

## **Appendix F**

# **Groundwater Monitoring Data Quality Assessment**

This page intentionally left blank.

## Contents

<b>F1</b>	<b>Introduction.....</b>	<b>F-1</b>
<b>F2</b>	<b>Purpose.....</b>	<b>F-1</b>
<b>F3</b>	<b>Scope.....</b>	<b>F-1</b>
<b>F4</b>	<b>Groundwater Monitoring Program Analytical Data Quality Requirements .....</b>	<b>F-1</b>
	F4.1 Analyte Reporting Conventions .....	F-4
	F4.2 Field QC Sample Types .....	F-4
	F4.3 Laboratory Quality Control Sample Types .....	F-7
	F4.4 Qualification Flags .....	F-8
<b>F5</b>	<b>Data Completeness .....</b>	<b>F-11</b>
	F5.1 Percentage of Successful Sampling Events .....	F-11
	F5.2 Percentage of Field Quality Control Samples Collected .....	F-11
	F5.3 Percentage of Useable Data.....	F-11
<b>F6</b>	<b>Laboratory Information and Analytical Methods .....</b>	<b>F-16</b>
	F6.1 Laboratory Information .....	F-16
	F6.2 Analytical Methods .....	F-16
<b>F7</b>	<b>Sample Preservation and Holding Times.....</b>	<b>F-19</b>
	F7.1 Sample Preservation .....	F-24
	F7.2 Holding Times.....	F-25
<b>F8</b>	<b>Field Quality Control.....</b>	<b>F-27</b>
	F8.1 Field Blanks.....	F-27
	F8.2 Field Duplicate Samples.....	F-37
	F8.3 Quadruplicate Total Organic Carbon and Total Organic Halides Samples.....	F-40
	F8.4 Field Split Samples.....	F-42
<b>F9</b>	<b>Laboratory Quality Control.....</b>	<b>F-44</b>
	F9.1 Laboratory Method Blanks.....	F-48
	F9.2 Laboratory Control Samples and Laboratory Control Sample Duplicates .....	F-54
	F9.3 Matrix Spikes and Matrix Spike Duplicates.....	F-58
	F9.3.1 Matrix Spikes by Laboratory .....	F-66
	F9.3.2 Matrix Spikes by Analyte Class.....	F-67
	F9.4 Laboratory Sample Duplicates .....	F-68
	F9.5 Surrogates and Surrogate Duplicates.....	F-70
<b>F10</b>	<b>Laboratory Performance.....</b>	<b>F-74</b>
	F10.1 Quarterly Blind Standard Evaluations.....	F-74
	F10.2 National Performance Evaluation Studies.....	F-79
	F10.2.1 Water Pollution/Supply Performance Evaluation Studies.....	F-79

F10.2.2 InterLaB RadChem Proficiency Testing Program Studies .....	F-83
F10.2.3 DOE Mixed Analyte Performance Evaluation Program .....	F-84
<b>F11 Data Usability Conclusions.....</b>	<b>F-85</b>
F11.1 Data Completeness .....	F-85
F11.2 Sample Preservation and Holding Time.....	F-85
F11.3 Field Quality Control.....	F-85
F11.4 Laboratory Quality Control .....	F-86
F11.5 Laboratory Performance.....	F-86
F11.6 Conclusions .....	F-87
<b>F12 References .....</b>	<b>F-89</b>

## Tables

<b>Table F-1. Quality Control Acceptance Criteria for Groundwater Samples .....</b>	<b>F-2</b>
<b>Table F-2. Quality Control Field Samples .....</b>	<b>F-4</b>
<b>Table F-3. Laboratory Qualifier Data Quality Flags.....</b>	<b>F-8</b>
<b>Table F-4. Review Qualifier Data Quality Flags .....</b>	<b>F-9</b>
<b>Table F-5. Data Completeness Summarized by Method .....</b>	<b>F-12</b>
<b>Table F-6. Analytical Methods.....</b>	<b>F-17</b>
<b>Table F-7. Groundwater Sample Container, Preservative, and Holding Time Requirements.....</b>	<b>F-21</b>
<b>Table F-8. Groundwater Sample Preservation Issues and Dispositions .....</b>	<b>F-24</b>
<b>Table F-9. Missed Sample Holding Time Issues.....</b>	<b>F-26</b>
<b>Table F-10. Field Blank Results Exceeding Quality Control Limits .....</b>	<b>F-28</b>
<b>Table F-11. Out-of-Limit Field Blanks Compared with Out-of-Limit Method Blanks.....</b>	<b>F-31</b>
<b>Table F-12. Field Duplicates Exceeding Quality Control Limits.....</b>	<b>F-37</b>
<b>Table F-13. Total Organic Carbon and Total Organic Halide Quadruplicate Results Exceeding Quality Control Limits. ....</b>	<b>F-41</b>
<b>Table F-14. Field Splits Exceeding Quality Control Limits .....</b>	<b>F-42</b>
<b>Table F-15. Laboratory Quality Control Results by Laboratory.....</b>	<b>F-44</b>
<b>Table F-16. Laboratory Quality Control Results by Analyte Class .....</b>	<b>F-46</b>
<b>Table F-17. Method Blank Out-of-Limit Results.....</b>	<b>F-49</b>
<b>Table F-18. Laboratory Control Sample Out-of-Limit Results.....</b>	<b>F-54</b>
<b>Table F-19. Matrix Spike Out-of-Limit Results.....</b>	<b>F-59</b>
<b>Table F-20. Laboratory Sample Duplicate Out-of-Limit Results.....</b>	<b>F-68</b>
<b>Table F-21. Surrogate Out-of-Limit Results .....</b>	<b>F-71</b>
<b>Table F-22. Groundwater Blind Standard Recovery and Precision Requirements<sup>a,b</sup> .....</b>	<b>F-74</b>

**Table F-23. Blind Standards Laboratory Success Rates for CY2014 ..... F-75**  
**Table F-24. CY2014 Blind Standard Out-of-Limit Results ..... F-77**  
**Table F-25. Summary of WSCF Performance Evaluation Studies ..... F-80**  
**Table F-26. Summary of TestAmerica Performance Evaluation Studies..... F-81**  
**Table F-27. Summary of GEL Performance Evaluation Studies ..... F-82**

This page intentionally left blank

## F Groundwater Monitoring Data Quality Assessment

### F1 Introduction

This appendix presents the data quality assessment (DQA) for laboratory data generated from groundwater samples collected during calendar year 2014 (CY2014) as part of the Hanford Site groundwater monitoring program. The purpose of this DQA is to determine whether these data meet the data quality requirements specified in [DOE/RL-91-50](#), *Hanford Site Environmental Monitoring Plan*, and CHPRC-00189, *CH2M HILL Plateau Remediation Company Environmental Quality Assurance Program Plan*.

