12.0 Quality Assurance

RA Westberg

Quality assurance (QA) and quality control (QC) practices encompass all aspects of Hanford Site environmental monitoring and surveillance activities. Hanford Site contractors, subcontractors, and multiple DOE organizations are involved in and conduct environmental monitoring and surveillance activities independently–each driven by different missions and regulatory requirements, but with the same goal in mind. This section describes the Environmental Surveillance program, part of the Public Safety and Resource Protection Program managed by MSA. The Environmental Surveillance program includes environmental surveillance and monitoring across multiple media types both on and off the Hanford Site. The program conducts multi-media environmental monitoring to assess Hanford Site and offsite human health exposures to radionuclides and chemicals and evaluate the potential impact of site operations on the environment. This section provides information on specific measures taken in 2014 to ensure quality and defensibility in project management, sample collection, and analytical results.

Note: Because of the complexity of the groundwater program, QA/QC specifications for groundwater sampling and program management are reported independently in the http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports and in Appendix D of this report and are not discussed in this section.

Quality assurances and controls of the Hanford Site and offsite surveillance programs are documented through QA program plans and describe applicable QA elements (e.g., MSC-23333, *Environmental Quality Assurance Program Plan*). Sample analyses across all media types are performed by onsite and offsite contracted laboratories, which are also required to meet these plan specifications. To ensure the highest quality data are obtained, accredited offsite laboratories used were audited for equipment and services before the contract awards were made.

DOE O 414.1D
QA Program Requirements

- Management/QA Program
- Personnel Training/Qualification
- Quality Improvement
- Documents and Records
- Work Processes
- Design
- Procurement
- Inspection and Acceptance Testing
- Management Assessment
- Independent Assessment

12.1 Program Management

Per federal requirements, environmental surveillance activities are subject to an overall QA program. This program satisfies the requirements for collecting and assessing environmental data in compliance with the following:

- 10 CFR 830, "Nuclear Safety Management," Subpart A, Quality Assurance Requirements
- DOE O 414.1D, *Quality Assurance*
- Analytical Services - Hanford Site, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD)
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*
- Richland Requirements Document 008, Quality Assurance Program Requirements
- Project-specific QA plans and documentation are found in MSC-23333 and describe the QA/QC elements associated with the Environmental Surveillance program.

12.1.1 Personnel Training and Qualifications

Hanford Site personnel are provided with the knowledge and skills necessary to perform specific jobs safely, effectively, and efficiently with minimal supervision. This capacity is accomplished by establishing and enforcing site-wide policies, procedures, and guidance through training programs that provide general and specialized training classes and housing hands-on training facilities dedicated to ensuring personnel are qualified and confident to perform the task safely. The following principles and practices are included in the training program and are documented in MSC-23333:

- Develop training standards and procedures that meet valid requirements and regulations and are consistent with industry-proven best management practices
- Recognize management's responsibility to lead and coach their employees to ensure employees are trained and remain proficient to perform assigned tasks
- Conduct evaluations of employee training to ensure regulatory compliance, compliance with standards and instructions, and improve the training process
- Employ instructional staff and subject matter experts who are qualified and maintain their instructional and subject area skills and knowledge
- Use a graded approach to develop training programs to ensure value and effectiveness.

12.2 Quality Control Samples

Several types of QC samples are collected during monitoring and sampling events. The QC samples are in place to help reduce data uncertainty and collect the highest quality data possible. The tasks vary by monitoring and sampling event, and QC procedures are followed in the field and laboratory to ensure reliable data are obtained.

Field environmental QC samples are collected to evaluate the potential for cross-contamination and provide information pertinent to field variability. Field QC samples require the collection of field duplicates, trip or field blanks, and equipment blanks.

Laboratory QC samples estimate the precision and accuracy of the analytical data and include method blanks, laboratory replicates, matrix spikes, and matrix spike duplicates. Table 12.1 summarizes the different types, characteristics, and frequency of QC samples.

A QC sample frequency goal of 5 percent, or 1 in 20 samples, where feasible, is set for environmental surveillance activities on the Hanford Site for the number of QC samples needed for environmental data collection and surveillance activities.

Blanks: A sample of the carrying agent (gas, liquid, or solid) normally used to measure selectively a material of interest that is subjected to the usual analytical process and associated procedures to establish a baseline or background value. This value is then used to adjust or correct the routine analytical results.

