Executive Summary

Since 1959, the U.S. Department of Energy (DOE) has annually published the Hanford Site Environmental Report in accordance with DOE O 231.1B, *Environment, Safety and Health Reporting,* and DOE O 458.1, *Radiation Protection of the Public and the Environment*. The purpose of the *Hanford Site Environmental Report for Calendar Year 2016* is to inform the public, regulators, employees, and other stakeholders of environmental and operating performance during the year.

Hanford Site operations are affected and, in many cases, regulated by numerous federal and state agencies enforcing legal requirements that address environmental compliance, remediation, planning, preservation, and waste management. For example, the DOE has sole authority to take action on matters under the *Atomic Energy Act* (AEA). In some cases, other federal agencies such as the Council on Environmental Quality, U.S. Environmental Protection Agency (EPA), and U. S. Fish and Wildlife Service have authority to regulate activities pursuant to the *National Environmental Policy Act* (NEPA); *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA); *Endangered Species Act (ESA);* and *Migratory Bird Treaty Act* (MBTA). The EPA has delegated authority to the State of Washington Departments of Ecology and Health to regulate activities in accordance with the *Resource Conservation and Recovery Act* (RCRA), *Clean Air Act* (CAA), and *Clean Water Act* (CWA). In still other cases, state laws for licensing and permitting apply to activities and have resulted in the Hanford Site Radioactive Air Emissions License, RCRA Permit, Air Operating Permit, and State Waste Discharge Permits.

In general, the laws, regulations, and other requirements applicable to Hanford Site operations include, but may not be limited to, those that address environmental quality; air quality and noise; water resources; hazardous waste and materials management; radioactive waste and materials management; ecological resources; cultural and paleontological resources; worker safety and health; radiological safety and radiation protection; transportation; emergency planning, pollution prevention, and conservation; and environmental justice. It is DOE's policy to carry out its mission in a sustainable manner to maximize energy and water efficiency; minimize chemical toxicity and harmful environmental releases; promote renewable and other clean energy development; and conserve natural, cultural, and ecological resources while sustaining assigned mission activities.

All previous annual Hanford Site environmental reports are available online through Mission Support Alliance, LLC (MSA) at *http://msa.hanford.gov/page.cfm/enviroreports*. The following sections summarize this year's annual report.

ES.1 Section 1, Introduction

The Hanford Site encompasses approximately 581 mi^2 (1,505 km^2) in Benton, Franklin, and Grant Counties, located in south-central Washington State within the semi-arid Pasco Basin of the Columbia Plateau (Figure ES-1). The Hanford Site was established in 1943 to provide plutonium production to fuel atomic weapons during World War II and the Cold War. The site has restricted public access and provides a buffer for areas used for former nuclear materials production, waste storage, and waste disposal. With the signing of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement [TPA]) in 1989 (Ecology et al. 1989a) by the Washington State Department of Ecology (Ecology), U.S. Environmental Protection Agency (EPA), and DOE (collectively, TPA agencies), the primary

mission shifted to developing new waste treatment and disposal technologies and characterizing and cleaning up the contamination from historical operations. The DOE is responsible for one of the largest nuclear cleanup efforts in the world, managing the legacy of five decades of nuclear weapons production. The Hanford Site's current mission focuses on environmental restoration, which includes remediation of contaminated areas, decontamination and decommissioning of Hanford Site facilities, waste management (i.e., waste storage, treatment, and disposal), and related scientific and environmental research and development of waste management technologies. In addition, the recently established Manhattan Project National Historical Park, of which the B Reactor and other Hanford Site structures are a part, focuses on historic preservation and public education.

Cleanup of the Hanford Site is overseen by two DOE offices, the Richland Operations Office (DOE-RL) and the Office of River Protection (DOE-ORP). DOE-RL and the DOE-ORP jointly manage the site through several contractors and their subcontractors. The DOE-RL serves as the Hanford Site property owner and oversees cleanup along the Columbia River and in Hanford's Central Plateau, including groundwater and waste site cleanup; management of solid waste, spent nuclear fuel, and sludge; facility cleanout, deactivation, and demolition; environmental restoration; plutonium management; and all site support services.

The DOE-ORP was established by Congress in 1998 as a field office to manage the retrieval, treatment, and disposal of approximately 56 million gal (204 million L) of radioactive tank waste currently stored in 177 underground tanks in the central part of the site. The tank waste is material left over from years of World War II and post-war production of nuclear weapons fuel. In support of this mission, DOE-ORP is responsible for the safe operation of the tank farms and 200 Area facilities, and construction and operation of the Waste Treatment Plant (WTP) located in the Central Plateau.

The DOE, U.S. Fish and Wildlife Service, and Washington Department of Fish and Wildlife each manage portions of the Hanford Reach National Monument.

The Manhattan Project National Historical Park, created in November 2015, is a partnership between DOE and the National Park Service. DOE continues to own, preserve, and provide public access to the five National Park facilities and areas at Hanford, while the National Park Service is responsible for interpretation of the Manhattan Project story, as well as visitor services. .

The DOE, Office of Science manages DOE's science and technology facilities, programs, goals, and objectives at the Hanford Site. Its principal laboratory is the Pacific Northwest National Laboratory (PNNL), operated by Battelle Memorial Institute for DOE since 1965.

ES.2 Section 2, Compliance Summary

To ensure the protection of human health and the environment through safe operations, DOE implements compliance programs designed to fulfill requirements of applicable federal, state, and local laws and regulations, and DOE orders, directives, policies, and guidelines. In addition, the Hanford Site operates under permits required under specific environmental protection regulations. Several federal, state, and local regulatory agencies are responsible for monitoring and enforcing compliance with applicable environmental regulations at the Hanford Site, including the EPA, Ecology, Washington State Department of Health (WDOH), and the Benton Clean Air Agency. The EPA and Ecology are the two main

agencies who regulate Hanford cleanup as part of the TPA. In addition, the Defense Nuclear Facilities Safety Board (DNFSB) provides oversight of DOE work. Congress created the DNFSB as an independent agency within the Executive Branch to identify the nature and consequences of potential threats to public health and safety at DOE's defense nuclear facilities, to elevate such issues to the highest levels of authority, and to inform the public. During 2016, the DNFSB oversaw projects pertaining to each contractor at the Hanford Site. In addition, the TPA commits DOE to comply with the remedial-action provisions of the CERCLA and the RCRA treatment, storage, and disposal (TSD) unit regulations and corrective-action provisions.