For the groundwater monitoring program during CY2014, 1,271 wells, aquifer tubes, and springs were sampled over the extent of the Hanford Site. These sampling events generated 16,453 samples: 3,987 field samples, 3 common (field and lab) samples, and 12,463 laboratory samples. From these 16,453 samples, Field Sampling Operations generated 19,706 field measurements, and four analytical laboratories reported 147,457 laboratory results for a total of 167,163 measurements.

### F2 Purpose

The purpose of this DQA is to determine whether the data generated from the CY2014 groundwater monitoring sampling effort meet the data quality requirements specified in [DOE/RL-91-50](#) and CHPRC-00189. Meeting the data quality requirements of these documents provides assurance that the data collected are of sufficient quantity and quality for the groundwater monitoring program.

### F3 Scope

This DQA focuses on the laboratory chemical and radiochemical data collected for the groundwater monitoring program. The data are evaluated to determine whether they meet the analytical criteria outlined in [DOE/RL-91-50](#) and CHPRC-00189. The DQA methodology includes data verification and data usability evaluations.

- Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. It includes confirmation that the specified sampling and analytical requirements have been completed as specified in [DOE/RL-91-50](#) and CHPRC-00189. This evaluation is documented in Section F-5. In addition, verification is performed for field quality control (QC) samples in Section F-8 and for laboratory QC samples in Section F-9.
- The data usability assessment is a determination of the adequacy of the data to support the groundwater monitoring program requirements and is based upon the verification results. This evaluation is summarized in Section F-10.

### F4 Groundwater Monitoring Program Analytical Data Quality Requirements

Table F-1 presents the groundwater monitoring program data requirements from [DOE/RL-91-50](#) and CHPRC-00189. QC results for groundwater monitoring samples were evaluated against these requirements as part of this DQA (see Sections F-8 and F-9). The QC samples governed by the QC requirements may be divided into two components: field QC samples and laboratory QC samples. Sections F-4.2 and F-4.3 describe these two types of QC samples.

Table F-1. Quality Control Acceptance Criteria for Groundwater Samples

Constituent	QC Element	Acceptance Criterion <sup>a</sup>	Corrective Action
<b>General Chemical Parameters</b>			
Alkalinity, chemical oxygen demand, conductivity, oil and grease, pH, total dissolved solids, total organic carbon, total organic halides, total petroleum hydrocarbons by GC <sup>b</sup>	MB <sup>c</sup> LCS DUP MS SUR EB, FTB Field Dup Field Split	<MDL 80% to 120% recovery ≤20% RPD <sup>h</sup> 75% to 125% recovery Statistically derived <2 times MDL ≤20% RPD <sup>h</sup> ≤20% RPD <sup>i</sup>	Flagged with “C” Data reviewed <sup>d</sup> Data reviewed <sup>d</sup> Flagged with “N” Data reviewed <sup>d</sup> Flagged with “Q” Flagged with “Q” Flagged with “Q” <sup>e</sup>
<b>Ammonia and Anions</b>			
Ammonia, anions, cyanide	MB LCS DUP MS EB, FTB Field Dup Field Split	<MDL 80% to 120% recovery ≤20% RPD <sup>h</sup> 75% to 125% recovery <2 times MDL ≤20% RPD <sup>h</sup> ≤20% RPD <sup>i</sup>	Flagged with “C” Data reviewed <sup>d</sup> Data reviewed <sup>d</sup> Flagged with “N” Flagged with “Q” Flagged with “Q” Flagged with “Q” <sup>e</sup>
<b>Metals</b>			
ICP metals, ICP-MS metals, mercury, uranium	MB LCS MS MSD EB, FTB Field Dup Field Split	<MDL <sup>f</sup> 80% to 120% recovery 75% to 125% recovery ≤20% RPD <2 times MDL ≤20% RPD <sup>h</sup> ≤20% RPD <sup>i</sup>	Flagged with “C” Data reviewed <sup>d</sup> Flagged with “N” Data reviewed <sup>d</sup> Flagged with “Q” Flagged with “Q” Flagged with “Q” <sup>e</sup>
<b>Volatile Organic Compounds</b>			
Volatiles by GC-MS	MB LCS MS MSD SUR EB, FTB, FXR Field Dup Field Split	<MDL <sup>g</sup> Statistically derived Statistically derived Statistically derived Statistically derived <2 times MDL <sup>g</sup> ≤20% RPD <sup>h</sup> ≤20% RPD <sup>i</sup>	Flagged with “B” Data reviewed <sup>d</sup> Flagged with “T” Data reviewed <sup>d</sup> Data reviewed <sup>d</sup> Flagged with “Q” Flagged with “Q” Flagged with “Q” <sup>e</sup>
<b>Semivolatile Organic Compounds</b>			
Herbicides by GC, PCBs by GC, pesticides by GC, phenols by GC, semivolatiles by GC-MS	MB LCS MS MSD SUR EB, FTB Field Dup Field Split	<2 times MDL Statistically derived Statistically derived Statistically derived Statistically derived <2 times MDL ≤20% RPD <sup>h</sup> ≤20% RPD <sup>i</sup>	Flagged with “B” Data reviewed <sup>d</sup> Flagged “N” or “T” Data reviewed <sup>d</sup> Data reviewed <sup>d</sup> Flagged with “Q” Flagged with “Q” Flagged with “Q” <sup>e</sup>

**Table F-1. Quality Control Acceptance Criteria for Groundwater Samples**

Constituent	QC Element	Acceptance Criterion <sup>a</sup>	Corrective Action
<b>Radiological Parameters</b>			
Gamma scan, gross alpha, gross beta, iodine-129, plutonium (isotopic), strontium-89/90, technetium-99, tritium, tritium (low level), uranium (isotopic)	MB LCS DUP MS EB, FTB Field Dup Field Split	<2 times MDA 70% to 130% recovery ≤20% RPD <sup>h</sup> 60% to 140% recovery <2 times MDA ≤20% RPD <sup>h</sup> ≤20% RPD <sup>i</sup>	Flagged with “B” Data reviewed <sup>d</sup> Data reviewed <sup>d</sup> Flagged with “N” Flagged with “Q” Flagged with “Q” Flagged with “Q” <sup>e</sup>

Sources: [DOE/RL-91-50](#), *Hanford Site Environmental Monitoring Plan*, and CHPRC-00189, *CH2M HILL Plateau Remediation Company Environmental Quality Assurance Program Plan*.

a. For the laboratory QC types LCS, DUP, MS, MSD, and SUR, laboratory-determined, statistical process-control limits were used when available, otherwise the limits shown in this table were used. For the laboratory duplicate types DUP, LCS duplicate, MSD, and SUR duplicate, the RPD limit of 20% was used if laboratory-determined limits were not available.