Field Duplicate Samples: Two samples produced from material collected in the same location at roughly the same time. The parent sample and its duplicate are each uniquely labeled and used to provide information on the homogeneity of the matrix and ensure consistency in sample collection procedures.

Laboratory Replicate Sample: A single sample aliquoted alternately into two sets of sample containers for duplicate analysis by the primary laboratory. Lab replicates are a measure of variation of aliquots analyzed from the same sample.

Spiked Sample: A normal sample of material (gas, liquid, or solid) to which a known amount of some substance of interest is added. Spiked samples check the accuracy of a routine analysis or the recovery efficiency of an analytical method. Spiked samples are exclusively used by the laboratory.

Table 12.1 Field and Laboratory Quality Control Sample Types, Characteristics, and Frequency

Sample Type	Primary Characteristics Evaluated	Frequency
Field QC Samples		
Field trip blank (FTB)	Volatile organic compound cross-contamination from other sources during transportation	1 per field trip
Equipment blank (EB)	Cross-contamination from non-dedicated equipment	1 per sampling method type per year for selected analytes
Duplicate	Reproducibility	1 per 20 samples, where feasible
Laboratory QC Samples		
Method blank	Laboratory contamination	[a]
Laboratory replicate	Laboratory reproducibility	[a]
Matrix spike	Matrix effect and laboratory accuracy	[a]
Matrix spike duplicate	Laboratory reproducibility/accuracy	[a]

[a] As defined in the laboratory contract or QA plan, and/or analysis procedures.

12.3 Sample Collection Quality Assurance and Quality Control

Environmental samples were collected for air, surface water, biota (wildlife and food and farm products), soil and vegetation, and sediment by trained personnel in accordance with approved desk instructions and/or procedures. Established sampling locations were accurately identified with visible postings or plotted GPS readings and documented to ensure continuity of data. In 2014, environmental samples collected were either submitted to General Engineering Laboratories, LLC (GEL) or the WSCF laboratory, located in the 200 Area of the Hanford Site for radiochemical analyses, from January 1, 2014, until the lab closed on May 31, 2014 (Table 12.2).

Table 12.2. Laboratories and Types of Environmental Surveillance Samples Analyzed

	Environmental Monitoring and Surveillance Samples			
Analytical Laboratory	**Air**	**Water**	**Biota**	**Other**
WSCF	X			X
GEL	X	X	X	X

GEL = General Engineering Laboratories, LLC WSCF = Waste Sampling and Characterization Facility

Personnel are trained to conduct sampling in accordance with approved schedules, instructions, and procedures. Field assessments are routinely performed by media task leads and documented. Field duplicate samples are used to assess sampling and measurement precision. In 2014, duplicate samples were collected and analyzed for offsite media in air, Columbia River water, milk, potatoes, sediment, and seep samples (Table 12.3).

Table 12.3. Hanford Site Offsite Media Field Duplicate Samples and Locations

Media	Location	Number of Samples

Air	300 South Gate	26
Columbia River Water	Hanford Townsite - HRM 28.7	5
Columbia River Water	Priest Rapids Dam	5
Milk	Sagemoor Area	1
Potato	East Wahluke Area	1
Sediment	Hanford Slough	1
Seep	Hanford Townsite	6

HRM: Hanford River Mile.

Field duplicates for Hanford Site samples and locations collected included air, soil, and natural vegetation (Table 12.4). Hanford Site air samples were collected and analyzed bi-weekly from two locations, then composited semiannually, by location, for isotopic analysis.

Table 12.4. Hanford Site Media Field Duplicate Samples, Locations, and Constituents Analyzed

Media	Location	Number of Samples
Air	200-West Area	26
Soil	Various	6
Water	Fast Flux Test Facility Pond	2
Wildlife	Various	6
Natural Vegetation	U-Plant	2

Analytical results for onsite and offsite parent and duplicate samples were reviewed against the criterion that the result must be greater than the minimum detectable activity value or the method detection limit to be evaluated (commonly known as a detect). To be considered an acceptable result (a result within the control limits); the relative percent difference (RPD) of the detected routine sample and its duplicate must also be less than 30 percent. Duplicate results for 2014 are shown in Tables 12.5 and 12.6.

