and REDOX Plant) in the 200 Areas as disposal facilities for Hanford Site remediation waste rather than demolishing these canyon buildings. The U-Plant was selected as a pilot project for the Canyon Disposition Initiative. The remaining canyon buildings are to be addressed individually, building on previous canyon disposition work.

Planning and sampling activities to support preparation of a CERCLA feasibility study for implementing the Canyon Disposition Initiative at U-Plant began in the mid-1990s. In fall 2005, EPA issued an ROD (DOE et al. 2005) with a remedy that calls for the process equipment already in U-Plant to be consolidated into the belowground plant process cells and for the cells, two lower galleries, and other void spaces to be filled with grout. The exterior walls and roof would then be collapsed in place and the site would be covered with an engineered barrier.

Implementation of the selected alternative began in 2009 for the 221-U facility. By October 2011, the equipment consolidation phase had been completed and facility voids below the canyon deck level (i.e., process cells, hot pipe trench, piping and electrical galleries, drain header, process sewer, and ventilation tunnel and ducts) were filled with grout in accordance with DOE/RL-2006-21, Remedial Design/Remedial Action Work Plan for the 221-U Facility. Due to the concerted effort to remove PFP, no action has been taken on this initiative since 2011.

5.2.3 300 Area

*Bob Cathel*


5.2.4 400 Area

*SA McMahand*

FFTF is a formerly operating 400-megawatt (thermal) liquid-metal cooled (sodium) research and test reactor located in the 400 Area (Figure 5-3). Built in the late 1970s, the original mission of the facility was to develop and test advanced fuels and materials and to serve as a prototype facility for future Liquid Metal Fast Breeder Reactor Programs. Other missions were also pursued. FFTF operated from April 1982 to April 1992 and provided the nuclear industry with significant advances in fuel performance, medical isotope production, material performance, and passive and active safety systems testing. The reactor was placed in a standby mode in December 1993. After multiple studies, a decision was made to complete facility deactivation, including removing all nuclear fuel, draining the sodium systems, and deactivating systems and equipment to place the facility in a low-cost, long-term S&M condition, all of which was completed in June 2009. FFTF remains in long-term S&M and routine surveillances are performed annually.

The FFTF decommissioning was included in DOE/EIS-0391, Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington, issued on November 12, 2012. The supplement analysis (DOE/EIS-0391D-SA-01), issued in February 2012,
concluded that there were no substantial changes. The DOE issued the final ROD on FFTF decommissioning on December 13, 2013 (78 FR 75913). The decision established that DOE will implement entombment, which would remove all above-grade structures including the reactor building. The below-grade structures, the reactor vessel, piping, and other components would remain in place and be filled with grout to immobilize the remaining radioactive and hazardous constituents. Waste generated from these activities would be disposed at the Integrated Disposal Facility (IDF) with an engineered modified RCRA Subtitle C barrier constructed over the filled area. Remote-handled special components would be processed at Idaho National Laboratory and returned to Hanford. Bulk sodium inventories would be processed at Hanford for use in the WTP.

Also at the 400 Area (outside the FFTF Property Protected Area) is a mammoth structure called the Fuels and Materials Examination Facility (FMEF). Although the FMEF was intended to be a support building for the FFTF and the future Liquid Fast-Breeder Reactor Program, the FMEF was never used in any kind of a nuclear capacity. When the nation abandoned the breeder reactor program, FMEF was also left without a mission and remains unused and largely vacant today.

Future activities will address demolition of 400 Area surplus facilities.

Figure 5-3. Aerial View of the Fast Flux Test Facility.

5.3 Waste Management Activities

WE Toebe

This section provides information regarding Hanford Site liquid and solid waste management.

5.3.1 Waste Classifications

Hanford Site cleanup operations result in the generation of solid wastes that must be evaluated for proper management. Solid wastes are reviewed against procedures in WAC 173-303-070(3).
“Designation of Dangerous Waste,” and are considered dangerous (i.e., hazardous) when the criteria for this classification are met. The radionuclides in solid waste are exempt from evaluation under WAC 173-303-070(3) but are subject to evaluation and categorization as transuranic, high-level waste (HLW), or low-level waste (LLW) under the Atomic Energy Act of 1954 (AEA). Wastes that contain constituents regulated under both WAC 173-303 and the AEA are classified as mixed wastes.

Radioactive and/or mixed wastes are managed in several ways. HLW is stored in large underground single-shell and double-shell tanks (DSTs). LLW typically is stored in tanks or containers. The method used to store LLW depends on the source, composition, and waste concentration. Transuranic waste is stored in vaults, in storage buildings, on aboveground storage pads, and underground pending future retrieval. DOE/RL-2018-12, Hanford Site Annual Dangerous Waste Report, lists the dangerous and mixed wastes that are generated, treated, and disposed of onsite or shipped offsite. Dangerous and mixed wastes are treated, stored, and prepared for disposal at several Hanford Site facilities. Dangerous waste generated at the site is shipped offsite for treatment and/or disposal. Some types of dangerous waste, such as used lead–acid batteries and aerosol products (e.g., spray paint), are shipped offsite for recycling.

Waste that does not contain hazardous or radioactive substances is non-regulated waste. Historically, non-regulated waste generated at the Hanford Site was disposed onsite. Beginning in 1999, non-regulated waste (e.g., refuse and drummed nonhazardous waste) has been disposed of at municipal or commercial solid waste disposal facilities. Non-regulated waste originates at several areas across the Hanford Site. Examples include construction debris, office trash, cafeteria waste, and packaging materials. Other materials and items classified as non-regulated waste include solidified filter backwash and sludge from the treatment of Columbia River water, failed and broken equipment and tools, air filters, uncontaminated used gloves and other clothing, and certain chemical precipitates (e.g., oxalates). Non-regulated demolition waste from the 100 Area decommissioning projects was buried in situ (in place) or in designated disposal locations on the Hanford Site. Unregulated medical waste is similar to typical household waste consisting of papers and plastics that are categorized as non-infectious. Regulated medical waste is waste that may transmit infection from a virus, bacteria, or parasite to humans. Since 1996, medical waste found at Hanford has been shipped to a commercial medical waste treatment and disposal facility.

5.3.2 Solid Waste Inventories
K Clem, KL Chase

The Solid Waste Information and Tracking System is a computer database used to track a portion of mixed and radioactive waste at the Hanford Site, primarily non-CERCLA containerized waste managed by CH2M Plateau Remediation Company (CHPRC), Mission Support Alliance (MSA), and Washington River Protection Solutions, LLC (WRPS). The database includes all waste necessary for all annual reporting requirements from DOE. The database does not include high-level radioactive waste volumes managed at Hanford Site tank farms.

As of December 31, 2017, quantities for both mixed and radioactive wastes generated onsite or received from offsite sources and disposed at the Hanford Site as tracked by the Solid Waste Information and Tracking System database are shown in Tables 5-2 and 5-3. Quantities of dangerous waste shipped offsite as tracked by the database are shown in Table 5-4. Hanford Site solid waste management is discussed in Section 5.3.3. All data is as of December 31, 2017.
### Table 5-2. Solid Waste\(^a\) Quantities Generated on the Hanford Site.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed</td>
<td>Tons</td>
<td>522</td>
<td>305</td>
<td>206</td>
<td>140</td>
<td>657</td>
<td>609</td>
</tr>
<tr>
<td></td>
<td>Metric tons</td>
<td>474</td>
<td>277</td>
<td>187</td>
<td>127</td>
<td>596</td>
<td>552</td>
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<tr>
<td>Radioactive</td>
<td>Tons</td>
<td>4,022</td>
<td>343</td>
<td>513</td>
<td>572</td>
<td>1550</td>
<td>665</td>
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<tr>
<td></td>
<td>Metric tons</td>
<td>3,649</td>
<td>311</td>
<td>465</td>
<td>519</td>
<td>1408</td>
<td>603</td>
</tr>
</tbody>
</table>

\(^a\) Solid waste includes containerized liquid waste.

### Table 5-3. Solid Waste\(^a\) Quantities Received on the Hanford Site from Offsite Sources.

<table>
<thead>
<tr>
<th>Waste Category(^b)</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed</td>
<td>Tons</td>
<td>320</td>
<td>66</td>
<td>36.5</td>
<td>38.4</td>
<td>97.9</td>
<td>105</td>
</tr>
<tr>
<td></td>
<td>Metric tons</td>
<td>290</td>
<td>60</td>
<td>33</td>
<td>35</td>
<td>88.9</td>
<td>95.3</td>
</tr>
<tr>
<td>Radioactive</td>
<td>Tons</td>
<td>257</td>
<td>82</td>
<td>62.8</td>
<td>57</td>
<td>91.4</td>
<td>113</td>
</tr>
<tr>
<td></td>
<td>Metric tons</td>
<td>233</td>
<td>74</td>
<td>60</td>
<td>52</td>
<td>82.9</td>
<td>102</td>
</tr>
</tbody>
</table>

\(^a\) Solid waste includes containerized liquid waste. Solid waste quantities do not include U.S. Navy reactor compartments.

\(^b\) Total includes Hanford Site-generated waste treated by an offsite contractor and returned as newly generated waste. Includes both low-level radioactive and transuranic waste.