ES.2.1 Tri-Party Agreement

From 1989 through December 31, 2016, a total of 1,286 TPA milestones were completed, and 341 target dates were met. During 2016, 38 specific cleanup milestones were scheduled for completion; of those, 14 milestones were deleted, 22 milestones were completed on time, no milestones were missed, and 2 were in negotiation. In addition, 2 target dates were met, 5 target dates were deleted, and 1 target date was in negotiation.

ES.2.2 Federal Facility Compliance Act

DOE provides mixed waste information annually as part of the Hanford Site Mixed Waste Land Disposal Restrictions Summary Reports pursuant to TPA Milestone M-026-01. In 2016, DOE/RL-2016-08, *Calendar Year 2015 Hanford Site Mixed Waste Land Disposal Restrictions Summary Report*, met the reporting requirement.

ES.2.3 Regulatory Inspections

During calendar year (CY) 2016, 80 regulatory agency inspections were conducted at DOE facilities on the Hanford Site: Ecology conducted 39, WDOH 33, EPA (Region 10) 2, the City of Richland 1, and DOE 5.

ES.2.4 RCRA

The Ecology and EPA inspections focused on TSD unit compliance with the *Hanford Facility Dangerous Waste Permit* (Ecology 2012) and WAC 173-303, "Dangerous Waste Regulations." Waste accumulation and universal waste management areas were also inspected. During 2016, permit modifications were processed to change requirements for TSD units pursuant to WAC 173-303-830, "Permit Changes."

ES.2.5 CERCLA

For waste sites where hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure, CERCLA requires a review every 5 years to evaluate the implementation and performance of a remedy to determine if the remedy is or will be protective of human health and the environment. During CY 2016, a draft version of the DOE/RL-2016-01, *Hanford Site Fourth CERCLA Five-Year Review Report*, addressing 2011 through 2015 was completed and transmitted to EPA for review. Based on subsequent feedback received from EPA and other agencies, work continued on this report through the remainder of CY 2016 and into CY 2017.

ES.2.6 Hanford Site Emission Sources

In 2016, the WDOH inspections focused on compliance of major and minor stack air emission units as well as diffuse and fugitive emission sources, with the Hanford Site Air Operating Permit and Radioactive Air Emissions License (FF-01). Ecology inspections included discharge points (e.g., emergency engines/generators) and packaged boiler systems regulated under the Hanford Site Air Operating Permit. During 2016, regulatory agencies conducted 35 *Clean Air Act* inspections on the Hanford Site. A

total of four violations were alleged involving airborne radioactive materials at the 618-10 Burial Ground and failure to monitor stack air emissions continuously or operating outside sampling system design parameters at PUREX, B-Plant, and the Canister Storage Building.

ES.2.7 Environmental Occurrences

Per DOE M 231.1-2, *Occurrence Reporting and Processing of Operations Information*, Environmental releases of radioactive and regulated materials from the Hanford Site are reported as legally required under the following categories: Operational Emergency; Recurring; Category 1 (significant impact); Category 2 (moderate impact); Category 3 (minor impact); and Category 4 (some impact). During 2016, there were no events for Category 1, 2, and 3; however, 47 Category 4 events occurred as a result of the discovery of legacy contamination at the Hanford Site.

ES.2.8 Emergency Planning and Community Right to Know Act

DOE/RL-2017-12, *2016 Hanford Site Tier Two Emergency and Hazardous Chemical Inventory*, was submitted to Ecology's Community Right-To-Know Unit; local emergency planning committees for Benton, Franklin, and Grant counties; and the City of Richland and Hanford Site Fire Department before the annual March 1 deadline. The Hanford Site had 54 hazardous chemicals that exceeded the reporting thresholds.

ES.2.9 Pollution Prevention Program

In 2016, 1,284 metric tons of non-hazardous (i.e., plastic, aluminum, cardboard, paper, wood, and metal) and hazardous (i.e., antifreeze, batteries, bulbs, and oils) wastes were recycled through Hanford Site programs administered through the Mission Support Contract. Emissions for fiscal year (FY) 2016 decreased from FY 2015 largely due to a decrease in facility energy use and non-fleet fuel use, and an increase in waste diversion from landfills. Reported greenhouse gas emissions for FY 2016 were 46,829 metric tons of carbon dioxide equivalent compared with 102,645 metric tons carbon dioxide equivalent from the FY 2008 baseline and 71,693 metric tons carbon dioxide equivalent reported for FY 2015. There was a 34.5% reduction in Scope 3 greenhouse gas emissions for the Hanford Site in FY 2016 from the FY 2008 baseline; emissions in FY 2016 were 27,259 metric tons carbon dioxide equivalent, whereas emissions in FY 2008 were 41,426 metric tons carbon dioxide equivalent. Greenhouse gas emissions from employee commuting, business travel, offsite wastewater treatment, and contracted solid waste disposal are primarily dependent on work locations and the number of workers employed at the Hanford Site.

ES.3 Section 3, Environmental Management System

Environmental management performance measures objectives for 2015 included fleet management, alternative fuel use, potable and non-potable water use, electricity use, facility fuel use, facility energy use, electronic product environmental assessment tool, sanitary waste reduction, and regulated waste reduction. The acquisition target for alternative fuel vehicles was not met in 2016. The acquisition target for alternative fuel vehicles was not met in 2016. The alternative fuel use target was surpassed for FY 2016; however, the target for petroleum-based fuel use was missed. The target objectives for potable and non-potable water, renewable electric energy, facility fuel, facility energy, and regulated waste reduction were met in FY 2016. The target objectives for the Electronic Product Environmental Assessment Tool were exceeded in FY 2016, with 100% of the purchases meeting the requirements. More Hanford Site sanitary waste was recycled than was sent to landfills in FY 2016.

ES.4 Section 4, Radiological Protection and Doses

Hanford Site radiation protection program staff conduct ongoing monitoring of external radiation sources; perform environmental radiological surveys; and evaluate potential radiological doses to the public. Results of 2016 monitoring efforts are provided below.

ES.4.1 External Radiation Monitoring

Sources of external radiation at the Hanford Site include waste materials associated with former plutonium production and processing facilities; radioactive waste handling, storage, and disposal; and cleanup and remediation activities. External radiation fields were monitored in 2016 at 125 locations near Hanford Site facilities and operations. The thermoluminescent dosimeter results were used individually or averaged to determine dose rates in a given area for a specific sampling period. During 2016, 10 new thermoluminescent dosimeter monitoring locations were added.