Relative Percent Difference (RPD)

A measure of the precision of the measurement of a sample (S) and its duplicate (D). The formula is as follows:

$$RPD = \left(\frac{|S - D|}{\frac{(S + D)}{2}} \right) \times 100$$

Table 12.5. Offsite Media[a] Field Duplicate Sample Results

Media	Detected Analytes	Number of Results Within Control Limits[b]	Percent of Results within Control Limits
Air	Alpha (gross)	15 of 26	58
	Beta (gross)	22 of 26	85
	Americium-241	1 of 1	100
	Antimony-125	1 of 1	100
	Colbalt-60	1 of 1	100
	Cesium-134	1 of 1	100
	Cesium-137	1 of 1	100
	Europium-152	1 of 1	100
	Europium-154	1 of 1	100
	Europium-155	1 of 1	100
	Hydrogen-3 (tritium)	12 of 12	100
	Plutonium-238	1 of 1	100
	Plutonium-239/240	1 of 1	100
	Potassium-40	1 of 1	100
	Ruthenium-106	1 of 1	100
	Strontium-90	1 of 1	100
	Uranium-234	1 of 1	100
	Uranium-235	1 of 1	100
	Uranium-238	1 of 1	100
Farm Products			
Milk	Hydrogen-3 (tritium)	1 of 1	100
	Potassium-40	1 of 1	100
Potato	Potassium-40	1 of 1	100
Surface Water			
Pond	Beta (gross)	0 of 1	0
	Hydrogen-3 (tritium)	1 of 1	100
	Cesium-137	0 of 1	0
Columbia River	Potassium-40	0 of 1	0
	Hydrogen-3 (tritium)	1 of 2	50
	Uranium-234	2 of 3	67
	Uranium-235	0 of 1	0
	Uranium-238	3 of3	100
Seep	Beta (gross)	1 of 1	100
Offsite Irrigation	Hydrogen-3 (tritium)	0 of 1	0
Sediment	Potassium-40	1 of 1	100
	Cesium-137	1 of 1	100
	Uranium-234	1 of 1	100
	Uranium-235	0 of 1	0
	Uranium-238	1 of 1	100
	Plutonium-239/240	1 of 1	100
Wildlife	Potassium-40	4 of 4	100
	Strontium-90	1 of 1	100

Table 12.5. Offsite Media[a] Field Duplicate Sample Results

Media	Detected Analytes	Number of Results Within Control Limits[b]	Percent of Results within Control Limits
Anions			
Surface Water	Chloride	1 of 1	100
	Fluoride	1 of 1	100
	NO_3-N	1 of 1	50
	Sulfate	1 of 1	100
Seep	Chloride	1 of 1	100
	Fluoride	1 of 1	100
	NO_3-N	1 of 1	100
	Sulfate	1 of 1	100
Sediment	Chloride	0 of 1	0
	Sulfate	1 of 1	100
Metals			
Surface Water	Copper	1 of 2	50
	Uranium	2 of 2	100
	Zinc	2 of 2	100
Seep	Copper	2 of 2	100
	Uranium	2 of 2	100
	Zinc	1 of 2	50
	Arsenic	1 of 1	100
Wildlife	Copper	1 of 1	100
	Manganese	1 of 1	100
	Zinc	2 of 2	100
	Selenium	1 of 1	100
Sediment	Arsenic	1 of 1	100
	Beryllium	1 of 1	100
	Cadmium	1 of 1	100
	Chromium	1 of 1	100
	Copper	1 of 1	100
	Lead	1 of 1	100
	Mercury	1 of 1	100
	Nickel	1 of 1	100
	Zinc	1 of 1	100