b. The source documents classify total petroleum hydrocarbons as a VOC. Total petroleum hydrocarbons have historically been classified as a general chemical parameter.

c. Does not apply to pH determinations.

d. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck, rerun, or flagging the associated groundwater monitoring data as suspect (Y flag) or rejected (R flag).

e. The source documents indicate that field splits with RPDs exceeding 20% are to be Q flagged. Prior to calendar year 2013, field splits were not Q flagged.

f. The source documents indicate that the method blank is to be compared to the required detection limit. Because the RDL is not readily accessible in the Hanford Environmental Information System database, the MDL was used instead. In most cases, the MDL is less than the required detection limit.

g. For the common laboratory contaminants 2-butanone, acetone, methylene chloride, toluene, and phthalate esters, the acceptance criterion is <5 times the MDL.

h. The RPD for duplicates is calculated only if at least one of the results is greater than or equal to five times the laboratory MDL or MDA.

i. The RPD for field splits is calculated only if at least one of the results is greater than or equal to five times the larger MDL or MDA of the two analyzing laboratories.

Data Flags:

B, C = Possible laboratory contamination (analyte was detected in the associated method blank).

N = Result may be biased (associated matrix spike result was outside the acceptance limits).

Q = Problem with associated field quality control sample (field blank, field duplicate, and/or field split results were out of limits).

T = Result may be biased (associated matrix spike result was outside the acceptance limits; used with GC-MS methods only).

DUP = laboratory sample duplicate

MB = method blank

EB = equipment blank

MDA = minimum detectable activity

FTB = full trip blank

MDL = method detection limit

FXR = field transfer blank

MS = matrix spike

GC = gas chromatography

MSD = matrix spike duplicate

GC-MS = gas chromatography - mass spectrometry

PCB = polychlorinated biphenyl

ICP = inductively coupled plasma

RPD = relative percent difference

ICP-MS = inductively coupled plasma - mass spectrometry

SUR = surrogate

LCS = laboratory control sample

## F4.1 Analyte Reporting Conventions

To conform to the analyte reporting conventions used in the annual report and to provide comparability of analytical results among the reporting laboratories, the following analyte reporting conventions are used in this data quality assessment:

- **Ammonium:** Ammonia, nitrogen-in-ammonia, and nitrogen-in-ammonium results are converted to and evaluated as ammonium ion.
- **Nitrate:** Nitrogen-in-nitrate results are converted to and evaluated as nitrate.
- **Nitrite:** Nitrogen-in-nitrite results are converted to and evaluated as nitrite.
- **Phosphate:** Phosphorus-in-phosphate results are converted to and evaluated as phosphate.
- **Strontium-90:** Total-beta-radiostrontium results are evaluated as strontium-90.
- **Total organic halides:** Total-halogens-(all) results are evaluated as total organic halides (TOX).

## F4.2 Field QC Sample Types

Field QC samples are used to assess the precision, repeatability, and potential contamination related to sampling and laboratory activities. Field QC samples include three types of field blanks (equipment blanks, full trip blanks, and field transfer blanks), field duplicates, and split samples. Table F-2 summarizes the various field QC sample types, their required collection frequencies, and the actual collection frequencies. Just as for groundwater samples, preservative reagents specific for the analyte(s) to be determined are added to the field QC sample bottles prior to the collection of the QC samples. All field QC samples are delivered to the laboratory without any differentiation between the field QC samples and actual groundwater samples. Table F-2 describes each type of field QC sample and its collection frequency.

**Table F-2. Quality Control Field Samples**

Field QC Sample Type	Number of Well Trips <sup>a</sup>	Number of QC Sample Sets Collected <sup>b</sup>	Frequency	
			Required <sup>c</sup>	Actual <sup>d</sup>
Full trip blanks	3,109	159	5%	5%
Field transfer blanks	211 <sup>e</sup>	228	100%	108%
Equipment blanks	499 <sup>f</sup>	72	10% <sup>g</sup>	14%
Field duplicates	3,109	210 <sup>h</sup>	5%	7%
TOC quadruplicates	193 <sup>i</sup>	209 <sup>j</sup>	N/R	108%
TOX quadruplicates	189 <sup>i</sup>	200 <sup>j</sup>	N/R	106%
Field split samples	3,109	78 <sup>k</sup>	as needed	3%

Sources: [DOE/RL-91-50](#), *Hanford Site Environmental Monitoring Plan*, and CHPRC-00189, *CH2M HILL Plateau Remediation Company Environmental Quality Assurance Program Plan*.

a. Includes trips to wells, aquifer tubes, and springs. Well trips are counted only if they are associated with routine groundwater monitoring results in the Hanford Environmental Information System *RESULT* table.

**Table F-2. Quality Control Field Samples**

Field QC Sample Type	Number of Well Trips <sup>a</sup>	Number of QC Sample Sets Collected <sup>b</sup>	Frequency	
			Required <sup>c</sup>	Actual <sup>d</sup>

b. Values listed include only field blanks, field duplicates, and field split sample sets collected for routine groundwater monitoring sampling events. A QC sample set consists of all the QC samples of a particular QC sample type (e.g., full trip blanks or field duplicates) for a given well trip and may contain multiple sample numbers.

c. Required frequency is from [DOE/RL-91-50](#) and CHPRC-00189.

d. Actual frequency =  $100 \times \text{Number of QC Sample Sets} / \text{Number of Well Trips}$ .

e. For each day that volatile organic compound samples are collected, one field transfer blank is required for each lab receiving that day's volatile organic compound samples. Multiple field transfer blanks may be required each day that volatile organic compound samples are collected if these samples are to be shipped to more than one lab for analysis.

f. Number of sampling events for which non-dedicated sampling equipment was used.

g. The 10% frequency is for routinely used, non-dedicated sampling equipment. For new types of non-dedicated sampling equipment, the equipment blank frequency is 100% until the decontamination procedure for the new equipment is shown to produce acceptable equipment blank results.

h. Number of pairs of field duplicate sample sets collected.

i. Number of well trips for which TOC or TOX samples were collected.

j. Number of sets of quadruplicate samples collected.

k. Number of pairs of field split sample sets collected.