ES.4.2 Radiological Release of Hanford Site Property

No property with detectable residual radioactivity above authorized limits was released from the Hanford Site in 2016.

ES.4.2.1 Radiological Clearance for Potentially Contaminated Personal Property with Hard-to-Detect Radionuclides. More than 19,000 items of personal property were unconditionally released from radiological areas on the Hanford Site; however, the majority of the items did not leave the site. These items primarily consisted of small articles such as flashlights, hard hats, radios, cameras, pens, pencils, respiratory protection, radiological control instruments, and industrial hygiene instruments. In January 2000, DOE issued a moratorium prohibiting the release of volume-contaminated metals and subsequently suspended the release of metals for recycling purposes from DOE radiological areas in July 2000. As a result, no volume of contaminated metals or metals for recycling purposes were released from Hanford in 2016.

ES.4.2.2 Radiological Clearance for Granular Activated Carbon for Offsite Shipment and Regeneration. Approximately 98,000 lb (44,400 kg) of granular-activated carbon was shipped offsite in 2016 for regeneration.

ES.4.3 Potential Radiological Doses to the Public and Biota

In 2016, scientists evaluated potential radiological dose to the public and biota resulting from exposure to Hanford Site liquid effluents and airborne emissions to determine compliance with pertinent regulations and limits. The primary sources of radionuclide contamination evaluated in the dose assessment included gaseous emissions from stacks and ventilation exhausts and contaminated groundwater seeping into the Columbia River. Potential radiological doses from 2016 Hanford Site operations were evaluated in detail to determine compliance with pertinent regulations and limits. Radiological doses were assessed in terms of the following:

- Dose to a hypothetical maximally exposed individual (MEI) at an offsite location
- Collective dose to the population residing within 50 mi (80 km) of Hanford Site operation areas

- Doses from recreational activities, including hunting and fishing
- Dose to a worker consuming drinking water on the Hanford Site
- Dose to a visitor of the Manhattan Project National Historical Park
- Doses from non-DOE industrial sources on and near the Hanford Site
- Absorbed dose received by biota exposed to radionuclide releases to the Columbia River and to radionuclides in onsite surfacewater bodies.

Additionally, air-pathway doses from stack and fugitive emissions to offsite and non-DOE Hanford Site employees calculated using regulation-specified EPA methods for comparison to the *Clean Air Act* standards in 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," were summarized.

The MEI is a hypothetical person whose location and assumed exposures are modeled in such a protective manner that it is highly unlikely any actual offsite individual would have received a higher Hanford-related dose. The dose to the MEI calculated in 2016 from Hanford Site operations was 0.12 mrem (1.2 µSv), which is 0.12% of the 100 mrem (1,000 µSv) annual public dose limit specified in DOE O 458.1. Many different exposure pathways are included in the dose calculations, but ingestion of food containing tritium from 300 Area air emissions was the single largest contributor. Collective dose was estimated for the entire population living with a 50-mi (80-km) radius of the air emissions sources and also individuals obtaining drinking water from the Columbia River downstream of the Hanford Site. A collective dose of 1.2 person-rem (0.012 person-Sv) was calculated as the sum of doses to all individual members of the exposed population.

Doses to a hypothetical individual were also calculated using measured concentrations of radionuclides in fish tissue and onsite drinking water. For recreational activities, a fish ingestion annual dose of up to 0.17 mrem (1.7 µSv) was estimated based on tissue samples of carp and bass collected from the Hanford Reach of the Columbia River. An annual dose of up to 0.20 mrem (2.1 µSv) was calculated for ingestion of Hanford Site drinking water from a 400 Area well. Lastly, annual doses were calculated for workers and visitors at the Hanford Townsite and White Bluffs Bank locations of the Manhattan Project National Historical Park (up to 0.00016 mrem (0.0016 µSv). Like the offsite MEI dose, these doses were far below the public dose limit. To place this information into perspective, these doses may be compared with those received from other routinely encountered sources of radiation. The 2009 National Council on Radiation Protection and Measurements report *Ionizing Radiation Exposure of the Population of the United States* (NCRP 2009)estimated that the overall annual exposure to ionizing radiation for the average American is 620 mrem (6,200 µSv), approximately half of which is related to natural sources and the other half attributable primarily to medical procedures.

ES.5 Section 5, Environmental Restoration and Waste Management

Below is a waste summary for environmental restoration and waste management activities, including Hanford Site River Corridor closure, cleanup and remediation, facility decommissioning, waste management operations, underground waste storage tank status, construction of the Waste Treatment

and Immobilization Plant and its associated facilities, and research activities related to waste cleanup. The following describes important 2016 cleanup and remediation activities at the Hanford Site.

ES.5.1 River Corridor

The River Corridor includes the Hanford Site 100, 300, and 400 Areas that border the Columbia River. Through 2016, 100 and 300 Area transitions to MSA Long Term Stewardship are complete for 220 mi^2 (570 km^2) of the River Corridor.

ES.5.2 100 Area Waste Sites

The 100 Area waste sites vary in complexity and waste type. Typical waste sites include waste burial grounds, liquid effluent waste sites, burn pits, retired septic systems, piping systems, and miscellaneous waste sites. In 2016, cleanup activities focused on completion of interim remedial actions in the 100-D, 100-H, and 100-N Areas. Waste generated from the cleanup of waste sites was disposed at the Environmental Restoration Disposal Facility (ERDF) in the 200 Areas.

ES.5.3 100-K Area

Construction was completed on the 105-K West Annex and construction activities were initiated on installing the Engineered Container Retrieval & Transfer System hardware in both the 105-K West Basin and Annex. Installation of the Engineered Container Retrieval & Transfer System hardware is forecast for April 2017. Maintenance and Storage Facility Pre-operational Acceptance Testing was completed. K-Basin Preoperational Acceptance Testing is forecast to be completed in 2017. Groundwater pump-and-treat operations continued, as well as testing systems and components to be used to remove K-Basin sludge at the Maintenance and Storage Facility located in the 400 Area prior to deployment to the K-West Basin, Annex, and its radiological environment. Remediation of waste sites to protect human health and the environment also continued.

ES.5.4 100 Areas Facilities Decommissioning

As of 2015, all deactivation, decommissioning, decontamination, and demolition activities in the 100 Area have been completed.