### Table 5-4. Dangerous Waste\(^a\) Quantities Shipped Off the Hanford Site.

<table>
<thead>
<tr>
<th>Waste Category(^b)</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Containerized (DW Only)</td>
<td>Tons</td>
<td>53</td>
<td>18</td>
<td>65.4</td>
<td>103</td>
<td>76.8</td>
<td>69.4</td>
</tr>
<tr>
<td></td>
<td>Metric tons</td>
<td>48(^b)</td>
<td>16.3(^b)</td>
<td>59.3(^b)</td>
<td>93.4(^b)</td>
<td>69.7(^b)</td>
<td>63.0</td>
</tr>
<tr>
<td>Containerized (MW Only)</td>
<td>Tons</td>
<td>43</td>
<td>91</td>
<td>50.6</td>
<td>33.7</td>
<td>65.7</td>
<td>69.7</td>
</tr>
<tr>
<td></td>
<td>Metric tons</td>
<td>39(^c)</td>
<td>82.5(^c)</td>
<td>45.9(^c)</td>
<td>30.6(^c)</td>
<td>59.6(^c)</td>
<td>63.2</td>
</tr>
<tr>
<td>Bulk Solids (DW Only)</td>
<td>Tons</td>
<td>26</td>
<td>3</td>
<td>—</td>
<td>22.1</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Metric tons</td>
<td>23.6</td>
<td>2.7</td>
<td>—</td>
<td>20.1</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Bulk Solids (Non-Rad/Non-DW)</td>
<td>Tons</td>
<td>120</td>
<td>17</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Metric tons</td>
<td>108.9</td>
<td>15.4</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Bulk Liquids (DW Only)</td>
<td>Tons</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>22</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Metric tons</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>20</td>
<td>—</td>
<td>1.36</td>
</tr>
<tr>
<td>Bulk Liquids (Non-Rad/Non-DW)</td>
<td>Tons</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Metric tons</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Totals</td>
<td>Tons</td>
<td>242</td>
<td>129</td>
<td>116</td>
<td>181</td>
<td>142</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>Metric tons</td>
<td>219</td>
<td>117</td>
<td>105</td>
<td>164</td>
<td>129</td>
<td>127</td>
</tr>
</tbody>
</table>

\(^a\) Does not include Toxic Substances Control Act waste

\(^b\) Dangerous waste only

\(^c\) Mixed waste (radioactive and dangerous)

— = no data met the criteria

DW = dangerous waste

MW = mixed waste
5.3.3 Solid Waste Management

Solid waste management includes treatment, storage, and disposal of solid waste and nuclear material produced during Hanford Site operations or received back from offsite sources authorized by DOE to ship waste to the site (e.g., Perma-Fix Northwest, U.S. Navy). These facilities are operated and maintained in accordance with state and federal regulations and facility permits. The following sections describe specific waste management locations at the Hanford Site.

5.3.3.1 Central Waste Complex. A solid waste storage facility located in the 200-West Area (Figure 5-4), the CWC operates under interim status standards specified in the RCRA Permit (WA7890008967), CWC Part A Form. CWC receives waste from the Hanford Site and offsite sources authorized by DOE to ship waste to the site for treatment, storage, and disposal; however, the majority of waste received at the CWC is generated from ongoing cleanup, research, and development activities at the Hanford Site. Waste types include low-level, mixed low-level, transuranic, and PCB radioactive. The CWC can store as much as 735,000 ft$^3$ (20,800 m$^3$) of waste, which is an adequate capacity to store the projected volumes of generated waste from the activities identified above, assuming on-schedule treatment and disposal of the stored waste. An outside storage area was constructed in 2007 to store large containers of suspect transuranic waste from waste retrieval operations. As of December 31, 2017, the volume of waste currently stored in the CWC Outside Storage Areas is approximately 198,126 ft$^3$ (5,610 m$^3$) and the volume of waste currently stored at CWC is approximately 446,629 ft$^3$ (12,647 m$^3$). All data is as of December 31, 2017.

![Figure 5-4. Aerial View of the Central Waste Complex.](image)

5.3.3.2 Waste Receiving and Processing Facility.

The Waste Receiving and Processing (WRAP) Facility began operating in 1997 with the mission to analyze, characterize, and prepare drums and boxes of low-level, mixed, and transuranic wastes for
disposal (Figure 5-5). The 52,000-ft² (4,800-m²) facility, along with two 21,500-ft² (2,000-m²) storage buildings, are located north of the CWC in the 200-West Area. The WRAP Facility is operating under interim status standards specified in the RCRA Permit (WA7890008967), WRAP Facility Part A Form.

Waste destined for the WRAP Facility includes stored and newly generated waste from current Hanford Site cleanup activities consisting of primarily contaminated cloth, paper, rubber, metal, and plastic (i.e., debris). Processed materials that qualify as low-level radioactive waste and meet disposal requirements are buried at the Hanford Site. Low-level radioactive waste not meeting burial requirements was processed at the WRAP Facility for onsite burial or prepared for future treatment at other TSD facilities. Waste determined to be transuranic was certified and packaged for shipment to the WIPP for disposal.

In response to budget constraints, actions were taken in late 2011 and 2012 to place the WRAP Facility into a layup status until future funding is available to restart the facility. The layup actions during the interim period maintain facility safety, environmental compliance, and operational viability to enhance the transition to operational status at the end of the layup period.

Figure 5-5. A worker loads 65 drums of mixed low-level waste debris for shipment from the Waste Receiving and Processing Facility to Perma Fix Northwest.

5.3.3.3 T-Plant Complex.

J Fullmer

The T-Plant Complex (Figure 5-6) is located in the 200-West Area and provides solid waste treatment, storage, and decontamination services for the Hanford Site and offsite facilities. The T-Plant Complex is operating under interim status standards specified in the RCRA Permit (WA7890008967), T-Plant Complex Part A Form, and is preparing to receive K-Basin sludge for storage.
5.3.3.4 Canister Storage Building

*DJ Watson*

The Canister Storage Building (CSB) is a large 42,000-ft² (3,902-m²) facility located in the 200-East Area. The facility stores approximately 2,300 tons (2,086 metric tons) of spent nuclear fuel packaged in about 400 multi-canister overpacks from the 100-K Basins, 100-N Reactor, and T-Plant. The multi-canister overpacks are stored in 220 carbon steel tubes in a below-grade concrete vault. The irradiated fuel was cleaned, packaged, dried, and relocated to the CSB beginning in 2004 to provide safe interim storage in a consolidated location, allowing for cleanup of older facilities, which reduces the cleanup footprint of the Hanford Site and risk. The CSB has a design life of 40 years and will safely store the multi-canister overpacks until they are permanently placed in a National Repository.

Adjacent to the CSB is the Interim Storage Area, which also contains spent nuclear fuel packaged in various containers. This spent nuclear fuel will be subsequently repackaged and sent to a National Repository.

5.3.3.5 Low-level Burial Grounds

*M Marrott, KL Chase*

The low-level burial grounds (LLBG) consist of eight separate burial areas regulated under the AEA: two are located in the 200-East Area and six are located in the 200-West Area. Two of the burial grounds are used for disposal of LLW and mixed waste (i.e., low-level radioactive waste with a dangerous waste component regulated by WAC 173-303). Located in the 200-West Area, the 218-W-5 Burial Ground contains Trenches 31 and 34; in the 200-East Area, the 218-E-12B Burial Ground contains Trench 94, which is dedicated for disposal of defueled U.S. Navy reactor compartments. Trenches that contain mixed LLW are regulated under RCRA. Five burial grounds in the 200-West Area were used to dispose of LLW and/or retrievable storage of transuranic waste, as were portions of the 218-E-12B Burial Ground. The 218-W-6 Burial Ground has never received waste. The LLBGs are operating under interim status.
standards specified in the RCRA Permit (WA7890008967), Low-Level Burial Grounds Part A Form. In addition, the LLBGs are included in DOE/RL-2004-60.

**Low-level Waste Burial Ground 218-W-5, Trenches 31 and 34.** Trenches 31 and 34 (Figure 5-7) are rectangular landfills with approximate base dimensions of 250 by 100 ft (76 by 30 m), with a variable depth of 30 to 40 ft (9 to 12 m). The trenches comply with WAC 173-303 requirements for double liners and leachate removal/collection systems. These lined disposal units were originally designated for mixed LLW; however, disposal of LLW in the unlined trenches ceased June 23, 2004. Since that date, Trenches 31 and 34 have accepted LLW and mixed LLW for disposal. Disposal in Trench 31 began in May 2005, and disposal in Trench 34 began in September 1999. The first operational layer of waste packages in both trenches have been covered with compacted gravel and soil, and waste is currently being placed on the second waste layer in both Trenches 31 and 34.

As of December 31, 2017, Trench 31 contains approximately 227,132 ft³ (6,432 m³) of waste in approximately 3,845 waste packages. Trench 34 contains approximately 186,758 ft³ (5,288 m³) of waste in 5,301 waste packages. In 2017, a total of 9,004 ft³ (255 m³) of waste was disposed of in Trenches 31 and 34.

![Figure 5-7. Trenches 31 (left) and 34 (right) are Used to Store and Dispose of Dangerous and Mixed Waste from Hanford Site Work.](image)

**Low-Level Waste Burial Ground, Trench 94.** The LLBG Trench 94 received two defueled U.S. Navy reactor compartments in 2017. The total number of reactor compartments received into Trench 94 (218-E-12B Burial Ground) is 131 as of December 31, 2017. All U.S. Navy reactor compartments shipped to the Hanford Site for disposal originated from decommissioned, defueled nuclear-powered submarines or cruisers. Decommissioned submarine reactor compartments are approximately 33 ft (10 m) in diameter, 47 ft (14.3 m) long, and weigh between 1,000 and 1,500 tons (900 and 1,400 metric
tions). Decommissioned cruiser reactor compartments are approximately 33 ft (10 m) in diameter, 42 ft (12.8 m) high, and weigh approximately 1,500 tons (1,362 metric tons).

5.3.3.6 Waste Encapsulation and Storage Facility

DJ Watson

Located in the 200-East Area, the WESF was constructed in 1970 and 1971 on the west end of B-Plant and became active in 1974. The WESF is operating under interim status standards specified in the RCRA Permit (WA7890008967), WESF Part A Form. The WESF is a storage only unit for strontium- and cesium-encapsulated salts in double-containment stainless-steel capsules in underwater pool cells. The water provides cooling and shielding for the capsules that are considered sealed sources.

The mission of the WESF was encapsulation and storage of cesium chloride and strontium fluoride salts that had been separated from the Hanford Site’s high-level radioactive tank waste. The current mission of WESF is safe storage of the cesium and strontium capsules. The facility is a two-story, 20,000-ft² (1,860-m²) building that is 157 ft (48 m) long and 40 ft (12 m) high. The facility is constructed of steel-reinforced concrete and partitioned into seven hot cells, a hot cell service area, operating areas, building service areas, and a pool cell area. The hot cells are labeled A through G. Initial RCRA closure of Hot Cells A through F was achieved on April 10, 2017, through grouting these cells to fix any radioactive materials present. Only Cell G remains active for supporting cesium and strontium capsule storage and eventual removal. The operating areas and other building service areas associated with the hot cells and pool cell provide areas for instrumentation monitoring, utility support, or manipulator repair, as required. On November 16, 2017, DOE-RL transmitted to Ecology for review and approval: the RCRA Part B Permit application for the packaging and transfer of capsules to dry storage and RCRA Part B Permit application for capsule interim storage. Site selection of the new Capsule Storage Area and site ecological and cultural resources reviews were initiated.