N/R = not required

QC = quality control

TOC = total organic carbon

TOX = total organic halides

- Equipment blanks (EB) are samples of reagent water that are pumped or washed through non-dedicated sampling equipment. EBs are used to monitor the effectiveness of equipment decontamination procedures and to monitor for contamination associated with field sampling equipment.
- Full trip blanks (FTB) are samples that contain reagent water and any required preservatives. An FTB is used to check for contamination in sample bottles and laboratory sample preparation. The FTB is analyzed for all constituents of interest and is collected in the same types of sample bottles used to collect groundwater samples. The FTB is filled during bottle preparation using the same sample preparation used for regular well samples. FTBs are not opened in the field.
- Field transfer blanks (FXR) are analyzed for volatile organic compounds (VOC) and are used to check for VOC contamination associated with sampling activities. At the time of sample collection, the FXR is filled at the sampling site by pouring reagent water from a cleaned glass container into VOC sample vials pre-loaded with any required preservative. After collection, the FXR is treated in the same manner as the other samples collected during the sampling event. One FXR is collected each day groundwater samples are collected for VOCs. If the VOC samples collected on a given day will be shipped to multiple laboratories, then an FXR is collected for each laboratory for that day.
- Field duplicate samples are replicate samples collected to determine the precision of sampling and the laboratory analytical measurement process by comparing results with an identical sample collected at the same time and location. Matching field duplicates are collected and stored in separate containers and are analyzed as separate samples by the same laboratory.

- Split samples are replicate samples sequentially collected from the same location in the same sampling event and analyzed by different laboratories. Split samples are used to evaluate interlaboratory precision and comparability.

Field blank (FB) results are evaluated by comparison with two times the method detection limit (MDL) or minimum detectable activity (MDA) of the performing laboratory; field blank results that exceed that limit and the results for any samples associated with the FB are given a review qualifier of Q (Table F-4). Associated samples are those collected on the same day and analyzed by the same method as the corresponding FB.

Field duplicate sample results are evaluated only if at least one result is five times the laboratory MDL or MDA. Split sample results are evaluated only if at least one result is five times the larger of the laboratory MDL or MDA of the two analyzing laboratories. Field duplicate and field split samples that qualify are evaluated using the relative percent difference (RPD) between the duplicate or split sample pair. The RPD is a measure of precision and is calculated as shown in Equation F-1:

$$\text{RPD} = \left| \frac{C_1 - C_2}{(C_1 + C_2)/2} \right| \times 100 \quad \text{(Equation F-1)}$$

where:

$C_1$  = parent sample analyte concentration or activity

$C_2$  = duplicate sample analyte concentration or activity

A perfect match between the parent sample and its duplicate yields an RPD of 0%. Results for field duplicate samples that exceed the RPD limit of 20% are given a review qualifier of Q (Table F-4). Only the two samples of the duplicate pair are considered to be associated samples. Historically, split samples that exceed the RPD limit have not been Q flagged. However, split samples collected since CY2013 that have results exceeding the RPD limit have been Q flagged. Only the two samples of the split pair are considered to be associated samples.

Total organic carbon (TOC) and TOXs are [Resource Conservation and Recovery Act of 1976 \(RCRA\)](#) indicator analytes; samples for these analytes are usually taken in quadruplicate (40 CFR 265.92, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,” “Sampling and Analysis”). Field quadruplicate sample results are evaluated only if at least one result is at least five times the laboratory MDL. Field quadruplicate results that qualify are evaluated using the percent relative standard deviation (%RSD) within the quadruplicate sample set. The %RSD is a measure of precision and is calculated as shown in Equation F-2:

$$\%RSD = \frac{\sqrt{\frac{\sum_{i=1}^n (C_i - \bar{C})^2}{(n-1)}}}{\bar{C}} \times 100 \quad \text{(Equation F-2)}$$

where:

$C_i$  =  $i^{\text{th}}$  sample concentration

$\bar{C}$  = average sample concentration

$n$  = number of results (usually four)

A perfect match of results within a quadruplicate sample set yields a %RSD of 0%. For any results in a qualifying quadruplicate data set that were less than the laboratory MDL, MDLs were used to compute the %RSD. Quadruplicate split sample results are evaluated only if at least one quadruplicate average is greater than or equal to five times the larger of the laboratory MDLs of the two analyzing laboratories. To determine the precision of a set of split quadruplicate samples, the RPD of the two averages for the quadruplicate split samples is determined and compared to 20%. Results for field quadruplicate samples that exceed a %RSD of 20% or quadruplicate split samples that exceed an RPD of 20% are not given a review qualifier.

### F4.3 Laboratory Quality Control Sample Types

Laboratory quality assurance (QA)/QC requirements govern nearly all aspects of analytical laboratory operation, including instrument procurement, maintenance, calibration, and operation. During the analysis of groundwater samples, laboratory QC samples are used to assess potential sample contamination, precision, and accuracy related to laboratory activities. Laboratory QC samples may include method blanks (MB), laboratory control samples (LCS), laboratory control sample duplicates (LCSD), matrix spike (MS) samples, matrix spike duplicates (MSD), and surrogates. The following bullets describe each type of laboratory QC sample and the way they are evaluated.

- Laboratory MBs provide a measure of the cleanliness during sample preparation and analysis. The appearance of measurable analytes in the MB may indicate contamination of customer samples during the analytical process.
- Laboratory sample duplicates, LCSDs, MSDs, and surrogate duplicates provide a measure of the reproducibility of the analytical process. The RPD is the metric used to determine reproducibility (Equation F-1). Laboratory sample duplicates qualify for evaluation only if at least one result is five times the laboratory MDL.
- LCSs, MSs, and surrogates contain known amounts of analytes and provide a measure of the accuracy of the analytical process. Percent recovery is the metric used to determine analytical accuracy (Equation F-3). Percent recoveries consistently less than or greater than 100% may indicate a bias in the analytical process.

These laboratory QC samples are included in sample preparation and analytical batches along with customer samples. An analytical batch typically consists of a maximum of 20 customer samples. The numbers and types of QC samples included in sample batches are dictated by the analytical method being used. Analytical methods usually employ only a subset of the available types of QC samples. At a minimum, most sample preparation and analytical methods include a MB, one of the duplicate types (e.g., sample duplicate), and one of the standard types (e.g., laboratory control sample).

Laboratory analytical accuracy for LCSs, MSs, and surrogates is evaluated using percent recovery as shown in Equation F-3:

$$\text{Percent Recovery} = \frac{C_m}{C_a} \times 100 \quad \text{(Equation F-3)}$$

where:

$C_m$  = measured analyte concentration or activity

$C_a$  = actual, known analyte concentration or activity

Perfect recovery of the measured analyte concentration or activity yields a percent recovery of 100%.

## F4.4 Qualification Flags

During the generation and evaluation of environmental analytical data, any of several qualification flags may be assigned to an individual result. The Hanford Environmental Information System (HEIS) database carries qualification flags applied from three sources: the laboratory (laboratory qualifier), a data reviewer (review qualifier), or a third party data validator (validation qualifier). Table F-3 presents the laboratory qualifier flags and Table F-4 outlines the review qualifier flags. For the CY2014 groundwater monitoring data set, no third party validation was performed, and no validation qualifiers were applied to the data set.