ES.5.5 200 Area (Central Plateau) Facilities Decommissioning

Central Plateau facilities include buildings and associated waste sites in the 200-East, 200-West, and 200-North Areas and those on the adjoining Rattlesnake Unit. The final push to prepare the four main process buildings (234-5Z, 236Z, 242Z, and 291Z) for demolition began in 2016. Two of these buildings (236Z and 242Z) were declared ready for demolition. Work at 242Z included grouting the sump pit, painting and isolating the E3 duct, and declaring 242Z and 242ZA ready for demolition. Work at 291Z included removal of process vacuum piping and asbestos abatement. The 2727Z and 2729Z Buildings were demolished and removed from the complex. The debris was removed from the site and taken to ERDF for final disposition.

ES.5.6 300 Area Facilities Decommissioning

Future activities in the 300 Area will address the 324 facility and the underlying 300-296 waste site, as well as the retained facilities and waste sites.

ES.5.7 400 Area Facilities – Fast Flux Test Facility Deactivation

The Fast Flux Test Facility remains in long-term surveillance and maintenance, and routine surveillances are performed annually.

ES.5.8 Solid Waste Management

Solid waste management includes the TSD of solid waste produced as a result of Hanford Site operations or received from offsite sources authorized to ship waste to the site. Active onsite solid waste facilities as of 2016 are described below.

ES.5.8.1 Central Waste Complex. Located in the 200-West Area, the Central Waste Complex receives waste from Hanford Site sources and any offsite sources authorized by DOE to ship waste to the site for TSD. Waste received includes low-level, transuranic, or mixed waste, and radioactive waste contaminated with polychlorinated biphenyls. Currently, the volume of waste stored in the Central Waste Complex Outside Storage Areas is approximately 162,781 ft^3 (4,609 m^3), with the remaining enclosed area storage totaling approximately 224,849 ft^3 (6,367 m^3).

ES.5.8.2 T-Plant. The T-Plant Complex is located in the 200-West Area and provides solid waste treatment, storage, and decontamination services for the Hanford Site and offsite facilities and is preparing to receive K-Basin sludge for storage.

ES.5.8.3 Canister Storage Building. Located in the 200-East Area, this 42,000-ft^2 (3,902-m^2) facility stores about 2,300 tons (2,086 metric tons) of spent nuclear fuel packaged in approximately 400 multi-canister overpacks from the 100-K Basins, 100-N Reactor, and T-Plant.

ES.5.8.4 Low-level Burial Grounds. This area consists of eight burial grounds located in the 200-East and 200-West Areas that are used to dispose of low-level waste and mixed waste. 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. Trench 31 contains approximately 218,900 ft^3 (6,200 m^3) of waste in approximately 3,740 waste packages. Trench 34 contains approximately 187,100 ft^3 (5,300 m^3) of waste in 5,280 waste packages. In 2016, a total of 12,360 ft^3 (350 m^3) of waste was disposed of in Trenches 31 and 34. The LLBG Trench 94 received two defueled U.S. Navy reactor compartments in 2016.

ES.5.8.5 Waste Encapsulation and Storage Facility. Located in the 200-East Area, the Waste Encapsulation and Storage Facility was constructed in 1970 and 1971 on the west end of B-Plant and became active in 1974. The Waste Encapsulation and Storage Facility is operating under interim status standards. A RCRA closure plan was approved for the initial closure of Hot Cells A through F. Initial closure will consist of stabilizing the contents and contamination in these hot cells by filling them with grout. Grouting the hot cells commenced in CY 2016.

ES.5.8.6 Integrated Disposal Facility. The Integrated Disposal Facility (IDF) is an unused landfill located in the south-central part of the 200-East Area. The landfill is an expandable RCRA hazardous, waste-compliant unit (i.e., a double high-density polyethylene-lined trench with leachate collection and a leak detection system) currently operating under RCRA final status standards. The IDF has a process design capacity of 2.89 million ft^3 (82,000 m^3).

ES.5.8.7 Environmental Restoration Disposal Facility. ERDF began operations in 1996 and serves as the central disposal site for contaminated waste removed during Hanford Site CERCLA cleanup operations. The largest disposal facility in the DOE complex, DOE and its contractors have disposed

17.9 million tons (16.2 million metric tons) of contaminated material at the ERDF since the facility began operations in 1996.

ES.5.9 Liquid Waste Management

The facilities described below are operated on the Hanford Site to store, treat, reduce, and dispose of various types of liquid effluent generated by site cleanup activities. In addition, remediation systems pump and treat contaminated groundwater in the 100-D, 100-H, and 200-West Areas.

ES.5.9.1 200 Area Effluent Treatment Facility. Located in the 200-East Area, the Effluent Treatment Facility (ETF) treats liquid w to remove toxic metals, radionuclides, and ammonia, in addition to destroying organic compounds. The treated waste is stored in tanks, sampled and analyzed, and discharged to the State-Approved Land Disposal Site (616-A Crib). The facility operated in 2016.

ES.5.9.2 200 Area Liquid Effluent Retention Facility. Across from the ETF, the Liquid Effluent Retention Facility (LERF) consists of three RCRA-compliant surface basins used to store aqueous waste. The volume of wastewater received for the LERF basin storage in 2016 was approximately 1.65 million gal (6.25 million L). The majority of wastewater received at the LERF was pipeline-transported, CERCLA-regulated leachate from ERDF, totaling approximately 0.784 million gal (2.96 million L). The other major contributor to wastewater received into LERF was approximately 0.416 million gal (1.57 million L) of process condensate from the 242-A Evaporator. Approximately 0.45 million gal (1.7 million L) of wastewater was received by tanker trucks from various other facilities. Approximately 5.17 million gal (19.6 million L) of wastewater in LERF was treated at ETF in 2016. 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 2016 was approximately 15.1 million gal (57.2 million L).

ES.5.9.3 200 Area Treated Effluent Disposal Facility. Located east of the 200-East Area, the Treated Effluent Disposal Facility is a collection and disposal system for non-RCRA waste streams and consists of approximately 11 mi (18 km) of buried pipelines connecting three pumping stations, the 6653 Building (known as the disposal sample station), and a 5-ac(2-ha) disposal ponds. The volume of unregulated effluent disposed to this facility in 2016 was approximately 305,000 gal (1,154,000 million L).