5.3.3.7 Integrated Disposal Facility

S Kosjerina

The IDF (Figure 5-8) is an unused landfill located in the south-central part of the 200-East Area. The IDF is an expandable lined landfill (i.e., a double high-density polyethylene-lined trench with leachate collection and a leak detection system). The landfill is divided lengthwise (north to south) into two distinct cells: the east cell (cell 2) is for disposal of low-level radioactive waste (non-RCRA permitted) and the west cell (cell 1) is for disposal of low-level mixed waste (radioactive and RCRA-regulated hazardous waste). The west cell is a permitted TSD facility under the Hanford Site RCRA Permit (WA7890008967). The landfill was constructed to accept low-level waste as well as mixed waste (e.g., vitrified low-activity waste [LAW] from the Waste Treatment Plant [WTP] and Demonstration Bulk Vitrification System [DBVS]). Additionally, mixed waste generated by IDF operations will be disposed in IDF.

The IDF has a process design capacity of 2.89 million ft³ (82,000 m³). The IDF is referenced in DOE/EIS-0391 as a future disposal option for Hanford Site wastes.

A PA for the IDF was completed in CY 2017 and review by the Low-Level Waste Federal Review Group (LFRG) was initiated. This PA addresses the requirements outlined in DOE O 435.1. The overall objective of this PA is to provide a basis for making informed decisions pertinent to operation and eventual closure of the IDF. A series of briefings and webinars on the IDF PA were held for DOE-ORP, several members of the Pacific Northwest National Laboratory, and the LFRG members.
5.3.3.8 Environmental Restoration Disposal Facility

*WA Borlaug, BL Lawrence*

The ERDF (Figure 5-9) is the largest disposal facility in the DOE cleanup complex. The landfill located near the 200-West Area covers 108 ac (43.7 ha) and has a current capacity of approximately 21 million tons (19.1 million metric tons).
Regulated by the EPA, the facility began operations in July 1996 and serves as the central disposal site for hazardous, low-level radioactive, and mixed low-level waste removed during Hanford Site cleanup operations conducted under CERCLA. The total available expansion area of the ERDF site was authorized in a 1995 ROD (EPA et al. 1995) to cover as much as 1.6 mi² (4.1 km²). To provide a barrier preventing contaminant migration into the vadose zone from the in-ground facility, the ERDF was constructed to RCRA Subtitle C minimum technology requirements, which includes a double-liner and leachate collection system (40 CFR 264.301, Subpart N, “Landfills”). The lower liner of the double-liner system is a composite liner system consisting of a 3-ft (0.9-m)-thick layer of compacted bentonite-admixed soil covered with high-density polyethylene (HDPE) geomembrane. An aggregate or geocomposite leak detection system lies immediately above the lower composite liner. A second liner consisting of HDPE geomembrane sits on top of the leak detection system and is covered with a 1-ft (0.3-m)-thick aggregate leachate collection layer. The leachate collection layer is covered with a 3-ft (0.9-m)-thick layer of soil to protect the underlying layers of the liner system.

Designed to be expanded as needed, ERDF consists of disposal areas called cells. There are currently 10 cells at ERDF. At closure a 15-ft (5-m)-thick enhanced RCRA Subtitle-C final cover will be placed over the cells.

As of December 31, 2017, DOE and its contractors have disposed of 18.2 million tons (16.5 million metric tons) of contaminated material at the ERDF since the facility began operations in 1996. The majority of cleanup waste disposed at ERDF is from the 220 mi² (570 km²) River Corridor located along the banks of the Columbia River. The waste consists mainly of soil contaminated during operations of Hanford’s nine plutonium production reactors and support facilities from 1943 to 1987, as well as contaminated rubble from building demolition. In addition, ERDF receives cleanup waste from other Hanford locations.

5.3.4 Liquid Waste Management
JE Lesser
Facilities are operated on the Hanford Site to store, treat, reduce, and dispose of various types of liquid effluent generated by site cleanup activities. These facilities are operated and maintained in accordance with federal and state regulations and facility permits.

5.3.4.1 200 Area Effluent Treatment Facility. The 200 Area Effluent Treatment Facility (ETF) (Figure 5-10) is located in the 200-East Area. The 200 Area ETF stores and treats liquid effluent to remove toxic metals, radionuclides, and ammonia, in addition to destroying organic compounds. The treatment process constitutes best available technology and includes pH adjustment, filtration, ultraviolet light and peroxide oxidation to destroy organic compounds, reverse osmosis to remove dissolved solids, and ion exchange to remove the last traces of contaminants. The facility began operating in December 1995 and has a maximum treatment capacity of 150 gal (570 L) per minute. The 200 Area ETF operates in accordance with the RCRA Permit.

The effluent discharges from the 200 Area ETF are managed in accordance with limitations set forth in the State Waste Discharge Permit ST-4500 and the 200 Areas ETF Delisting Petition approval conditions. The treated effluent is stored in tanks, sampled and analyzed, and discharged via a dedicated pipeline to the State-Approved Land Disposal Site (also known as the 616-A Crib), an underground drain field located just north of the 200-West Area. Percolation rates for the field were established by site testing and evaluation of soil characteristics. Tritium in the liquid effluent from the ETF cannot be practically
removed. The location of the disposal site maximizes the time for migration of tritium to the Columbia River to allow for radioactive decay (the half-life of tritium is 12.35 years). The 200 Area ETF operated in 2017.

![Image](image.jpg)

**Figure 5-10.** The Effluent Treatment Facility Receives Liquids from the Liquid Effluent Retention Facility.

5.3.4.2 Liquid Effluent Retention Facility. Across from the ETF, the Liquid Effluent Retention Facility (LERF) (Figure 5-12) consists of three RCRA-compliant surface impoundments to store process condensate from the 242-A Evaporator, groundwater from various operable unit pump-and-treat systems, leachate from ERDF and LLBG Trenches 31 and 34, and other aqueous waste. The LERF provides a steady flow and consistent pH for the 200 Area ETF feed. Each basin has a maximum capacity of 7.8 million gal (29.5 million L) and is constructed of two flexible, HDPE membrane liners. A system is provided to detect, collect, and remove leachate from between the primary and secondary liners. Beneath the secondary liner is a soil and bentonite clay barrier, should the other liners fail. Each basin has a floating membrane cover constructed of low-density polyethylene to keep out windblown soil and weeds and minimize evaporation of organic compounds and tritium that may be present in the basin contents. The facility began operating in April 1994 and received liquid waste resulting from RCRA- and CERCLA-regulated cleanup activities. Historically, RCRA and CERCLA wastewaters were segregated in the surface basins and processed with different disposal destinations; however, this process became unnecessary after an amendment to the ERDF Record of Decision (ROD) was approved by EPA (DOE 2017). The amendment allows ERDF to receive both CERCLA and RCRA; therefore, segregation of wastewaters is no longer required.

The volume of wastewater received for the LERF basin storage in 2017 was approximately 3.03 million gal (11.5 million L). The majority of wastewater received at the LERF was pipeline-transported, CERCLA-regulated leachate from ERDF, totaling approximately 1.2 million gal (4.5 million L).
The other major contributor to wastewater received into LERF was approximately 0.77 million gal (2.91 million L) of process condensate from the 242-A Evaporator. Approximately 1.1 million gal (42 million L) of wastewater was received by tanker trucks from various other facilities. Approximately 3.34 million gal (12.6 million L) of wastewater in LERF was treated at ETF in 2017. The treated effluent was discharged to the soil at the State-Approved Land Disposal Site. The volume of wastewater being stored in the LERF at the end of 2017 was approximately 18.2 million gal (68.9 million L).

5.3.4.3 200 Areas Treated Effluent Disposal Facility. Located east of the 200-East Area, the 200 Area’ Treated Effluent Disposal Facility (Figure 5-12) is a collection and disposal system for non-RCRA waste streams. Individual waste streams must be treated or otherwise comply with best available technology and all known available and reasonable treatment methods in accordance with WAC 173-240, “Submission of Plans and Reports for Construction of Wastewater Facilities,” which is the responsibility of the generating facilities. Effluent discharges comply with the limitations established in State Waste Discharge Permit ST-4502.

The 200 Area Treated Effluent Disposal Facility consists of approximately 11 mi (18 km) of buried pipelines connecting three pumping stations (the 6653 Building, known as the disposal sample station, and two 5-ac (2-ha) disposal ponds). The facility began operating in April 1995 and has a capacity of
3,400 gal (12,900 L)/min. The volume of non-radioactive, non-dangerous waste is disposed to this facility in 2017 was approximately 96,212 million gal (803 million L).

![Figure 5-12. 200 Areas’ Treated Effluent Disposal Facility Ponds A and B.](image)

### 5.3.4.4 242-A Evaporator

Located in the 200-East Area, the 242-A Evaporator concentrates dilute liquid tank waste by evaporation in accordance with the RCRA Permit. The resultant water vapor is captured, condensed, filtered, sampled, sent to the nearby LERF for storage, and then further treated at ETF. This process reduces the volume of liquid waste sent to the DSTs for storage and reduces the potential need for additional tanks.