Table 12.6. Hanford Site Media Field Duplicate Sample Results

Detected Analytes	Number of Results in Control Limits[a]	Percentage of Results in Control Limits
Air Filters		
Alpha (gross)	24 of 27	89
Beta (gross)	22 of 27	81
Antimony-125	2 of 2	100
Cesium-134	2 of 2	100
Cesium-137	2 of 2	100
Colbalt-60	2 of 2	100
Europium-152	2 of 2	100
Europium-154	2 of 2	100
Europoum-155	2 of 2	100
Plutonium-238	2 of 2	100
Plutonium-239/240	2 of 2	100
Ruthenium-106	2 of 2	100
Strontium-90	2 of 2	100
Uranium-234	2 of 2	100
Uranium-235	2 of 2	100
Uranium-238	2 of 2	100
Soil		
Antimony-125	3 of 3	100
Cesium-134	1 of 3	33
Cesium-137	3 of 3	100
Cobalt-60	3 of 3	100
Europium-152	3 of 3	100
Europium-154	3 of 3	100
Europium-155	2 of 3	66
Plutonium-238	3 of 3	100
Plutonium-239/240	3 of 3	100
Ruthenium-106	3 of 3	100
Strontium-90	2 of 3	67
Uranium-234	3 of 3	100
Uranium-235	3 of 3	100
Uranium-238	3 of 3	100
Natural Vegetation		
Antimony-125	1 of 1	100
Cesium-134	1 of 1	100
Cesium-137	0 of 1	0
Cobalt-60	1 of 1	100
Europium-152	1 of 1	100
Europium-154	1 of 1	100
Europium-155	1 of 1	100
Plutonium-238	1 of 1	100
Plutonium-239/240	1 of 1	100
Ruthenium-106	1 of 1	100
Strontium-90	1 of 1	100
Uranium-234	1 of 1	100
Uranium-235	1 of 1	100
Uranium-238	1 of 1	100

[a] Number of reported results within control limits for radiological analysis is those with the relative percent difference value less than 30 percent, and the result is greater than the minimum detectable activity.

12.4 Media Audits and Comparisons

Selected sediment, surface water, food and farm products, wildlife, soil, and vegetation samples are provided to the WDOH for comparative analysis as part of the Public Safety and Resource Protection QA program (DOE/RL-91-50). The Hanford Environmental Radiation Oversight Program of the WDOH independently verifies the quality of DOE monitoring programs at the Hanford Site. Since 1985, WDOH and DOE have collaboratively participated in the collection of environmental samples located on or in the surrounding areas of the Hanford Site (WDOH 320-097, *Hanford Environmental Radiation Oversight Program 2011 Data Summary Report*). This includes, but is not limited to, conducting split, collocated, and independent sampling at locations that have the potential to release radionuclides to the environment, or that could be impacted by such releases. This program is not intended to characterize completely the environmental radiation on the Hanford Site; but provide oversight to Hanford Site contractors in determining the impact of Hanford releases on the environment and the public. More information can be found on the WDOH website at WDOH's Environmental Sciences. Media types analyzed by the WDOH included the following:

- Air Filters from 11 locations
- Apricots from 1 location
- Leafy vegetables from 2 locations
- Potatoes from 2 locations
- Sediment from 5 locations
- Cherries from 2 locations
- Quail from 1 location
- Bass from 1 location
- Carp from 2 locations
- Columbia River surface water from 2 locations
- Offsite irrigation water from 2 locations
- Columbia River shoreline springs (seeps) from 6 locations.

No comparison data were available at the time this report was written; however, links to past data summary reports and other environmental science publications for the Hanford Environmental Radiation Oversight program are available online at http://www.doh.wa.gov/communityandenvironment/radiation/publications/environmentalsciences.aspx.

12.5 Laboratory Quality Assurance Programs

Contracted analytical laboratories are required to maintain internal QC programs and participate in independent QC programs used to determine analytical precision and accuracy. These laboratories house chemical technologists who are qualified to perform these analyses through formal classroom education and on-the-job training. Internal QC programs for contracted laboratories involve routine calibrations of counting instruments, yield determinations of radiochemical procedures, frequent radiation-check sources and background counts, replicate and spiked sample analyses, use of matrix and reagent blanks, and maintenance of control charts to indicate analytical deficiencies. Examples of independent QC programs are the Mixed Analyte Performance Evaluation Program (MAPEP) (DOE 2004) and the DOE Consolidated Audit Program (DOECAP). They are described in the following sections.

12.5.1 Analytical Quality Assurance and Quality Control

Hanford Site environmental samples were sent to one laboratory in 2014 (Table 12.7) and included routine chemical and radiological analyses of air, water, soil and vegetation, sediment and biota. In 2014, General Engineering Laboratories, LLC (GEL) participated in independent QA and QC programs including MAPEP and DOECAP. These managed programs use standardized audit methods, processes, and procedures to ensure, annually, the validity, reliability, and defensibility of data from the contract laboratories.