**Table F-3. Laboratory Qualifier Data Quality Flags**

Flag	Definition
B	Inorganics and wetchem* – The analyte was detected at a value greater than or equal to the MDL but less than the CRDL. Organics – The analyte was detected in both the associated method blank and in the sample. Radionuclides – The associated method blank has a result $\geq 2x$ the MDA and, after corrections, the result is $\geq$ MDA for this sample.
C	Inorganics and wetchem* – The analyte was detected in both the sample and the associated method blank, and the sample concentration was less than or equal to five times the blank concentration.
D	All – Analyte was determined using a secondary dilution factor greater than one. The primary preparation required additional dilution either to bring the analyte within the calibration range or to minimize interference.
E	Inorganics – Reported value is estimated because of interference. See any comments that may be in the laboratory report case narrative. Organics – Concentration exceeds the calibration range of the GC-MS.
J	Organics – The analyte was detected at a value greater than or equal to the MDL but less than the CRDL.
N	All (except GC-MS methods) – The matrix spike recovery is outside control limits. The associated sample data may be biased.
O	All – The laboratory control sample recovery is outside control limits.
T	Organics (GC-MS methods only) – The matrix spike recovery is outside control limits. The associated sample data may be biased.
U	All – The constituent was analyzed for but was not detected.
X	All – Indicates a result-specific comment is provided in the data report and/or case narrative.

\* Wetchem is a miscellaneous group of analytical methods such as the colorimetric determination of hexavalent chromium, the titrimetric determination of alkalinity, or the distillation and titrimetric determination of sulfide.

CRDL = contract required detection limit

MDA = minimum detectable activity

GC-MS = gas chromatograph - mass spectrometer

MDL = method detection limit

**Table F-4. Review Qualifier Data Quality Flags**

<b>Flag</b>	<b>Definition</b>
A	Indicates an issue with the chain of custody that could affect data integrity.
F*	Result is undergoing further review. This review qualifier is assigned when a RDR is first processed.
G*	Result has been reviewed through the RDR process and determined to be correct, or the laboratory has supplied a corrected result after reviewing the original result or after reanalyzing the sample.
H	Laboratory holding time was exceeded before the sample was analyzed.
P*	Potential problem. Collection/analysis circumstances make the result questionable.
Q	An associated QC sample is out of limits; the associated sample number is listed in the Result Comment field for the Q-flagged result. See Section F-4.2 for the definition of associated samples.
R*	Do not use. Further review indicates the result is not valid. This review qualifier is used only when documented evidence exists that the result is not valid. Generally, results that are “R” qualified will be excluded from statistical evaluations, maps, and other interpretations.
Y*	Result is suspect. Review had insufficient evidence to show result valid or invalid.
Z*	Miscellaneous circumstance exists. Additional information for this record may be found in the Result Comment field in the HEIS <i>RESULT</i> table and/or in the Sample Comment field in the HEIS Sample table.

\* These flags are applied as part of the RDR process.

HEIS = Hanford Environmental Information System database

QC = quality control

RDR = Request for Data Review

Of the review qualifier flags, the Request for Data Review (RDR) process most commonly generates F, G, R, and Y flags (Table F-4). The F flag indicates the analytical result is under review within the RDR process; an F flag is typically resolved to a G flag, R flag, or Y flag during the RDR process. The G flag indicates that the result has been reviewed within the RDR process and determined to be valid. In some cases, the G flag is applied to a result after the old, reviewed result has been replaced by a new value from the laboratory; the new laboratory value may be a correction of the originally reported value or may be from a re-analysis of the sample. The R flag indicates the analytical result has been reviewed and rejected as invalid based upon a known reason such as an instrument calibration failure. The Y flag indicates the analytical result has been reviewed and is considered questionable based on additional evidence, such as a result that does not fit with the historical trend for the sample source and is inconsistent with related parameters.

The Q flag review qualifier is applied to the analytical results of those samples associated with field QC samples having analytical results that exceed the QC criteria given in [DOE/RL-91-50](#) and CHPRC-00189 and outlined in Table F-1. Associated samples are defined in Section F-4.2.

This page intentionally left blank

## F5 Data Completeness

Data completeness is a measure of how much of the data set is judged to meet the quality criteria and thus is useable for the groundwater monitoring program. The completeness goal is determined as a percentage of data judged “good” versus all data collected for the program and is set at a minimum of 85%<sup>1</sup> ([DOE/RL-91-50](#)). Completeness statistics are calculated and presented for:

- The percentage of successful sampling events during CY2014 versus the number of scheduled sampling events
- The percentage of field QC samples collected versus the number of QC samples required
- The percentage of the data set that meets quality criteria.

### F5.1 Percentage of Successful Sampling Events

During CY2014, 2,987 sampling events were planned, and 2,981 of these sampling events were successfully executed for a sampling event completion rate of 99.8%. An additional 245 sample events originally scheduled for CY2013 were sampled in CY2014 for a total of 3,232 well trips during CY2014 in support of groundwater monitoring. Sources sampled included wells, aquifer tubes, and springs. This completion rate indicates that sufficient sampling events were completed to meet groundwater monitoring program requirements. The 3,109 well trips listed in Table F-2 reflect only those CY2014 sampling events that resulted in groundwater monitoring field and laboratory data appearing in the HEIS *RESULT* table.

### F5.2 Percentage of Field Quality Control Samples Collected

The types and collection frequencies of field QC samples for the groundwater monitoring program are given in [DOE/RL-91-50](#) and CHPRC-00189; the collection of quadruplicate samples at RCRA sites for TOC and TOX is mandated by 40 CFR 265.92. Section F-4.2 gives a more complete discussion of field QC samples. Table F-2 summarizes those QC types, their required collection frequencies, and the actual collection frequencies. The table indicates that the requirements for the minimum collection frequencies for groundwater monitoring field QC samples were met during CY2014.

To determine the collection frequency for EBs, the only non-dedicated sampling equipment currently tracked in the electronic database are “Bailer”, “Kabis”, and “Portable Grundfos.” Non-dedicated sampling manifolds are also used for collection of some groundwater samples, but are not tracked in the database. Consequently, the number of well trips for EBs reported in Table F-2 underestimates the actual number of well trips that use non-dedicated sampling equipment, and the actual sampling frequency for EBs is less than 17%. Until the use of non-dedicated sampling manifolds is tracked, a more accurate estimate of the actual sampling frequency for EBs is unavailable.

For the TOC and TOX quadruplicate samples, the sampling frequency is slightly greater than 100% due to the collection of eleven split sample sets for TOC and a single split sample set for TOX.

### F5.3 Percentage of Useable Data

This section provides an overview of data usability; subsequent sections provide detailed information regarding data compliance with quality requirements.