The 242-A completed two campaigns in 2017. These campaigns processed a volume of 1,517,000 gal (5,742,467 L), which resulted in a volume reduction of 557,000 gal (2,108,473 L). In 2017, upgrades to the facility included a stack extension to vessel vent 296-A-22 and an upgrade to the process sampling station.
5.3.5 Underground Waste Storage Tanks
Hanford’s 54.1 million gal (204.8 million L) of highly radioactive and chemical waste is stored in 177 underground tanks until it is prepared for disposal (Figure 5-13). The tank waste is material left over from years of World War II and post-war production of nuclear weapons. There are 149 single-shell tanks (SSTs) of which 11 tanks have been declared retrieval complete and 7 tanks have been declared retrieved to the limit of retrieval technology per HNF-EP-0182, Waste Tank Summary Report for Month Ending December 31, 2017. There are 28 double-shell tanks (DSTs). The SST and DST tanks are grouped into 18 farms in the 200-East and 200-West Areas. This section provides information about the SSTs and DSTs and activities that occurred in 2017 related to their operation and closure.

Figure 5-13. Aerial Over of the 200 Areas Tank Farms.

5.3.6 Single-Shell Tank System
The SST system was constructed between 1943 and 1964 to store mixed waste generated on the Hanford Site; 61 of the tanks are assumed to have leaked. Pumpable liquids in the SSTs were transferred to the newer and safer DSTs several years ago, under the Interim Stabilization Program, to help prevent additional environmental releases. The SST system is undergoing closure in accordance with TPA Appendices H and I and currently operates under interim status standards. In 2017, progress continued in retrieving waste from the C Farm tanks and transferring it to newer, safer DSTs to prepare to feed tank waste to the WTP (Figure 5-14). C Farm is one of 18 tank farms located on the Hanford Site. Fifteen of the 16 tanks have completed retrieval. Retrieval activities continue at tank C-105; however, retrieval was suspended in September 2015 pending the installation of a third technology retrieval system. Retrieval operations are scheduled to resume during summer 2018.
At the end of 2017 there were 28.7 million gal (108.2 million L) of waste in the SSTs. Waste volumes are provided in HNF-EP-1082. Table 5-5 summarizes the waste retrieved and stored in the SST system from 2010 through 2017.

5.3.7 Double-shell Tank System

The DST system includes 28 DSTs (25 tanks in 200-East Area and 3 in 200-West Area) located in six tank farms (AN, AP, AW, AY, AZ, and SY) that were constructed between 1968 and 1986 to store mixed waste generated on the Hanford Site. The DST system is operating under interim status standards specified in the RCRA Permit (WA7890008967), Double-Shell Tank System Part A Form.

The tanks contain liquids and settled solids from past nuclear operations, including waste transfers from older SSTs. The DST system storage capacity is approximately 31.5 million gal (119 million L) of radioactive and chemical waste. DST space is being managed to store waste pending treatment by the WTP and includes emergency pumping space of 1.27 million gal (4.8 million L) available at all times.

In the AY Farm, tank AY-102 was determined to have leaked waste into the annulus. Due to that determination, retrieval activities were performed in 2017. Tank AY-102 was declared retrieved to the limit of retrieval technologies in February 2017.

At the end of 2017, there were 25.5 million gal (96.6 million L) of waste in the DSTs. Waste volumes are provided in HNF-EP-0182. Table 5-5 summarizes the waste retrieved and stored in the DST system from 2010 through 2017.
### Table 5-5. Tank Farm System Quantities of Waste Retrieved and Stored.

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Units</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
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<tbody>
<tr>
<td>Double Shell Tanks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DSTs year-end waste total volume</td>
<td>gal</td>
<td>25,835</td>
<td>25,948</td>
<td>26,580</td>
<td>26,733</td>
<td>26,575</td>
<td>25,791</td>
<td>25,542</td>
<td>25,487</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>97,796</td>
<td>98,224</td>
<td>98,000</td>
<td>101,195</td>
<td>100,597</td>
<td>97,630</td>
<td>96,676</td>
<td>96,481</td>
</tr>
<tr>
<td>DSTs year-end waste solids volume</td>
<td>gal</td>
<td>12,869</td>
<td>9,331</td>
<td>5,948</td>
<td>5,897</td>
<td>6,215</td>
<td>6,351</td>
<td>6,257</td>
<td>6,294</td>
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<tr>
<td></td>
<td>L</td>
<td>48,817</td>
<td>98,2234</td>
<td>22,516</td>
<td>22,323</td>
<td>23,526</td>
<td>24,041</td>
<td>23,685</td>
<td>23,825</td>
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<tr>
<td>DSTs year-end waste supernatant volume</td>
<td>gal</td>
<td>12,966</td>
<td>16,617</td>
<td>20,632</td>
<td>20,836</td>
<td>20,360</td>
<td>19,440</td>
<td>19,285</td>
<td>19,193</td>
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<tr>
<td></td>
<td>L</td>
<td>49,082</td>
<td>62,902</td>
<td>78,101</td>
<td>78,873</td>
<td>77,071</td>
<td>73,588</td>
<td>73,002</td>
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<td>242-A Evaporator volume evaporated</td>
<td>gal</td>
<td>548</td>
<td>0</td>
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<td>0</td>
<td>793</td>
<td>1,329</td>
<td>305</td>
<td>557</td>
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<td>L</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>3,002</td>
<td>5,031</td>
<td>1,154</td>
<td>2,108</td>
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<tr>
<td>Single Shell Tanks</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSTs year-end waste total volume</td>
<td>gal</td>
<td>29,434</td>
<td>29,573</td>
<td>29,272</td>
<td>29,185</td>
<td>28,789</td>
<td>28,586</td>
<td>28,533</td>
<td>28,724</td>
</tr>
<tr>
<td>SSTs year-end waste solids volume</td>
<td>gal</td>
<td>29,403</td>
<td>29,429</td>
<td>29,182</td>
<td>29,073</td>
<td>28,655</td>
<td>28,445</td>
<td>28,418</td>
<td>28,578</td>
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<tr>
<td></td>
<td>L</td>
<td>111,302</td>
<td>111,401</td>
<td>110,466</td>
<td>110,053</td>
<td>108,471</td>
<td>107,676</td>
<td>107,574</td>
<td>108,179</td>
</tr>
<tr>
<td>SSTs year-end waste supernatant volume</td>
<td>gal</td>
<td>31</td>
<td>144</td>
<td>90</td>
<td>112</td>
<td>134</td>
<td>141</td>
<td>115</td>
<td>146</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>117</td>
<td>545</td>
<td>340</td>
<td>424</td>
<td>507</td>
<td>534</td>
<td>435</td>
<td>553</td>
</tr>
</tbody>
</table>

* Multiply volumes shown by 1,000. 1 gallon = 3.785 liters.

5.3.8 Underground Waste Storage Tanks and Associated Facilities

R Hyson

Throughout 2017, the U.S. Department of Energy, Office of River Protection (DOE-ORP) and its contractors met with and provided information to the DNFSB and its technical staff to answer questions regarding the following Hanford Site Tank Farm projects:

- Low Activity Waste Pretreatment System
- Maintenance Program
- Wireless Safety Instrumented System.

5.3.8.1 Defense Nuclear Facilities Safety Board Recommendation 2012-2. On September 28, 2012, the DNFSB issued Recommendation 2012-2, *Hanford Tank Farms Flammable Gas Safety Strategy*. The DNFSB’s recommendation documented their position that DOE needs to upgrade the DST ventilation systems and other instrumentation systems used for safety-related functions at the Hanford tank farms.

On June 6, 2013, DOE delivered the *Implementation Plan (IP) for Recommendation 2012-2* (DOE 2013) to the DNFSB. To date, seven IP actions have been completed and provided to the DNFSB.
On March 24, 2016, DOE delivered a letter from the Secretary of Energy that revised the IP for DNFSB recommendation 2012-2. The revised IP described a more efficient approach pertaining to the deployment of safety-significant portable exhauster units for use during off-normal events and the actions completed to date that have been incorporated into the Tank Farms DSA. The margin of safety at the Tank Farms will be further improved as IP actions are completed. The implementation of safety-significant real-time flow monitoring will be of particular benefit, adding both defense-in-depth and a simplified control strategy.

The DNFSB responded to the DOE-ORP via letter on September 16, 2016, concluding that the proposed safety-significant portable exhauster concept was consistent with the DNFSB’s recommendation and acknowledging appreciation of the updated deliverable schedule contained in the IP.

On December 11, 2017, DOE-HQ notified the DNFSB of the revision to the expected completion date for DNFSB recommendation 2012-2, Action 3-1, *Provide [safety-significant (SS)] annulus level detectors in each of the [double shell tank (DST)] annuli where the flammable gas hazard exists.* DOE-ORP continues to provide status updates to DNFSB staff on all remaining actions.

Work will continue in 2018 on implementing Action 2-2, installation of safety significant instrumentation for real-time monitoring of the ventilation exhaust flow from each DST. Once complete, the selected air flow meter will be used to monitor DST ventilation exhaust flow in real time. DOE-HQ will continue to work with the DNFSB to keep them apprised of ongoing IP efforts for Recommendation 2012-2, currently scheduled for completion in December 2018.


### 5.3.9 Single-Shell Tank Closure and Corrective Measures Program

**P Rutland**

The SST Closure and Corrective Measures Program is responsible for the closure of SST WMAs, conducting performance assessments (PAs), and performing agreed upon interim measures in and around SST WMAs.

Current efforts are focused on the development, submittal, and review of closure documents for WMA C; conducting PAs for WMA C, WMA A-AX; and project activities necessary to support the design and construction of additional interim surface barriers. Additional activities include documenting past characterization work, planning for future interim measures, and monitoring the performance of implemented interim measures.

#### 5.3.9.1 Closure of WMAs.

Closure activities in CY 2017 continued to focus on the development of closure strategies and closure documents.

Closure documents were prepared and updated to meet the requirements of [DOE O 435.1, Radioactive Waste Management](https://www.doe.gov/offices/ofvms/owms/radioactive-waste-management), and the RCRA. Closure documents updated during CY 2017 include the draft DOE O 435.1 Tier 1 Closure Plan for WMA C and the draft Waste Incidental to Reprocessing evaluation
document for WMA C. A draft RCRA Tier 2 Closure Plan for WMA C and a draft RCRA Tier 3 Closure Plan for the 241-C-200 Series tanks were submitted to the Washington State Department of Ecology for review. The purpose of the closure documents is to reach agreement with regulatory agencies on closure requirements for WMA C and to enable closure activities to proceed.