ES.5.9.4 242-A Evaporator. The 242-A Evaporator in the 200-East Area concentrates dilute liquid tank waste by evaporation, reducing the volume of liquid waste sent to double-shell tanks for storage and the potential need for other double-shell tanks. In 2016, two operating campaigns were completed at 242-A Evaporator with a volume reduction of 305,000 gal. The facility underwent upgrades in the control room in 2016.

ES.5.10 Underground Waste Storage Tanks

Most Hanford Site waste is stored in 149 large underground single-shell and 28 double-shell tanks grouped into 18 tank farms located on the Central Plateau.

ES.5.10.1 Single-shell Tank System. This system is undergoing closure, as the radioactive and hazardous waste stored in single-shell tanks is being transferred to more safe, double-shell tanks. The retrieval status is 15 of the 16 tanks are complete (one was completed in 2016, and one is in progress for CY 2017). Retrieval of C-111 was completed on March 28, 2016, and the retrieval certificate for

C-111 was submitted to the state in August 2016. Retrieval activities continue at C-105. By the end of 2016, more than 75% of the waste has been retrieved from Tank C-105.

ES.5.10.2 Double-shell Tank System. The double-shell tank system includes 28 double-shell tanks located in the 200-East and 200-West Areas. At the end of 2016, there were 25.6 million gal (96.7 million L) of waste in the DSTs.

ES.5.10.3 Underground Waste Storage Tanks and Associated Facilities Progress on DNFSB. Throughout 2016, the DOE-RL, DOE-ORP, and its contractors met with and provided information to the DNFSB and its technical staff to resolve concerns regarding the 242-A Evaporator, Low-Activity Waste (LAW) Pretreatment System, Waste Compatibility Program, 222-S Laboratory, and Recommendation 2012-2 (DOE 2013).

ES.5.10.4 Single-Shell Tank Closure and Correct Measures Program. The Single-Shell Tank (SST) Closure and Corrective Measures Program (formerly known as the Vadose Zone Program) is responsible for the closure of SST Waste Management Areas, conducting performance assessments (PAs), and performing agreed upon interim measures in and around SST waste management areas (WMAs). Closure activities in CY 2016 continued to focus on the development of closure strategies and closure documents. Work was conducted during CY 2016 to prepare PAs for WMA C, the IDF, and WMA A-AX. The WMA C and WMA A-AX PAs supports closure of WMA C and WMA A-AX, respectively, while the IDF PA supports operations of the IDF. Milestones for the construction of interim surface barriers were renegotiated during CY 2016, and construction of the SX Farm interim surface barriers is scheduled to begin in October 2017.

ES.5.11 Hanford Tank Waste Treatment and Immobilization Plant

The WTP is being built on 65 ac (26 ha) on the Central Plateau to treat radioactive and hazardous waste currently stored in 177 underground tanks. In 2016, DOE and Bechtel National Inc. (BNI) finalized modifications to the WTP contract that prioritize finishing the LAW Facility, Balance of Facilities, and Analytical Laboratory to feed waste directly from the Hanford Tank Farms to LAW under an approach called Direct Feed Low-Activity Waste.

ES.5.11.1 Pretreatment Facility. In 2016, work continued to resolve the remaining technical decisions that have impacted design and construction at the Pretreatment Facility since 2012. Significant progress on the technical decisions was made in 2016 with resolution of the three most significant ones being achieved in January 2017. In December 2016, the final phase started for full-scale testing of control equipment and systems designed to safely mix radioactive waste in Pretreatment vessels. Testing is expected to finish in late 2017.

ES.5.11.2 High-level Waste Facility. At this facility, high-level waste is combined with materials in high-temperature melters, poured into waste containers to form a solid, immobilized glass form. In 2016, experts at Mississippi State University began conducting tests of the safe change high-efficiency particulate air filters that will be used in the Pretreatment, LAW, and high-level waste facilities. Tests included studies of the filter performance under combined operating conditions that exceed the requirements for standard nuclear-grade filters.

ES.5.11.3 Low-Activity Waste Facility. In 2016, construction continued on the installation of the final pieces of major engineered equipment for the off-gas treatment system, including the Thermal

Catalytic Oxidizer, the ammonia skid, and the caustic scrubber. Crews also completed fabrication work on two 300-ton (272-metric tons) melters that will be the heart of the vitrification process in the LAW Facility.

ES.5.11.4 Analytical Laboratory. Once operational, the laboratory will process about 10,000 waste samples a year to support glass formulation and waste-form compliance. In September 2016, WTP workers brought in permanent power to Building 87, the primary electrical switchgear building. Permanent power has now been successfully distributed to three additional Balance of Facilities. This achievement represents the transition from temporary construction-phase utilities to permanent utilities that will operate WTP. Pre-construction activities began on Effluent Management Facility in 2016 and formal construction will commence in 2017, with approval of a Temporary Authorization from Ecology.

ES.5.12 Long-term Stewardship

The Hanford Site's Long-Term Stewardship (LTS) Program has responsibilities within the 220 mi^2 (570 km^2) of the Hanford Site's River Corridor and bounded by 46 mi (74 km) of Columbia River shoreline; these responsibilities include managing post-cleanup obligations for 1,527 waste sites and 6 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 in the LTS records and document libraries. During the 2015 and 2016 inspections of the cocooned reactors, several housekeeping tasks were identified that the LTS Program completed in 2016 and early 2017 to minimize future deterioration of the cocooned structure and improve protectiveness of human health and the environment.

ES.5.13 Scientific and Technical Contributions to Hanford Site Cleanup

The PNNL scientific and technical contributions to cleanup at the Hanford Site were focused on applied science, technology development and maturation, and basic science contributions. These contributions were funded through the DOE-Environmental Management Offices of Soil and Groundwater Remediation and Tank Waste and Waste Processing, DOE-RL, CH2M Plateau Remediation Contractor (CHPRC), DOE-ORP, Washington River Protection Solutions, and BNI. Efforts included performing scientific and technical evaluations and reviews and developing and advancing new technologies to address site cleanup challenges. Researchers continued an effort to identify the speciation of technetium in tank wastes. Under normal processing conditions, technetium is usually present as the pertechnetate ion. However, a significant portion of the technetium in Hanford waste tanks is present as a complex soluble species. Several candidate complexes may be present in tank wastes, and actual waste samples were secured for testing during 2016.

ES.6 Section 6, Air Monitoring

Hanford Site contractors monitor airborne emissions from site facilities to determine compliance with federal and state regulatory requirements and assess the effectiveness of emission control equipment and pollution management practices. The natural state of air in the outdoor environment, ambient air is also monitored at site facilities, away from facilities, and offsite in nearby and distant communities.