---

<sup>1</sup> DOE/RL-91-50 defines this completeness goal on a quarterly basis. For this data quality assessment, the completeness goal is applied over the entire calendar year.

Table F-5 summarizes the percentage of useable groundwater monitoring data generated from samples collected during CY2014; overall data completeness is 96.7%. This is well above the data completeness goal of 85% as specified in [DOE/RL-91-50](#) and indicates that the large majority of data collected for the groundwater monitoring program is useable. The CY2014 data completeness rate of 96.7% is similar to the 97.4% rate of CY2013 and the 96.6% rate of CY2012.

Data completeness was judged on the following:

- F, R, and Y review qualifier flags associated with the data<sup>2</sup>
- Q-flag review qualifiers for data associated with FBs exhibiting possible contamination, data with poor field-sample-duplicate reproducibility, or data with poor field-split reproducibility
- Samples with missed holding times
- Samples with laboratory qualifiers indicating MB contamination.

**Table F-5. Data Completeness Summarized by Method**

HEIS Method Name	Total Results <sup>a</sup>	Results in Review <sup>b</sup>	Suspect Results <sup>c</sup>	Rejected Results <sup>d</sup>	Field QC Flags	Missed Holding Time	Method Blank Qualifiers	Results Flagged <sup>e</sup>
<i>Overall Percent Complete = 96.7%</i>								
<b>Overall Totals:</b>	<b>167,163</b>	<b>853</b>	<b>131</b>	<b>809</b>	<b>1,704</b>	<b>787</b>	<b>1,380</b>	<b>5,486</b>
<i>General Chemical Parameters: Percent Complete = 98.4%</i>								
<b>Totals</b>	<b>27,167</b>	<b>14</b>	<b>14</b>	<b>159</b>	<b>150</b>	<b>73</b>	<b>44</b>	<b>429</b>
160.1_TDS	12	1	-	-	-	-	-	1
1664A_OILGREASE	11	-	-	4	2	1	-	7
2320_ALKALINITY	2,880	-	2	40	34	4	-	80
2540C_TDS	22	-	-	-	-	-	4	4
310.1_ALKALINITY	2,017	2	2	-	42	64	5	98
360.1_OXYGEN_FLD	2,282	2	2	13	-	-	-	17
410.4_COD	32	-	-	-	-	-	-	-
8015M_TPH_GC	21	-	-	-	-	-	-	-
9020_TOX	947	-	-	-	59	4	-	61
9060_TOC	1,305	4	-	62	7	-	35	102
9223_COLIFORM	32	-	-	-	-	-	-	-
CONDUCT_FLD	3,986	3	3	10	-	-	-	16
PH_ELECT_FLD	3,990	1	1	10	-	-	-	12

<sup>2</sup> The F flag review qualifier (“result in review”) was included in the assessment of CY2013 groundwater monitoring results for this report. After the RDR review, F-flagged results will be resolved to one of the other RDR flags as appropriate.

Table F-5. Data Completeness Summarized by Method

HEIS Method Name	Total Results <sup>a</sup>	Results in Review <sup>b</sup>	Suspect Results <sup>c</sup>	Rejected Results <sup>d</sup>	Field QC Flags	Missed Holding Time	Method Blank Qualifiers	Results Flagged <sup>e</sup>
REDOX_PROBE_FLD	1,468	-	1	-	-	-	-	1
TEMP_FLD	3,990	-	1	10	-	-	-	11
TURBIDITY_FLD	3,980	1	2	10	-	-	-	13
WTPH_DIESEL	153	-	-	-	4	-	-	4
WTPH_GASOLINE	39	-	-	-	2	-	-	2
<b>Ammonia and Anions: Percent Complete = 92.3%</b>								
<b>Totals</b>	<b>12,885</b>	<b>6</b>	<b>9</b>	<b>50</b>	<b>208</b>	<b>696</b>	<b>60</b>	<b>993</b>
300.0_ANIONS_IC	8,373	6	7	50	154	410	41	646
300.7_CATIONS_IC	25	-	-	-	-	-	-	-
350.1_AMMONIA	113	-	-	-	11	8	6	20
376.1_SULFIDE	8	-	-	-	-	-	-	-
4500D_SULFIDE	29	-	-	-	-	-	-	-
4500E_CN	78	-	-	-	-	2	-	2
9012_CYANIDE	164	-	1	-	2	-	9	10
9034_SULFIDE	15	-	-	-	2	-	4	5
9056_ANIONS_IC	4,080	-	1	-	39	276	-	310
<b>Metals: Percent Complete = 95.9%</b>								
<b>Totals</b>	<b>80,716</b>	<b>828</b>	<b>96</b>	<b>563</b>	<b>737</b>	<b>18</b>	<b>1,161</b>	<b>3,306</b>
200.8_METALS_ICPMS	7,023	5	2	397	251	2	35	671
6010_METALS_ICP	32,334	10	9	124	118	-	292	551
6010_METALS_ICP_TR	15,265	24	57	-	139	-	312	513
6020_METALS_ICPMS	22,430	22	14	-	208	-	519	713
7196_CR6	3,059	761	14	42	4	16	1	835
7470_HG_CVAA	136	-	-	-	-	-	2	2
COLOR_TK_FE_FLD	10	-	-	-	-	-	-	-
UTOT_KPA	459	6	-	-	17	-	-	21
<b>Volatile Organic Compounds: Percent Complete = 97.8%</b>								
<b>Totals</b>	<b>25,326</b>	<b>-</b>	<b>9</b>	<b>20</b>	<b>445</b>	<b>-</b>	<b>108</b>	<b>563</b>