Work associated with the closure of WMA C initiated in CY 2017 included a Grout Testing program to develop grouts for closure of the C-200 Series tanks and associated pipe encasement, characterization activities for the 241-C-301 Catch Tank, and the evaluation for removal of remaining equipment.

A data quality objectives (DQO) process was completed and an associated DQO summary report (RPP-RPT-60227, Rev 0) was developed for a focus area around tanks 241-A-104 and 241-A-105 in WMA A-AX in CY 2017.

5.3.9.2 Performance Assessments. Work was conducted during CY 2017 to support ongoing PA development and documentation updates associated with WMA C, the IDF, and WMA A-AX. The WMA C and WMA A-AX PAs support closure of WMA C and WMA A-AX, respectively, while the IDF PA supports operations of the IDF.

Review by Ecology of three of the four WMA C HFFACO Appendix I initial drafts of PA documents (RPP-ENV-58806, Rev 0; RPP-RPT-58329, Rev 2; RPP-RPT-59197, Rev 1) was completed and Ecology’s comments were received in July 2017 (17-NWP-085). Dispositioning the Ecology comments in a comment resolution process was initiated in the latter half of CY 2017. In addition, Maintenance and Monitoring Plans and an Unresolved Waste Management Question (UWMQ) procedure were developed to support the WMA C PA maintenance effort. This work is being performed to meet federal and state requirements along with the requirements in the TPA (Ecology et al. 1989a), Appendix I. To meet these requirements, DOE-ORP released a set of four complementary reports (RPP-ENV-58782, Rev 0; RPP-ENV-58806, Rev 0; RPP-RPT-58329, Rev 2; RPP-RPT-59197, Rev 1), each focusing on specific requirements for addressing impacts of individual contamination sources that will remain in WMA C after closure (i.e., existing contamination in the vadose zone, past tank leaks and unplanned releases, and tank residuals [radionuclides/hazardous chemicals]).

Preparation of a draft PA for WMA A-AX continued in CY 2017. The WMA A-AX PA is being prepared to meet federal, state, and TPA (Ecology et al. 1989a) Appendix I requirements. The work supports risk assessment and modeling efforts needed to help guide retrieval and RCRA Facility Investigation/Corrective Measures Study characterization activities. The draft PA documents prepared in CY 2017 include model package reports for the geologic framework model and the flow and contaminant transport numerical model, a tank residual data package, a soil inventory data package, and an engineered system data package.

5.3.9.3 Interim Surface Barriers. Interim surface barriers (ISBs) were constructed at T and TY Tank Farms in 2008 and 2010, respectively. The effectiveness of the two interim surface barriers is being assessed through an ongoing barrier-monitoring program, and monitoring results are reported annually. Monitoring indicates that the barriers are effective in drying of the vadose zone beneath the barriers.

Two additional interim surface barriers have been designed to be placed over portions of the SX Tank Farm. Construction of two ISBs in SX Farm began in October 2017. The SX Tank Farm interim surface barriers are being constructed of modified asphalt and a single evapotranspiration basin. Located south
of SX Tank Farm, the evapotranspiration basin will be used to dispose of water collected by the ISBs. In addition, the design of a third ISB for SX Farm was developed in CY 2017.

5.4 Hanford Tank Waste Treatment and Immobilization Plant
M. Schappell

The WTP is being built on 65 ac (26 ha) in the 200-East Area to treat radioactive and hazardous waste stored in 177 underground tanks on the Central Plateau. The WTP comprises four major facilities (Pretreatment Facility, HLW Facility, Low-Activity Waste [LAW] Facility, and Analytical Laboratory) along with support buildings and associated infrastructure (Balance of Facilities [BOF]). Construction of the WTP is managed in accordance with the RCRA Permit. In 2017, Bechtel National Inc. (BNI) began executing against its new contract modifications, signed in December 2016 with DOE, that prioritize finishing the LAW Facility, BOF, and Analytical Laboratory to feed waste directly from the Hanford Tank Farms to the LAW facility under an approach called Direct Feed Low-Activity Waste (DFLAW). The DFLAW approach calls for the treatment of tank waste in the LAW facility as soon as 2022. The DFLAW approach also calls for a capability called the Effluent Management Facility (EMF).

A description of the WTP facilities and the progress at each facility in 2017 is provided in the following sections.

5.4.1 Pretreatment Facility
The Pretreatment Facility is where waste will be received from the Tank Farms and separated into low-activity and HLW streams for transport to the LAW and HLW facilities for processing. In 2017, work continued to resolve the remaining technical decisions that have impacted design and construction at the Pretreatment Facility since 2012. The Pretreatment team completed final testing of the Standard High Solids Test Vessel pulse jet mixers and control systems. Significant progress on the technical decisions was made in 2017 with resolution of the last decisions anticipated in the second quarter CY 2018.

5.4.2 High-Level Waste Facility
The HLW Facility is where HLW from the Pretreatment Facility will be combined with glass-forming materials in high-temperature melters; poured into waste canisters; and allowed to cool to form a solid, immobilized glass form. In 2017, the HLW team completed the Facility Completion Plan and the Design and Operability Report. In September 2017, DOE-ORP approved HLW’s Preliminary Design Safety Analysis (PDSA). It also received three autosamplers for HLW. The autosampling system will collect verification samples used to ensure the glass produced will meet requirements.

5.4.3 Low-Activity Waste Facility
The LAW Facility is where low-activity waste will be mixed with glass-forming materials in high-temperature melters; poured into containers; and allowed to cool to form a solid, immobile glass form. In 2017, WTP workers completed installation of the caustic scrubber, assembly of the two melters in LAW, and installation of the 48-ft (1,463-cm) elevation electrical bulk cable.

5.4.4 Analytical Laboratory
Once operational, the Analytical Laboratory will process about 10,000 waste samples annually to support glass formulation and waste-form compliance.
5.4.5 Balance of Facilities
The WTP’s Balance of Facilities is made up of 22 facilities that provide utilities and services to operate the LAW, HLW, Analytical Laboratory, and Pretreatment facilities. The support utilities include: electrical power distribution system; backup power systems; compressed air; chilled, process, potable, and fire water systems; steam systems; and communication and control systems. Turnovers from construction to startup began in 2016 and will continue through 2019. The BOFs are non-nuclear industrial buildings. By the end of 2017, workers had completed the startup and testing phase for 20% of BOF systems. Of the 56 systems 11 successfully completed startup and testing and were transitioned over to the commissioning phase, 28 were in the startup phase, and 17 were nearing construction turnover to startup by December 2017. That equates to 70% of utility systems that workers had transferred from the construction phase to the startup phase. WTP workers also energized the BOF switchgear building, one of the two switchgear buildings providing power to the Vit Plant. It provides electrical support for BOF structures that will provide utilities and services such as steam, air, and water to the vitrification facilities. This achievement represents the transition from temporary construction-phase utilities to permanent utilities that will operate WTP. As the remaining checks and punch list closeout for the infrastructure facilities is completed, the facilities will be tested for DFLAW operations and declared ready for integrated system testing.

5.4.6 Effluent Management Facility
Concrete placements of the Effluent Management facility began in March 2017. EMF will involve four structures: the main processing facility, a utility building, an electrical building, and the low-point drain building. During the LAW vitrification process, effluent (or liquid secondary waste) is created and will be transferred to the EMF for treatment and disposition. Design is 82% complete as of December 31, 2017, and bulk and equipment procurements are underway. Placement of concrete for the floor slab of the utility and process buildings was completed in 2017. Construction of the EMF is scheduled to be completed in early 2020, with concurrent startup activities commencing in mid-2019 and completing in 2020.

5.4.7 Waste Treatment and Immobilization Plant Progress on Defense Nuclear Facilities Safety Board
R Hyson
Throughout 2017, DOE-ORP and its contractors met with and provided information to the DNFSB and its technical staff to update and review WTP technical topics. The DOE-ORP provided responses in 2017 to address questions in the areas of 1) spray leak methodology, 2) pulse jet mixer control, 3) plugging and wear of process piping, 4) electrical distribution system, 5) erosion/corrosion, and 6) potential criticality in process vessels. The DOE-ORP continues to work with DNFSB and the contractor to provide resolutions and a path forward on technical issues.

5.4.7.1 Defense Nuclear Facilities Safety Board Recommendation 2011-1. The DNFSB issued Recommendation 2011-1, Safety Culture at the WTP, on June 9, 2011. On December 27, 2011, the U.S. Department of Energy (DOE) transmitted the Department’s Implementation Plan (IP). All IP actions from this plan are complete. In addition, several follow-on Office of Enterprise Assessments (DOE-EA) and internal safety culture reviews were conducted. The latter reviews revealed continued areas to improve, as well as positive improvements overall in both the DOE-ORP and Bechtel National, Inc. (BNI) culture.
Both DOE-ORP and BNI have embedded positive safety culture attributes into their systems and processes, including 1) policies and procedures, 2) required and ongoing training, 3) senior leader performance monitoring, 4) contract and incentives modifications, 5) strong employee engagement activities, and 6) strengthened organizational learning through added assessments and surveys. DOE-ORP and BNI continue to implement and regularly improve their Safety Culture Sustainment Plans (IP Action 2-12), which includes continued effectiveness evaluations and actions to further promote a strong safety culture.

Senior leader performance monitoring, modeled after NEI 09-07, have determined that both DOE-ORP and BNI are continuously improving since Recommendation 2011-1 was issued, and that the organizations are on track to sustaining a positive safety culture. Leaders continue to drive positive safety culture practices.

All related information for recommendation 2011-1, is available on the DNFSB website at: https://www.dnfsb.gov/board-activities/recommendations/safety-culture-waste-treatment-and-immobilization-plant.

5.5 Long-Term Stewardship

R Ranade

The Hanford Site’s Long-Term Stewardship (LTS) Program has responsibilities within the 220 mi² (570 km²) of the Hanford Site’s River Corridor and bounded by 46 mi (74 km) of Columbia River shoreline (Figure 5-15); these responsibilities include managing post-cleanup obligations for 1,638 WIDS sites and six Manhattan Project Era production reactors that have been placed in interim safe storage. More than 24,000 cleanup and historic documents have been identified, indexed, and tagged as LTS records. The LTS program manages and provides S&M of facilities and Institutional Controls to ensure continued protectiveness of human health and the environment once cleanup actions have been completed.