ES.6.1 Air Emissions

Small quantities of particulate and volatilized forms of radionuclides and nonradioactive chemical pollutants are emitted to the environment from federal and state permitted emission sources. Most facility radioactive air emission units are monitored periodically or continuously if they have the potential to exceed 1% of the standard for public dose at 10 mrem (100µSv)/yr. Non-radioactive constituents and parameters are monitored directly, sampled, and analyzed or estimated based on inventory usage. Air emission data collected in 2016 were comparable to those collected in 2015.

ES.6.2 Ambient Air Monitoring

A network of continuously operating samplers at 60 locations across the Hanford Site was used during 2016 to monitor radioactive airborne materials in air near site facilities and operations. Ambient air was monitored in 2016 at six locations in the 100-K Area, and analytical results showed radionuclide concentrations at or below typical Hanford Site levels. Uranium-234 and -238 were detected in approximately 20% of the samples, and tritium was detected in approximately 28% of the samples. All other radionuclides of concern were below analytical detection limits. Air sampling was conducted at 21 locations in the 200-East Area during 2016. Generally, radionuclide levels measured in the 2016 air composite samples were similar to those measured in previous years. Uranium-234 and -238 were detected in approximately 28% of the samples. Air sampling was conducted at 23 locations in the 200-West Area during 2016. Radionuclide levels measured were similar to results for previous years. At the Treatment Effluent Disposal Facility station, components for tritium sampling were added in July. The results from these 4-week samples showed slightly lower tritium concentrations than those seen in stations located in/near the 300 Area. Air sampling was conducted at five locations at ERDF (200-West Area). Radionuclide levels measured at this site were comparable to previous years. Air monitoring was conducted at four locations at the 618-10 Burial Ground Project north of the 300 Area. Radionuclide levels measured at this site were comparable to previous years.

ES.6.3 Hanford Site and Offsite Ambient Air Monitoring

Airborne radionuclide samples were collected in 2016 by 40 continuously operating samplers at or in the vicinity of the Hanford Site. All sample results in 2016 showed very low radiological concentrations in air. All radionuclide concentrations (Appendix C, Table C-6) were less than their respective EPA Table 2 concentration values. The EPA concentration values (40 CFR 61, Appendix E, Table 2) are concentrations that would result in an annual dose of 10 mrem (100 µSv)/yr from airborne radiological material.

ES.7 Section 7, Water Monitoring

Eight DOE-owned, contractor-operated public water systems supply drinking water to DOE facilities on the Hanford Site. MSA operates six of the public water systems and the CHPRC operates two systems. The City of Richland supplies water to the 300 Area, Richland North Area, and Hazardous Materials Management and Emergency Response facility.

ES.7.1 Hanford Site Drinking Water Monitoring

Routine chemical, physical, and microbiological monitoring of Hanford Site drinking water is performed regularly as mandated by EPA's Community Water System requirements. All DOE-owned Hanford Site systems were in compliance with drinking water standards for radiological, chemical, and microbiological contaminant levels for 2016. Contaminant concentrations measured during the year were similar to those observed in recent years.

ES.7.2 Columbia River Water Monitoring

The 2016 annual average tritium concentrations measured upstream and downstream of the Hanford Site were similar to concentrations measured in recent years. Statistical analyses indicated that monthly tritium concentrations in river water samples at the City of Richland raw water intake facility were slightly higher than concentrations in samples from Priest Rapids Dam.

ES.7.2.1 Columbia River Water – Fixed Location Samples. Individual radiological contaminant concentrations measured in Columbia River water during 2016 were well below the DOE-derived concentration standards (Appendix D).

ES.7.2.2 Columbia River Transect Samples. The 100-N Area, Hanford Townsite, 300 Area, and City of Richland transects have higher tritium concentrations near the Hanford Site shore (Benton County) when comparing levels to the opposite shoreline. However, 2016 showed similar concentrations of tritium when comparing the City of Richland fixed station to the Benton County shoreline transect sample. Strontium-90 concentrations in Hanford Reach transect samples collected in 2016 were similar to upstream reference concentrations for most locations. Uranium concentrations in all transect samples collected during 2016 were below the EPA drinking water standard of 30 µg/L (approximately 20 pCi/L [0.74 Bq/L]). Average strontium-90 levels measured in Columbia River water collected upstream and downstream of the Hanford Site during 2016 were similar to those reported in previous years.

ES.7.2.3 Inorganic and Organic Chemical Results. Inorganic and organic analyses detected metals and anions in Columbia River transect samples upstream and downstream of the Hanford Site. Copper and uranium were detected in most samples while detections of arsenic, lead, nickel, and zinc were detected in a few samples. All dissolved metal concentrations in river water were less than the Washington State ambient surfacewater quality criteria for the protection of aquatic life.

ES.7.3 Columbia River Sediment Monitoring.

Samples of the surface layer of Columbia River sediment were collected at depths of 0 to 6.3 in. (0 to 16 cm) from 13 river locations that were predominantly submerged. All sediment samples were analyzed for gamma-emitting radionuclides, anions, hexavalent chromium, strontium-90, uranium-234, uranium-235, plutonium-238, uranium-238, plutonium-239/-240, metals, mercury, and total organic carbon. Analytical results for 2016 showed similar concentrations of cesium-137 at Priest Rapids and McNary Dam sediment collection locations. Uranium-234 concentrations were slightly elevated in the 300 Area DR-42-2 location when compared to other sediment collected from the Hanford Reach, McNary Dam, and Priest Rapids Dam samples in 2016.

ES.7.4 Columbia River Seep Water

Samples of Columbia River shoreline seep water and three associated shoreline sediment samples were collected along the Hanford Reach in 2016 and analyzed for radiological, inorganic, and organic contaminants. In 2016, 12 of 15 seeps were successfully sampled. All samples collected were analyzed for tritium. Some samples from selected seeps were analyzed for alpha, anions, beta, carbon-14, hexavalent chromium, metals, strontium-90, technetium-99, uranium-234, uranium-235, uranium-238, and volatile organic compounds.

ES.7.5 Pond Water and Sediment

West Lake is the only naturally occurring pond on the site, and the area has not received radioactive discharges for some time. The surfacewater collected within the footprint of West Lake was analyzed for tritium, uranium-234, uranium-235, and uranium-238. Tritium concentrations in surfacewater collected from West Lake in 2016 were below the laboratory-reported required detection limit. Two uranium-234 and two uranium-238 results were above applicable DOE-derived concentration standards (DOE/EH-0676) for riparian and aquatic receptors. One sample showed the highest concentrations of uranium-234 and uranium-238 compared to concentrations seen over the last few years.