Table 12.7 DOE Mixed Analyte Performance Evaluation Program Results for General Engineering Laboratories, LLC

Environmental Sample Media and Analytes		MAPEP 30Series March 2014 [a]	MAPEP 31 Series August 2014 [a]
Radionuclides			
Air Filters	Alpha (gross), beta (gross), americium-241, cesium-134, cesium-137, cobalt-60, plutonium-238, plutonium-239/240, strontium-90, uranium-234/233, uranium-238	100% Acceptable	100% Acceptable
Water	Alpha (gross), beta (gross), americium-241, cesium-134, cesium-137, cobalt-60, iodine-129 plutonium-238, plutonium-239/240, potassium-40, strontium-90, technetium-99, tritium, uranium-234/233, uranium-238	Uranium-234/233 [b] Uranium-238 [b]	100% Acceptable
Vegetation	Cesium-134, cesium-137, cobalt-60, plutonium-238, plutonium-239/240, strontium-90, uranium-234/233, uranium-238	Uranium-235 [b]	100% Acceptable
Soil	Cesium-134, cesium-137, colbalt-60, plutonium-238, plutonium-239/240, strontium-90	Technetium-99 [b] Uranium-235 [b] Uranium-238 [b] Uranium-total [b]	100% Acceptable
Inorganic Compounds			
Water	Antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, zinc	100% Acceptable	Lead[b]
Organic Compounds			
Water	1,4-Dichlorobenzene	100% Acceptable	100% Acceptable

[a] Performance results 100 percent acceptable for all analytes unless otherwise noted.
[b] Result not acceptable, Bias > 30 percent due to the sensitivity evaluation of the analyte in the sample. No adverse effect on Hanford sample.

GEL was audited by DOECAP in March 2014. The objective of DOECAP is to ensure the application of consistent standards between the analytical laboratories supporting the DOE complex and its compliance programs. Audit objectives included assessing the ability of the laboratory to produce data of acceptable and documented quality through analytical operations that follow approved and technically sound methods, and the handling of DOE samples and associated waste in a manner that protected human health and the environment. GEL also participated in MAPEP Studies 30 and 31 and a number of Environmental Resource Associates's proficiency studies for water, soil, air filter, and vegetation matrices.

Prior to shutdown, WSCF maintained Ecology and American Industrial Hygiene Association accreditation and had an internal QA program plan. In 2014, WSCF did not participate in laboratory performance evaluation programs.

12.5.2 Laboratory Performance Evaluation and Proficiency Testing

Participation of Hanford Site analytical laboratories in DOE and EPA laboratory performance evaluation programs serves to ensure data quality. Hanford Site environmental monitoring contract laboratories

participate in MAPEP-sanctioned proficiency testing provided by an independent laboratory (e.g., Environmental Resource Associates).

DOE's MAPEP provides critical QA testing for environmental analytical services. Radiological and non-radiological (organic and inorganic) constituents are evaluated by performing semiannual proficiency testing of the Hanford Site DOE laboratories, and other federal, state, commercial, and international laboratories. MAPEP proficiency tests help to ensure the accuracy of analytical results reported to DOE and other stakeholders, while also providing an efficient means for laboratories to demonstrate analytical proficiency. Results to past MAPEP studies can be found on the DOE's Mixed Analyte Performance Evaluation Program webpage at http://www.id.energy.gov/resl/mapep/mapepreports.html.

GEL's MAPEP program results were 100 percent acceptable for Studies 30 and 31 in 2014 for air and water; however, radiological results for vegetation in Study 30 failed for uranium-234 and uranium-238 due to sensitivity evaluations. Radiological vegetation results for Study 31 were 100 percent acceptable. Results of MAPEP Studies 30 and 31 for GEL are provided in Table 12.7 or at http://www.id.energy.gov/resl/mapep/mapepreports.html.

In 2014, due to DOE direction to close the WSCF, this laboratory did not participate in MAPEP Studies 30 and 31. WSCF did not provide any other proficiency studies prior to shut down; therefore, it is uncertain whether the laboratory participated in 2014.

12.6 Data Recording and Data Management

Record keeping is a vital part of all environmental programs on the Hanford Site. Maintenance of environmental data is essential for QA, regulatory compliance, trend analysis, and optimization purposes. The Environmental Surveillance program is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with applicable programmatic requirements governing data management procedures. Project documentation includes environmental sample logbooks and processing forms, and as applicable, monthly, quarterly, and annual occurrence reports. Several electronic data repositories are used to house the environmental data, all of which have their own internal QA and QC policies and procedures.