Since 2010, through collaborative efforts with DOE and its prime contractors, cleaned-up waste sites and other facilities in 14 geographic areas and 6 cocooned reactor facilities were transitioned (mid-contract) from the River Corridor Closure Contractor to MSA’s LTS program via contract modification, which included the preparation of a transition and turnover package (TTP). This documentation was prepared for each segment or area transitioned to LTS. Transition of 100-N, 100-IU-6 and Segment 4B, and the 300 Area was completed in 2017 giving LTS management responsibilities for the entire River Corridor area with few exceptions. Figure 5-16 illustrates the transition time line.
Figure 5-15. Final Transition of Long-Term Stewardship Surveillance and Maintenance Areas.
The TTP was used to document the condition of the land at the time of transition and to convey relevant information about the area. Topics include site assessments, record of cleanup activities, as-left conditions, remaining regulatory actions, resource management, information management, and ongoing S&M requirements. Information management activities continue during the entire process to ensure that documents cited in the TTP are identified, located, stored, protected, and made accessible.

The LTS program has conducted inspection and S&M activities for the reactors placed in Interim Safe Storage, also known as cocooning (the 105-F Reactor in October 2014 and the other five reactors in 2015 and 2016). Interim Safe Storage is designed to protect the reactor for 75 years while radioactive decay continues, ultimately making the structures safe for demolition and removal. Next reactor entries and internal inspections will be conducted in 2025 to assess the condition of the structures and evaluate potential deterioration of the reactor core, shield walls, and roof.

Hanford’s LTS program has successfully shifted from a program focused on transitioning land and waste sites to a program focused on data management for those buildings and waste sites within the program and which require Institutional Controls. LTS submitted a revised copy of HNF-54166, Rev. 6, Long Term Stewardship Surveillance and Maintenance Plan, to DOE in 2017.

The LTS program maintains an internal library of documents referenced in the TTPs and additional information that may be relevant to the closure history. These are the documents that tell the story. The majority of these documents are in the Hanford Administrative Record; however, the LTS library also includes Official Use Only documents that have not yet been released to the public and those that were only placed in DOE’s Integrated Document Management System (IDMS). Currently in the LTS information systems there are over 24,000 documents and 22,000 photos; more are added as the program continues to evolve.

5.6 Scientific and Technical Contributions to Hanford Site Cleanup

RA Peterson

5.6.1 Waste Processing

In support of Washington River Protection Solutions (WRPS), PNNL has contributed the following:

- Developed the fundamental knowledge needed to advance low-temperature and low-cost waste forms and improve processing of Hanford’s low-activity and secondary wastes. PNNL applied its expertise in mineralogy, geochemistry, waste form fabrication, and waste form performance to support the tank farm contractor in evaluating low-temperature waste forms for Hanford Waste Treatment and Immobilization Plant (WTP) secondary wastes, including processes at the Effluent Treatment Facility and the Effluent Management Facility (EMF), planned for onsite disposal. The data generated and analyses of these waste forms are critical to qualifying these waste forms for disposal in the Integrated Disposal Facility (IDF) and will help provide the scientific basis for IDF performance assessment (PA) maintenance. The technologies can be extended to evaluate the potential for low-cost, low-temperature, supplemental low-activity waste (LAW) treatment options.

- Served as the lead laboratory integrating across the complex to provide the technical basis for the glass waste form strategy, including defining data needs and testing protocols, to support the IDF PA. In fiscal year (FY) 2017, PNNL conducted investigations using alternative testing techniques to address critical data needs identified in the previously issued technical approach document. These
tests include measuring Stage III dissolution rates of immobilized low-activity waste (ILAW) glass in accelerated testing, proposing an updated term to accurately describe ion exchange processes in long-term glass dissolution (an effort with the Vitreous State Laboratory of The Catholic University of America), developing innovative solutions to expedite compilation of rate law parameters required for PA modelling, and characterizing dissolution behavior of enhanced waste loading ILAW glass. The FY 2017 testing focused on delivering critical PA input data for enhanced glasses, which is needed to support implementation of glasses that will allow higher waste loadings to be targeted for facility operational efficiency and to reduce mission life.

- Established a radioactive test platform in the Radiochemical Processing Laboratory (RPL). PNNL has installed a radioactive waste processing test platform that includes ion exchange, crossflow filtration, and melter unit operations. The test platform provides the ability to develop and assess the baseline Direct Feed Low-Activity Waste (DFLAW) flowsheet with respect to integrated unit operations, provides process data (such as technetium speciation) necessary to inform critical decisions on disposal options, and allows testing of a wide variety of proposed changes to the baseline flowsheet (before facility implementation; lowering risks) with actual waste samples from the Hanford tank farms. The first application of this test platform is to treat tank waste and evaluate the disposition routes for melter off-gas materials and alternative waste qualification approaches with actual waste samples. In FY 2017, the RPL received approximately 2.11 gal (8 L) of AP-105 supernatant from the tank farms. PNNL is currently processing this waste through the filtration unit operation. The filtered waste will ultimately be processed through ion exchange, a melter feed will be generated, and then the waste will be processed through a laboratory-scale melter. This platform also will be available to evaluate alternative processing strategies for DFLAW and support waste qualification.

- Summarized prior data and collecting new data on confined sluicing retrieval technology. PNNL developed a report that describes the development and application of confined sluicing retrieval technology. To support confined sluicing evaluations, PNNL completed a study to estimate/bound the waste characteristics of tank 241-A-105 waste in order to select appropriate simulant materials for retrieval testing. PNNL is conducting development testing of the Hanford Waste End Effector (HWEE) to provide information for initial assessment of the HWEE for Hanford single-shell tank (SST) retrieval. PNNL will install the HWEE on a PNNL-designed robotic gantry system, apply instrumentation to measure reaction forces and process parameters, prepare and characterize simulant materials, and implement the retrieval test program. The tests will involve retrieval of sludge and hardpan simulants to determine pumping rate, dilution factors, and screen fouling rate. A primary goal of the HWEE is to minimize water usage during tank retrieval to minimize downstream impact on tank farm volume space.

- Served as the test authority in the evaluation of ultrasonic nondestructive examination (NDE) technology for Hanford under-tank inspection. PNNL is leveraging its 50-year NDE Reliability Test & Evaluation program to define and administer testing to establish the extent to which emerging and commercial ultrasonic NDE technologies can satisfy an under-tank inspection strategy for Hanford double-shell tanks (DSTs). The results of the evaluation will provide the technical basis necessary for purposeful selection of ultrasonic NDE technologies that will enable volumetric under-tank inspection. Flaw detection and measurement robustness testing is being performed at PNNL using full-scale mockups of primary tank swaths that contain representative DST plate geometries,
materials, and surface conditions; representative welds and weld patterns; and surrogate flaws to mimic flaw types having the potential to develop in DST plates and threaten leak integrity.

- Provided the technical underpinning for the Low-Activity Waste Pretreatment System (LAWPS). PNNL is using its expertise in simulant development; crossflow filtration; ion exchange; fluid dynamics; and hydrogen gas generation, retention, and release to develop the technical underpinning for the LAWPS. The data generated by this program will provide the basis for integrated testing of the system and technical defensibility of the hydrogen management strategy to enable maturation of the design, construction, and safe operations of the LAWPS. In addition, test data are being evaluated to recommend and support additional integrated testing that will establish a more robust performance envelope prior to facility construction.

- Defined the strategy and recommended processes for supporting the implementation of regular updates of the technical basis for the industrial hygiene program for tank vapors at the Hanford Site. The technical basis for this program is dependent on sound scientific and engineering understanding and analysis of tank contents, sampling and analysis, transport and dispersion, real-time measurement, and toxicology and health effects of tank vapors. PNNL is applying its technical expertise in chemistry, measurement, atmospheric sciences, biology/toxicology, chemical engineering, and fluid dynamics to develop, test, analyze, and recommend best practices for identifying, detecting, and monitoring chemicals of potential concern and establishing necessary exposure action levels to ensure worker protection. PNNL is also supporting the analysis of respirator cartridge testing on vapors from the Hanford waste tanks.

- Initiated development of a data visualization tool to enhance the accessibility and transparency of tank vapors sampling data. The Tank Vapors Data Access and Visualization application is being developed for WRPS and will significantly enhance the accessibility of sampling data for tank vapors. This application is presently available for limited internal use by WRPS staff but will eventually be available for public access. Data sets available through this application include headspace samples, samples from exhaust stacks and other emission points, and samples from outside the tanks where work could be performed. Limited data sets are also available from the pilot testing of real-time sensors that are part of the Vapor Monitoring and Detection System.

- Identified and developed underlying technical bases for the River Protection Project (RPP) Reference Integrated Flowsheet. PNNL is using its expertise in waste chemistry and physical properties, fluid dynamics and scaling, waste processing technology development, waste form development and testing, and applied engineering solutions to identify and resolve technical gaps and develop innovative solutions for the baseline integrated flowsheet. The technical work generated by this project closes flowsheet and operations gaps and realizes opportunities by providing technically defensible bases and tools used in establishing flowsheet strategies and modeling parameters to predict and plan the successful execution of the RPP waste cleanup mission.

- Addressed safety issues associated with isolation valves for double-valve isolation that have been installed in the Hanford Tank Farms Waste Transfer System for 10 or more years. Using PNNL’s expertise in Hanford waste characterization and simulant development, a technically justifiable performance-based simulant was designed for extended abrasive wear testing at the Multi-Phase Transport Evaluation Loop Facility. Results from the simulant cycle tests provide WRPS with performance characteristics that can be used to verify compliance with the documented safety
analysis limits for valve seat leakage. Test results provide a technical basis for 3- and 2-in. (7.6- and 5–cm) valves installed at the Hanford Site to operate in an abrasive slurry environment for over 1500 and 5000 cycles, respectively. These results also provide a technical basis to define and plan maintenance and equipment replacement schedules. The test methodology and infrastructure established from testing valve models currently in service at the Hanford tank farms are now being used to evaluate and benchmark additional valve manufacturers and models against those involved in previous test campaigns to expand the number of qualified providers. Test results will be used to evaluate and potentially certify additional valve types as replacement valves for existing infrastructure or for incorporation into designs for future waste processing systems.