ES.7.6 Offsite Irrigation Water

To assess the potential for Hanford Site-associated contaminants to affect food products irrigated with Columbia River downstream of the site, water samples were collected three times during the irrigation season from a canal east of the Columbia River and from the Horn Rapids irrigation pumping station. Most radionuclide concentrations measured in irrigation water in 2016 were at similar levels detected in Columbia River transect water samples collected upstream of the Hanford Site.

ES.7.7 Liquid Effluent Monitoring

Liquid effluent disposal is governed by applicable regulations and permits. When discharges occur, sampling and analyzing is performed to identify select radioactive parameters and nonradioactive hazardous materials. Discharge monitoring reports that contain contaminant data from these analyses are submitted to Ecology.

ES.8 Section 8, Groundwater Monitoring

During Hanford Site operations, chemical and radioactive waste was released into the environment and contaminated soil and groundwater beneath portions of the site, mostly in the 200-East, 200-West, 300, and 100 Reactor Areas along the river. Groundwater monitoring data and information on well locations, construction details, and screened intervals, are available through the DOE Environmental Dashboard Application at https://ehs.hanford.gov/eda/ or on the PNNL-Hanford Online Environmental Information eXchange website at http://phoenix.pnnl.gov. The data and additional groundwater monitoring details are available in DOE/RL-2016-67, *Hanford Site Groundwater Monitoring Report for 2016*.

ES.9 Section 9, Soil Monitoring

Soil samples were collected on or adjacent to waste disposal sites and from locations downwind and near or within the boundaries of operating facilities and remedial action sites. Soil samples from offsite locations are collected every 3 to 5 years and were last collected in 2015.

Radionuclide concentrations in soil samples collected from or adjacent to waste disposal facilities in 2016 were higher than the concentrations in samples collected farther away. As expected, data also showed that concentrations of certain radionuclides in 2016 were similar or higher in different operational areas when compared to concentrations measured in distant communities in previous years. Historically, the predominant radionuclides detected were activation and fission products in the 100 Area, fission products in the 200 and 600 Areas, and uranium in the 300 and 400 Areas.

ES.10 Section 10, Biota Monitoring

DOE conducted agricultural monitoring at several locations that vary annually near the Hanford Site to assess potential contaminant concentrations in food and farm products as a result of site activities. Plant and animal species on the site are also monitored to assess abundance, condition, and population distributions. Data collection and analysis are integrated with environmental monitoring of biotic and abiotic media, and analytical results are used to characterize potential risks or impacts.

ES.10.1 Agricultural Monitoring

Food and farm products (apricots, corn, leafy vegetables, melons, milk, potatoes, tomatoes, and wine must) were collected in 2016 at locations near the Hanford Site. Radionuclide concentrations in most food and farm product samples in 2016 were below the analytical laboratory detection levels; however, some potential Hanford Site-produced contaminants (e.g., tritium) were found at low levels in some samples. Data for potassium-40 and beryllium-7 are included to show the natural radioactive elements that exist in food products relative to concentrations of potential Hanford Site-produced contaminants.

ES.10.2 Fish and Wildlife Monitoring

The fish and wildlife species sampled and analyzed for Hanford Site operations-produced contaminants during CY 2016 were smallmouth bass (*Micropterus dolomieu*), common carp (*Cyprinus carpio*), elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), and California quail (*Callipepla californica*). Most fish and wildlife samples are collected on and around the Hanford Site and analyzed for human-pathway exposure every 2 to 3 years. Reference samples are obtained at locations determined not to be affected by Hanford Site effluents and emissions at least every 5 years.

ES.10.2.1 Smallmouth Bass. Manmade gamma-emitting radionuclides, including cesium-137, were not detected in 2016 in any of the muscle samples analyzed. Strontium-90 was not detected in smallmouth bass samples collected in 2016 from the reference area or Hanford Reach locations. Three bass samples were analyzed for 17 different trace metal concentrations. Barium, copper, manganese, mercury, selenium, silver, and zinc were detected above the analytical detection limit.

ES.10.2.2 Common Carp. Manmade gamma-emitting radionuclides, including cesium-137, was not found in 2016 in any of the muscle samples analyzed. Strontium-90 was not detected in common carp filet or carcass samples in 2016. Uranium-234 was detected in 7 of the 11 samples. Uranium-235 was detected in 4 of the 11 samples. Uranium-238 was detected in 6 of the 11 samples for 2016. This was slightly less detects than in 2014 in a similar number of samples. Barium, copper, lead, manganese, mercury, selenium, thorium, uranium, and zinc were detected above the analytical detection limit.

ES.10.2.3 Mule Deer and Elk. Cesium-137 was not detected in any of the seven muscle tissue samples collected as a Hanford sample or a reference sample. Strontium-90 was detected in all four bone samples analyzed during 2016. Ten metals (aluminum, barium, cadmium, chromium, copper, manganese, selenium, silver, thorium, and zinc) were found above analytical detection limits in 2016.

ES.10.2.4 Upland Game Birds. Manmade gamma-emitting radionuclide, cesium-137, was not detected above the detection limit (0.03 pCi/g [0.001 Bq/g] wet weight) for any upland game bird

muscle samples analyzed in 2016. Strontium-90 concentrations were detected in two quail bone samples collected in 2016.

ES.10.3 Vegetation Monitoring

Plant populations and habitats occurring on the Hanford Site are surveyed and monitored to assess potential risks or impacts to biota. Data from Hanford Site and offsite vegetation samples are analyzed for atmospheric deposition of contaminants in and around operational areas onsite and in uncultivated areas offsite. These data provide a baseline against which unplanned releases can be compared. Radionuclide concentrations in vegetation samples collected from or adjacent to waste disposal facilities in 2016 were similar to or slightly higher than concentrations in samples collected farther away, including concentrations measured offsite in 2015. Generally, the predominant radionuclides were activation and fission products in the 100 Area, fission products in the 200 and 600 Areas, and uranium in the 300 and 400 Areas. Vegetation samples collected in 2016 at locations in the 100-N, 200-East, 200-West, 400, and 600 Areas were comparable to those collected in previous years. Vegetation samples collected in the 200 and 600 Areas showed concentrations of uranium-234, uranium-235, and uranium-238 that were comparable to historical data.