Table F-5. Data Completeness Summarized by Method

HEIS Method Name	Total Results <sup>a</sup>	Results in Review <sup>b</sup>	Suspect Results <sup>c</sup>	Rejected Results <sup>d</sup>	Field QC Flags	Missed Holding Time	Method Blank Qualifiers	Results Flagged <sup>e</sup>
8015_VOA_GC	65	-	1	-	-	-	-	1
8260_VOA_GCMS	25,256	-	8	20	445	-	108	562
RSK175_VOA_HDSPC_GC	5	-	-	-	-	-	-	-
<i>Semi-Volatile Organic Compounds: Percent Complete = 100.0%</i>								
<b>Totals</b>	<b>11,486</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>2</b>
8081_PEST_GC	461	-	-	-	-	-	-	-
8082_PCB_GC	175	-	-	-	-	-	-	-
8270_SVOA_GCMS	10,850	-	-	-	-	-	2	2
<i>Radiological Parameters: Percent Complete = 98.0%</i>								
<b>Totals</b>	<b>9,583</b>	<b>5</b>	<b>3</b>	<b>17</b>	<b>164</b>	<b>-</b>	<b>5</b>	<b>193</b>
906.0_H3_LSC	441	-	1	-	3	-	-	3
906.0ML_H3_LSC	11	-	-	-	-	-	-	-
9310_ALPHABETA_GPC	1,346	2	-	-	17	-	-	19
ALPHA_GPC	297	-	-	-	4	-	-	4
AMCMISO_EIE_PLT_AEA	12	-	-	-	-	-	-	-
AMCMISO_EIE_PREC_AEA	10	-	-	-	-	-	-	-
AMCMISO_IE_PREC_AEA	13	-	-	-	3	-	-	3
BETA_GPC	358	-	1	-	50	-	-	51
C14_LSC	315	-	-	-	-	-	-	-
GAMMA_GS	3,134	-	-	-	-	-	-	-
I129_SEP_LEPS_GS	36	-	-	-	-	-	-	-
I129LL_SEP_LEPS_GS	370	-	-	1	14	-	-	15
NP237_IE_PRECIP_AEA	25	-	-	-	-	-	-	-
NP237_LLE_PLATE_AEA	10	-	-	-	-	-	-	-
PUISO_IE_PRECIP_AEA	68	-	-	-	-	-	-	-
PUISO_PLATE_AEA	126	-	-	-	-	-	-	-
SE79_SEP_IE_LSC	19	-	-	-	2	-	-	2
SRISO_SEP_PRECIP_GPC	171	-	-	-	-	-	-	-

**Table F-5. Data Completeness Summarized by Method**

HEIS Method Name	Total Results <sup>a</sup>	Results in Review <sup>b</sup>	Suspect Results <sup>c</sup>	Rejected Results <sup>d</sup>	Field QC Flags	Missed Holding Time	Method Blank Qualifiers	Results Flagged <sup>e</sup>
SRTOT_SEP_PRECIP_GPC	829	3	1	5	30	-	2	41
TC99_3MDSK_LSC	271	-	-	1	19	-	-	20
TC99_EIE_LSC	276	-	-	-	5	-	-	5
TC99_ETVDSK_LSC	312	-	-	-	-	-	-	-
TC99_SEP_LSC	4	-	-	-	-	-	-	-
THISO_IE_PLATE_AEA	75	-	-	-	-	-	-	-
TRITIUM_DIST_LSC	425	-	-	-	2	-	-	2
TRITIUM_EIE_LSC	392	-	-	10	5	-	-	15
UIISO_IE_PLATE_AEA	9	-	-	-	1	-	-	1
UIISO_IE_PRECIP_AEA	183	-	-	-	9	-	3	12
UIISO_PLATE_AEA	45	-	-	-	-	-	-	-

a. Groundwater monitoring results were pulled from the HEIS on February 12, 2015 and include both field and laboratory results.

b. Results in review have a review qualifier of F-

c. Suspect results have a review qualifier of Y.

d. Rejected results have a review qualifier of R.

e. The value in the *Results Flagged* column may be less than the sum of the values in the individual flag columns if the same result has multiple QC issues.

HEIS = Hanford Environmental Information System database

QC = quality control

Of the 167,163 total results noted in Table F-5, 96.7% met QC requirements. Of the 5,486 QC failures summarized in the table, 31.1% of the results were due to out-of-limit field QC and were Q-flagged, and 25.2% were due to out-of-limit MBs. Of the 1,704 Q-flagged results, 81.8% were Q-flagged for associated out-of-limit field blanks, 13.6% for field duplicates exceeding the RPD limit, and 5.6% for field splits exceeding the RPD limit. These Q-flag percentages may sum to greater than 100% because a result may be flagged for multiple field QC issues (e.g. out-of-limit field blank and out-of-limit field duplicate). Details of the issues associated with these QC failures are provided in subsequent sections.

The poorest completion rate was 92.3% for ammonia and anions; most of the failures were for anions determined by ion chromatography ([EPA Method 300.0](#), *Determination of Inorganic Anions by Ion Chromatography*, and [EPA Method 9056](#), *Determination of Inorganic Anions by Ion Chromatography*). Of the QC failures for ammonia and anions, 70.1% were due to missed holding times.

After ammonia and anions, metals had the next poorest completion rate at 96.2%. Hexavalent chromium had the largest number of review-qualified results. Nearly all the hexavalent chromium results with review qualifiers of F, P, R, or Y were generated at TARL. After the closure of the WSCF facility, TARL

became the primary laboratory performing hexavalent chromium determinations for groundwater samples. To handle the increased sample load, TARL adopted an automated method to replace their manual method. Initially, the automated method did not perform sample turbidity corrections (WSCF's automated hexavalent chromium method did perform turbidity corrections). Consequently, many samples that were not field filtered showed a high bias in hexavalent chromium results compared to filtered sample results, ICP-MS total chromium values, and historical trends of hexavalent chromium values. Those hexavalent chromium values that have a review qualifier of F at the time of this report will be resolved to G, P, R, or Y flags after further data review. TARL implemented automated turbidity corrections in January, 2015, after Soil and Groundwater Remediation Project personnel identified the issue.

Of the other metals, nickel had the Q review qualifier applied to 108 of 3,471 results. Most (87.0%) of the Q flags were applied for contamination of an associated FB.

The remaining completion rates were 98.4% for the general chemical parameters, 97.8% for the volatile organic compounds, 100.0% for the semivolatile organic compounds, and 98.0% for the radiochemical parameters.

## **F6 Laboratory Information and Analytical Methods**

Samples collected for the groundwater monitoring program were sent to the four laboratories described in Section F-6.1 for analysis. Each sample is tracked by a unique HEIS database number. Analytical requests for chemical and radiochemical services to be completed by the laboratories were documented on the chain-of-custody forms. Analytical results provided by the laboratories were documented by sample data group (SDG) in data packages. The analytical results were also electronically uploaded and stored in the HEIS database.

### **F6.1 Laboratory Information**

The samples collected were analyzed at the following four laboratories:

- GEL Laboratories, LLC (GEL, Charleston, South Carolina) provided sample analysis for chemical and radiochemical constituents; GEL Laboratories generated about 33.3% of the analytical laboratory results.
- TestAmerica Richland (TARL, Richland, Washington) provided sample analysis for chemical and radiochemical constituents; TARL generated 5.0% of the analytical laboratory results.
- TestAmerica St. Louis (TASL, St. Louis, Missouri) provided sample analysis for chemical and some radiochemical constituents; TASL generated 29.0% of the analytical laboratory results.
- Waste Sampling and Characterization Facility (WSCF, Hanford Site, managed by Mission Support Alliance, LLC) performed chemical and radiochemical analyses on groundwater samples. WSCF generated 32.7% of the analytical laboratory results. This laboratory was shut down by the U.S. Department of Energy (DOE) in 2014. As of May 5, 2014, WSCF's groundwater monitoring sample load was redirected to the three commercial laboratories listed above.