- Performed a structural integrity analysis of record to qualify the AN and AW DSTs for increased storage volume. Since 2003, PNNL has performed the structural integrity analyses of record for the DSTs and SSTs at the Hanford Site. These analyses dictate the maximum waste level allowed in the DSTs. In 2008, PNNL completed a structural analysis that demonstrated that the AP tanks could safely store an additional 38 in. (96.5 cm) of waste, representing 720,000 gal (2,725,496 L) of additional storage volume in the eight AP tanks. In 2017, WRPS requested that PNNL perform a similar analysis to qualify the AN and AW tanks for increased waste height. Similar conclusions to those of the AP analysis are expected, which could increase the storage capacity of the 13 AN and AW tanks by 1,170,000 gal (4,428,932 L).

- Enhanced the tank farm PHOENIX (PNNL Hanford Online Environmental Information Exchange) web application to provide online access to and visualization of important tank farm data. PNNL has added significant new functionality to the PHOENIX applications for the DOE Office of River Protection (ORP). This year, an application has been developed for exploring the best basis inventory estimates for tank waste, including the capability to view changes in those estimates over time. In addition, email alerts have been developed to notify staff when new data of interest become available.

In support of other projects at the Hanford Site, PNNL is contributing the following:

- Supported resolution and closure of S-1 Technical Issue 4 concerning the pulse-jet mixing (PJM) vessels in the WTP Pretreatment Facility. PNNL has been supporting design evaluations, full-scale standard high solids vessel test planning, development of simulants, and analysis of the new PJM controls systems. The testing project began controls testing in late 2016 and started the full-scale standard high solids vessel testing in June 2017. PNNL’s support is also critical to the performance evaluations of the low solids PJM vessels that are located in the WTP Pretreatment Facility. Working alongside the Bechtel National, Inc. (BNI) engineering team and back at the laboratories at PNNL’s Richland Campus, PNNL staff has been integral in supporting the resolution of the PJM technical concerns with the WTP.

- Developed enhanced glass formulations, key process control models, and tactical processing strategies to ensure safe and successful operations for the WTP high-level waste (HLW) and LAW vitrification facilities. Applying expertise in waste form development, melter processing, and waste form performance, PNNL has increased waste loading, troublesome component solubility limits, and melting rate; significantly increasing projections of waste throughput and decreases in glass volume. In late FY 2017, PNNL will issue updated process control models and algorithms for the LAW and HLW vitrification facilities, which provide the technical underpinning for implementation of
enhanced glasses. Development and implementation of enhanced glass property models and glass formulations will reduce the cost of Hanford tank waste management by reducing the schedule for tank waste treatment and reducing the amount of HLW and LAW glass for storage, transportation, and disposal. Enhanced glass formulations may also result in more cost effective direct vitrification of the HLW fraction without significant pretreatment. The advances in aluminum oxide and chromium(III) oxide solubility in borosilicate glasses should reduce or eliminate the need for caustic or oxidative leaching in pretreatment. The ability to target higher sodium oxide concentrations will translate into higher waste loadings and ultimately lower container counts for the LAW integrated flowsheet. The integration of increased waste loading, reduced leaching/washing requirements, and improved melting rates provides a system-wide approach to improve the effectiveness of the WTP process.

- Developed technologies to enhance technetium management strategies for LAW vitrification. The primary objective is to achieve high technetium retention in LAW glass without recycling the melter off-gas solution. Recycling the off-gas stream also increases the concentrations of other troublesome and volatile components in the melter feed, which decreases the loading of waste coming from the tank farms and thus increases the glass volume. Two major research areas include: 1) understanding the fundamental mechanism of technetium volatilization from and incorporation into glass melt and 2) incorporating technetium into various minerals directly from LAW or from off-gas solution, which can be used to increase the technetium retention in glass or can serve as a separate waste form.

- PNNL provided a fundamental understanding of technetium chemistry and translating that understanding into solutions for technetium management. PNNL is using cutting edge technologies to evaluate the nature of technetium present in Hanford tank waste. PNNL is using actual waste samples to evaluate the speciation and fate of technetium during waste processing. Using the information obtained from these samples, PNNL is able to develop new process flows for the treatment and disposition of technetium as well as the development of state-of-the-art sensors for identifying technetium speciation.

- Provided the fundamental understanding of radionuclide migration through concrete materials. PNNL developed and conducted diffusion experiments to measure the effect of concrete waste form properties (including iron content, carbonation, microcracking, and moisture content) on radionuclide release and migration in near-field environments representative of the arid environmental conditions at the Hanford Site. This knowledge provides the technical understanding necessary to assess the efficacy of the waste package in isolating the Category 3 low-level radioactive wastes from the hydrologic environment. Any failure of concrete encasement may result in water intrusion and consequent mobilization of radionuclides from the waste packages.

5.6.2 Nuclear Fuel and Material Management
In support of nuclear fuel and material management at the Hanford Site, PNNL is contributing the following:

- Lead actual waste testing to enable retrieval, storage, and treatment of K-Basin sludges. PNNL has partnered with Hanford contractors on characterization and management of suspect nuclear fuel and K-Basin sludge for 25 years. PNNL has performed all essential characterization and much of the data evaluation of K-Basin sludge, enabling retrieval and storage at Hanford’s T-Plant. PNNL
maintains the inventory of well-characterized K-Basin sludge samples to allow for testing of future treatment options. Suspect nuclear fuel fragments from the K-Basin are expected to be added to this inventory in FY 2018. As part of this sample stewardship, sludge shear strength as a function of time was measured to better understand how the sludge currently stored in the large engineered containers may develop strength or otherwise change during interim storage. Increased sludge strength may adversely affect sludge transfer operations. PNNL also conducted essential characterization activities of the K-Basin water sand filter; the results are being used for proper waste designation and disposal. PNNL has supported alternatives analysis, engineering evaluations, and process development and process/unit operation validation tests, and will continue these functions as the overall project progresses toward final sludge treatment and disposition.

- Conducted accident thermal analyses to update the safety basis documentation for the K-Basin Sludge Transport System Transport Package. This package consists of a vessel carrying the sludge payload contained within a lead-lined shipping cask. This 11-ft-tall assembly sits upright on a flatbed trailer and is being used to transport sludge waste to the Hanford Central Plateau interim storage location at T-Plant. To recertify this package with an enhanced payload capacity for upcoming shipments, PNNL’s Radioactive Packaging and Transportation team is modeling thermal transients for a hypothetical accident condition involving a pool fire. This is a standard requirement for transport of large quantities of nuclear materials.

- Provided source term estimates and atmospheric dispersion modeling in support of demolition of the Plutonium Finishing Plant (PFP) at Hanford. The release and dispersion modeling uses the facility design, measurements of residual radioactive contamination, plans for the demolition technologies and timing, and multiple years of meteorological information to estimate peak anticipated concentrations of contaminants in air and on nearby surfaces. The results have been used to modify the demolition techniques so that occupational and environmental standards may be met. The information has been shared with Hanford Site managers, decommissioning workers, and regulators so that all parties are cognizant of the potential hazards.

- Provided radiological characterization to Hanford Site contractors using nondestructive assay (NDA) methods and techniques. PNNL’s NDA program uses gamma spectroscopy and neutron counting techniques to provide radiological characterization of waste containers and facility components (e.g., HEPA filters, pipes, glove boxes, ductwork) to support environmental remediation activities with waste classification/disposal, transportation, environmental reporting, safeguards and security, work planning, and facility safety basis development.

- PNNL provided high-range gamma and neutron radiological instrument calibrations to Hanford Site contractors. Working with the Hanford Site Support Services contractor, PNNL uses its unique gamma and neutron irradiators to calibrate radiation detection and survey instruments that cannot otherwise be calibrated. In addition to instrument calibrations, PNNL also troubleshoots and repairs radiological instruments and high-purity germanium detectors for the Hanford Site. Hanford contractors rely on these instruments and detectors to safely accomplish site remediation activities.

5.6.3 Environmental Remediation

In support of environmental remediation at the Hanford Site, PNNL is contributed the following:
• Reduced the uncertainty associated with quantifying contaminant fluxes and providing a linkage to effective monitoring of vadose zone contaminant sites. Through development of a novel approach, geophysical monitoring is being integrated with predictive simulation to improve estimates of contaminant flux to groundwater. The flux assessment tool will be validated using a synthetic lifecycle simulation of vadose contamination within the BY Cribs area and will provide a method for monitoring contaminant flux to groundwater so that potential flux mitigation technologies can be implemented.

• Provided the technical leadership for conducting CERCLA treatability studies of remediation technologies for the deep vadose zone in the Hanford Central Plateau. PNNL is finalizing the monitoring and field testing of soil desiccation and integrating this information into an evaluation that will support inclusion of desiccation in future feasibility studies for the Hanford Central Plateau. PNNL is also providing the technical basis for design and implementation of a field test using ammonia as a reactive gas to sequester uranium in the vadose zone. Treatability tests in the Central Plateau are important for demonstrating remedy feasibility, cost of implementation, and potential negative impacts prior to field-scale implementation. Field treatability testing of the PNNL-developed technology will be initiated in FY 2018.

• Evaluated candidate remediation technologies for the Hanford Central Plateau vadose zone. PNNL is conducting laboratory studies of candidate vadose zone technologies for contaminants including uranium and technetium-99. The technology information will provide remedy options in FY 2018, when the site will determine what additional treatability tests will be conducted for the deep vadose zone in the Central Plateau.

• Identified natural phases of technetium-99 in soil and groundwater and the potential conditions and attenuation mechanisms that immobilize technetium-99 in the subsurface. The total inventory of technetium-99 released to the environment at the Hanford Site is estimated at 700 curies, with ~100 curies released from SST leaks and the remainder disposed of in the cribs, trenches, and other waste sites at the Hanford Site. To date, the technetium-99 speciation in the deep vadose zone is unknown. If a significant amount of technetium-99 in the vadose zone is immobilized, this will provide critical knowledge to support the use of monitored natural attenuation as part of the remediation decision for long-term technetium-99 management.