ES.10.3.1 Radiological Contamination. Investigations of radioactive contamination in vegetation were conducted in and near operational areas to monitor the presence or movement of radioactive materials around areas of known or suspected contamination or to verify radiological conditions at specific project sites. All samples collected during investigations were field-surveyed for alpha- and beta-gamma radiation. Radiological contamination was found in 45 vegetation samples surveyed during the 2016 investigations.

ES.10.3.2 Vegetation Control. Vegetation control activities help prevent, limit, or remove contaminated plants or undesirable plant species. Approximately 5,444 ac (2,203 ha) were treated with herbicides in 2016 on radiological waste sites, around operations areas, and along roadways to keep areas free of deep-rooted vegetation (e.g., Russian thistle, also known as tumbleweed). Follow-up treatments are included in the total treated acres; several areas received more than one herbicide application.

ES.10.4 Waste Site Remediation and Revegetation

In 2016, only 2 ac (0.8 ha) across the Hanford Site were planted with grass seed to stabilize areas where traffic and erosion had damaged the grass cover on waste sites. Waste sites in the 200-East and 200-West Areas were designed and constructed with a cap of perennial grass essential to performance of engineered waste sites.

ES.11 Section 11, Resource Protection

DOE is responsible for managing and protecting biological and cultural resources on the Hanford Site. Ecological and cultural resource monitoring are conducted to collect and track data needed to ensure compliance with applicable laws, regulations, and policies (including management plans) governing DOE activities.

ES.11.1 Ecological Protection

Ecological monitoring data provide baseline information about the plants, animals, and habitats under DOE stewardship at Hanford that is required to make cleanup decisions. During 2016, DOE continued to monitor and evaluate species that are protected by federal or state laws and regulations or are of special interest to the public and stakeholders. Fall Chinook salmon redds, steelhead redds, and bald eagle nesting and night roosting activity were assessed because these species have the potential to be impacted by Hanford Site operations. Additional monitoring efforts included raptor nest monitoring, roadside and sagebrush bird surveys, mule deer, snake hibernacula, and long-billed curlews.

ES.11.2 Endangered and Threatened Species

Two endangered and threatened fish species, spring-run Chinook salmon and steelhead, are known to occur regularly on the Hanford Site. One additional fish species (bull trout) was recorded at the site, but scientists believe that the species is transient. Umtanum desert buckwheat and White Bluffs bladderpod, federally listed as threatened plant species, also occur on the site. No other plants or animals known to occur on the Hanford Site are currently federally listed as threatened or endangered, though the Washington ground squirrel is a candidate for federal listing. In addition, 12 plant species and 4 bird species have been listed as either endangered or threatened by Washington State. Numerous additional species of animals and plants are listed as candidate or sensitive species by Washington State. There are 31 state-level sensitive and candidate species of animals and 17 sensitive plant species occurring or potentially occurring on the Hanford Site.

ES.11.3 Cultural and Historic Resource Protection

DOE is responsible for managing and protecting the Hanford Site's cultural and historic resources in accordance with applicable federal cultural resources laws and regulations and DOE management plans. In 2016, Hanford Site archaeologists completed 97 *National Historic Preservation Act of 1966* (NHPA) Section 106 cultural resources reviews. Twenty-seven undertakings had the potential to affect cultural resources. Thirty-five projects affected historic buildings and were determined exempt by Hanford Site archaeologists after meeting the DOE-approved historic buildings programmatic agreement (DOE/RL-96-77) exemption criteria following an initial review. Twenty-five projects had been reviewed for effects to cultural resources under previous NHPA Section 106 reviews. Ten projects were reviewed and completed by Hanford Site archaeologists under an emergency declaration. A total of 5,950.29 ac (2,407.99 ha) of new ground was surveyed for cultural resources from NHPA Section 106 project-specific surveys.

ES.11.4 Collection Management and Curation

The Hanford History Project provides professional curatorial and archival services for the management, conservation, and public access of the Hanford Collection, which consists of artifacts and multimedia relating to the Manhattan Project and Cold War Era. In addition to public outreach and education, Washington State University, Tri Cities (WSU-TC) provides a repository for the collection that meets the requirements of 36 CFR 79, "Curation of Federally-Owned and Administered Archaeological Collections," including protecting these resources from theft, fire, breakage, or deterioration. During 2016, five artifacts were evaluated for inclusion and picked up from Hanford Site facilities and delivered to the Hanford History Project repository at WSU-TC, leaving 26 (3.5%) of the 743 tagged artifacts scheduled for collection between 2016 and 2048. The transition of the Hanford Collection to the WSU-TC facility began in July 2015 and continued through September 2016. During 2016, the remaining 60% of the Collection was moved from the artifact staging facility on the Hanford Site to either the WSU-TC curation facility in the Innovation Center Building or to a staging room for screening prior to transition.

ES.12 Section 12, Quality Assurance

Quality assurance (QA) and quality control (QC) programs for the Hanford Site and offsite environmental surveillance were documented through project-specific QA plans and describe applicable QA elements. Several types of field QC samples are collected to ensure the validity of the sampling procedures and the resulting sample data. The potential cross-contamination between samples during the sampling process is evaluated using trip blanks and equipment blanks. Additionally, field duplicates are collected to evaluate sample matrix heterogeneity and sample collection reproducibility. In 2016, field duplicate samples were collected and analyzed for air, soil, Columbia River water, natural vegetation, milk, wine, mulberries, wildlife, irrigation water, sediment, and seep samples. The accepted method of evaluating the precision or reproducibility of duplicate samples is the calculation of the Relative Percent Difference. In 2016, Hanford Site Environmental Surveillance samples were sent to two laboratories (GEL and TARL). These laboratories participated in various independent QA and QC programs including Mixed Analyte Performance Evaluation Program (MAPEP) and DOE Consolidated Audit Program. GEL's MAPEP program radiological results were issued warnings for biased strontium-90 results in the 20 to 30% range. However, these results are considered acceptable. GEL's MAPEP results for inorganic compounds in water were issued a warning for mercury in MAPEP study 35. However, this is considered an acceptable result. TARL's MAPEP program radiological results for studies 34 and 35 in 2016 received warnings for plutonium-238 in air and technetium-99 in water. However, these results are considered acceptable. TARL had unacceptable results for technetium-99, strontium-90, and americium-241 due to false positive results.