• Provided the technical knowledge necessary to understand the attenuation processes controlling the behavior and fate of contaminants within the 200-DV-1 Operable Unit on the Hanford Central Plateau. PNNL is advancing the development and utility of conventional site conceptual models to enable accurate quantification of current and predicted future flux of contaminants across multiple scales. Remediation of inorganic and radionuclide contaminants in vadose zone environments is foundational for protection of groundwater. The mass flux/discharge of contaminants through the vadose zone is a primary factor controlling vadose zone contaminants in groundwater. PNNL is quantifying attenuation processes, applying the mass-flux-based conceptual model framework that integrates this information, and conducting predictive analyses to understand and quantify moisture and contaminant flux in the vadose zone to provide the technical defensibility for groundwater remediation decisions and long-term predictions of contaminant fluxes to groundwater.

• Conducted hydraulic and chemical analysis of a perched-water zone in the Hanford Central Plateau 200-DV-1 Operable Unit. PNNL is analyzing and interpreting hydraulic and chemical data to improve
the understanding of the perched-water zone in support of remedy operations and optimization. The perched-water zone is an important contaminant source for the underlying groundwater. The difficult hydrologic setting and complex contaminant conditions need to be quantified to enable effective remedy application and to provide the technical defensibility needed to transition from the active (pump-and-treat) remedy to remedies suitable for unsaturated conditions.

- Provided the scientific and technical understanding necessary to predict behavior of and remediate comimgled contaminants in 200-UP-1 Operable Unit. PNNL is using a multiple lines-of-evidence approach to understand the effects of dynamic biogeochemical processes on the fate and transport of comimgled contaminants (uranium, iodine, technetium, nitrate) in heterogeneous geological media. This work provides the technical underpinnings for identifying simultaneous or sequential remedies and long-term support for enhanced natural attenuation.

- Addressed conceptual site model data gaps to support 200-UP-1 Operable Unit iodine-129 technical evaluation. The conceptual site model is being updated with key data, most importantly biogeochemical drivers for iodine speciation that previously were not understood, to define the iodine cycle, interactions with co-contaminants, source terms, inventory, and speciation to provide a technical basis to support evaluation of remediation approaches for iodine-129 and complete the 200-UP-1 remedial investigation report. The updated conceptual model for iodine is not only required by the 200-UP-1 record of decision (ROD), but is also needed to adequately address known attenuation mechanisms that were not previously recognized or accounted for in assessments.

- Evaluated candidate remediation technologies in support of the 200-UP-1 Operable Unit ROD-required iodine-129 remedy evaluation. While other contaminants in the 200-UP-1 Operable Unit could be addressed with a remedy, the iodine-129 contamination requires additional evaluation to select an appropriate remedy or determine if a technical impracticability waiver is appropriate. PNNL conducted a literature search to identify candidate technologies and is applying laboratory testing to determine if any of the candidates are suitable for treatability testing and subsequent consideration as an iodine-129 remedy. This level of technical rigor is needed to address the difficult nature of iodine-129 contamination and to provide defensibility for the associated iodine-129 remedy decision.

- Provided expert technical support to the development of the remedial investigation/feasibility study document for the 100-BC-5 Operable Unit. PNNL is providing technical expertise and input to CH2M Hill Plateau Remediation Company (CHPRC) for the 100-BC-5 remedial investigation/feasibility study. PNNL is providing input for modeling strategies and developing a systematic and holistic approach to support monitored natural attenuation evaluations at BC-5 and across all operable units at the site. PNNL’s support is critical to developing and adapting national guidance for application at this site.

- Provided the technical underpinnings required to understand the interactions among co-contaminants in the 200-BP-5 Operable Unit. PNNL is applying a multiple lines of evidence approach to quantify and understand the impacts of geochemistry and microbiology to determine the mechanism(s) controlling attenuation of comimgled plumes, in particular with cyanide, the perceived inhibitor of mechanisms of attenuation. This effort supports the long-term goal of providing the technical defensibility for monitored natural attenuation as a viable remedial alternative once pump-and-treat operations cease to be effective.
• Provided the technical knowledge to design a sampling and analysis strategy that includes quantifying and interpreting attenuation processes for the 200-WA-1 Operable Unit in the Hanford Central Plateau. PNNL is synthesizing and interpreting national guidance for attenuation characterization to provide the site contractor with a technical basis for design of vadose zone characterization. These approaches will enable attenuation processes to be incorporated into mass-flux-based conceptual and numerical models. The level of complexity required to represent attenuation mechanisms is important for providing the technical defensibility for both remedy decisions and technical infeasibility waivers.

• Provided advanced microbial techniques and expertise to support optimization of the 200-West pump-and-treat system for carbon tetrachloride and nitrate remediation to improve effectiveness. The 200-West pump-and-treat fluidized bed biofilm reactors (FBBRs) are composed of complex groundwater microbial consortia that under engineered conditions remove carbon tetrachloride, chromium, and nitrate from groundwater. PNNL is applying molecular tools (i.e., microbial fingerprinting and sequencing) to determine the spatiotemporal identity, composition, and function of the microbial community within the FBBR to support performance decisions and optimization of the pump-and-treat system.

• Evaluated the fate of iodine-129 in the existing 200-West pump-and-treat system. In addition to providing information about pump-and-treat system operations to the site, this investigation of iodine-129 fate in ion exchange and biological treatment components of the pump-and-treat system is being used to support evaluation of potential ex situ treatment technologies for iodine-129 in the ROD-required iodine-129 remedy evaluation for the 200-UP-1 Operable Unit.

• Provided hydraulic and geochemical analyses to address operational issues and provide optimization information for the 100 Area pump-and-treat systems. PNNL is conducting studies for the 100-K Area to quantify the effect of influent geochemistry on co-contaminants in the aquifer to determine whether changes are needed to aboveground operational conditions. PNNL is also conducting hydraulic analyses of the semi-confined portions of the 100-H Area to provide the hydrologic basis for optimizing pump-and-treat operations.

• Conducted monitoring to support source area remedy implementation in the 300-FF-5 Operable Unit. PNNL is installing and operating electrical resistivity tomography (ERT) monitoring that enables the site contractor to have near-real-time feedback on amendment injection performance and provides an opportunity to optimize delivery. PNNL is also applying sediment testing to quantify the change in uranium mobility caused by the source treatment, which provides a metric for determining treatment success. In addition, PNNL is supporting the implementation of this PNNL-developed technology.

• Developed a grout formulation that meets well construction requirements and improves the resolution of geophysical characterization and monitoring. Because standard well grouting materials are highly conductive, they interfere with geophysical techniques such as ERT. PNNL is developing and testing a revised grout formulation with lower electrical conductivity. This new grout directly supports new field applications of ERT in the Hanford 300-FF-5 Operable Unit and for deep vadose zone treatability tests that are being initiated in FY 2018. It also enables improved use of ERT for future applications as electrodes are emplaced during characterization and monitoring efforts in the
Hanford Central Plateau, which will provide direct measures of both active and passive remedy performance.

- Provided the environmental science and risk and decision expertise to develop the remedial investigation work plan for the Pre-Hanford Orchards Lands operable unit, enabling DOE to decide if pre-Hanford pesticides must be remediated. Farmstead communities existed adjacent to the Columbia River from 1880 to 1943. The Hanford River Corridor includes approximately 8,300 ac (3,359 ha) of historical farmsteads, of which approximately 5,000 ac (2,023 ha) are historical orchard lands. Based on what is known about the history of the site, and the current site conceptual model, the major contaminant for this operable unit is residual lead arsenate, which was used as a pesticide. PNNL characterized 133 decision units (4,996 ac [2,022 ha]). The project uniquely deployed handheld x-ray fluorescence analyzers in the field, significantly reducing schedule and cost. Current efforts are focused on completing the draft remedial investigation report.

- Completed the over 20-year Prototype Hanford Barrier performance assessment and is transitioning this barrier test site into long-term monitoring. Building on the 20 years of performance monitoring, PNNL is preparing the barrier site to transition into long-term monitoring following NQA-1 requirements for instrumentation and data collection. DOE has identified long-term surface barriers as a candidate remedy for contamination in the deep vadose zone to reduce contaminant flux into the groundwater. The Prototype Hanford Barrier over the 216-B-57 crib was completed in 1994 but past monitoring accounts for only about 2% of the design life.

- Lead the national, multi-institutional Deep Vadose Zone Applied Field Research Initiative to provide the scientific underpinnings and develop and demonstrate transformational remedial strategies. The initiative is providing the framework for a coordinated, integrated, and leveraged research and technology development strategy to target understanding and remediation of vadose zone environments. This approach integrates efforts from SC to enhance our understanding of vadose zone challenges and infuses investments from EM to develop cost-effective characterization and monitoring methods, and remedial strategies and design. The results provide a systems-based understanding of water, gas, and chemical exchange within this complex deep vadose zone to drive improved long-term predictions of contaminant behavior; flux to groundwater; and, ultimately, the risks to human health and the environment. The initiative is critical for providing the scientific and technical understanding to develop, demonstrate, and predict the near- and far-term impact of remedial strategies that prevent contamination from reaching groundwater.

- Improved the PHOENIX groundwater toolset by adding new capabilities requested by users. PNNL developed a Remediation Dashboard to visually represent the remediation progress of Hanford’s groundwater treatment systems. This tool makes it easy for stakeholders, regulators, and others to understand the effectiveness of remedies and to see progress toward cleanup objectives. Another capability is being added to the groundwater toolset that will allow users to receive customized email alerts when data of interest are added (e.g., new sample results) and to save queries that will facilitate periodic analysis of areas of interest.

- PNNL developed a set of web-based analysis tools to meet DOE needs for groundwater data assessments. New tools use the data access capabilities from the PHOENIX system to enable users to compile water-level or contaminant data. The tools provide data filtering, statistical, and analysis capabilities so that users can evaluate the groundwater flow system and contaminant plume
dynamics. Tools were designed to provide technical defensibility for remedy performance, monitoring design, and interpretation, and will be freely available on the web.

5.7 References