Sections F-8 and F-9 discuss the analytical data provided by these laboratories.

### **F6.2 Analytical Methods**

For the analysis of chemical constituents, the analyzing laboratories used standard methods from U.S. Environmental Protection Agency (EPA), ASTM International (formerly American Society for

Testing and Materials), and the American Public Health Association. For radiological constituents, the analyzing laboratories employed methods that are recognized as acceptable within the radiochemical industry.

Samples were analyzed using the methods listed in Table F-6. Both single-component and multiple-component analytical methods were used. Single-component analytical methods, such as EPA Method 9012 for cyanide or EPA method 7470 for mercury, yield a single analytical result per analysis. Multi-component analytical methods, such as EPA Method 200.8 for inductively coupled plasma - mass spectrometry metals or EPA method 8260 for gas chromatography - mass spectrometry for VOCs, yield results for multiple analytes per analysis. Multi-component methods may generate results for both target and non-target analytes.

**Table F-6. Analytical Methods**

<b>Parameter</b>	<b>Analytical Method</b>	<b>Source</b>
<b><i>General Chemical Parameters</i></b>		
Alkalinity	EPA Method 310.1	EPA <sup>a</sup>
Alkalinity	Standard Method 2320	Standard Methods <sup>b</sup>
Chemical Oxygen Demand	EPA Method 410.4	EPA <sup>c</sup>
Coliform	Standard Method 9223	Standard Methods <sup>b</sup>
Oil and Grease	EPA Method 1664A	EPA <sup>d</sup>
Total Dissolved Solids	EPA Method 160.1	EPA <sup>a</sup>
Total Dissolved Solids	Standard Method 2540C	Standard Methods <sup>b</sup>
Total Organic Carbon (TOC)	EPA Method 9060	EPA <sup>e</sup>
Total Organic Halides (TOX)	EPA Method 9020	EPA <sup>e</sup>
Total Petroleum Hydrocarbons	EPA Method 8015 (modified)	EPA <sup>e</sup>
Total Petroleum Hydrocarbons - Gasoline	NWTPH-Gx	Washington State Department of Ecology <sup>f</sup>
Total Petroleum Hydrocarbons - Kerosene	NWTPH-Dx	Washington State Department of Ecology <sup>f</sup>
<b><i>Ammonia and Anions</i></b>		
Ammonium Ion	EPA Method 350.1	EPA
Anions by Ion Chromatography	EPA Method 300.0	EPA <sup>g</sup>
Anions by Ion Chromatography	EPA Method 9056	EPA <sup>e</sup>
Cations by Ion Chromatography	EPA Method 300.7	EPA <sup>h</sup>
Cyanide	Standard Method 4500E-CN	Standard Methods <sup>b</sup>
Cyanide	EPA Method 9012	EPA <sup>e</sup>
Sulfide by Titrimetry	EPA Method 376.1	EPA
Sulfide	EPA Method 9034	EPA <sup>e</sup>
Sulfide	Standard Method 4500D-Sulfide	Standard Methods <sup>b</sup>

**Table F-6. Analytical Methods**

<b>Parameter</b>	<b>Analytical Method</b>	<b>Source</b>
<b><i>Metals</i></b>		
Hexavalent Chromium	EPA Method 7196	EPA <sup>e</sup>
Mercury	EPA method 7470	EPA <sup>e</sup>
Metals by ICP-AES	EPA Method 6010	EPA <sup>e</sup>
Metals by ICP-MS	EPA Method 200.8	EPA <sup>i</sup>
Metals by ICP-MS	EPA Method 6020	EPA <sup>e</sup>
Uranium	ASTM D5174	ASTM
<b><i>Volatile Organic Compounds</i></b>		
Non-Halogenated Volatiles by GC	EPA Method 8015	EPA <sup>e</sup>
Non-Halogenated Volatiles by Headspace Equilibrium - GC	EPA Method RSKSOP-175	EPA
Volatile Organic Compounds by GC-MS	EPA Method 8260	EPA <sup>e</sup>
<b><i>Semivolatile Organic Compounds</i></b>		
Organochlorine Pesticides	EPA Method 8081	EPA <sup>e</sup>
Polychlorinated Biphenyls	EPA Method 8082	EPA <sup>e</sup>
Semivolatile Organic Compounds	EPA Method 8270	EPA <sup>e</sup>
<b><i>Radiological Parameters</i></b>		
Americium-Curium Isotopes	Ion-exchange Separation/Electroplate/AEA	Lab Specific
Americium-Curium Isotopes	Ion-exchange Separation/Precipitation/AEA	Lab Specific
Carbon-14	Chemical Oxidation/LSC	Lab Specific
Gamma-Emitting Isotopes	Gamma Energy Analysis	Lab Specific
Gross Alpha-Beta by GPC	Gas Proportional Counter	Lab Specific
Gross Alpha-Beta by GPC	EPA Method 9310	EPA <sup>e</sup>
Iodine-129	Separation/Precipitation/LEPS	Lab Specific
Neptunium-237	Ion-exchange Separation/Precipitation/AEA	Lab Specific
Plutonium Isotopes	Ion-exchange Separation/Precipitation/AEA	Lab Specific
Plutonium Isotopes	Separation/Electroplate/AEA	Lab Specific
Selenium-79	Ion-exchange Separation/LSC	Lab Specific
Strontium-90	Separation/Precipitation/GPC	Lab Specific
Strontium-90 (total-beta radiostrontium)	Separation/Precipitation/GPC	Lab Specific
Technetium-99	Ion-exchange Separation/LSC	Lab Specific

**Table F-6. Analytical Methods**

Parameter	Analytical Method	Source
Technetium-99	Disk Separation/LSC	Lab Specific
Thorium Isotopes	Ion-exchange Separation/Electroplate/AEA	Lab Specific
Tritium	EPA Method 906.0	EPA
Tritium	Distillation/LSC	Lab Specific
Tritium	Ion-exchange Purification/LSC	Lab Specific
Uranium Isotopes	Ion-exchange Separation/Electroplate/AEA	Lab Specific
Uranium Isotopes	Ion-exchange Separation/Precipitation/AEA	Lab Specific
Uranium Isotopes	Separation/Electroplate/AEA	Lab Specific

- a. [EPA-600/4-79-020](#), *Methods for Chemical Analysis of Water and Wastes*.
- b. APHA/AWWA/WEF, 2012, *Standard Methods For the Examination of Water and Wastewater*.
- c. [O'Dell, 1993](#), *Method 410.4 The Determination of Chemical Oxygen Demand by Semi-Automated Colorimetry*.
- d. [EPA-821-R-98-002](#), *Method 1664, Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry*.
- e. [SW-846](#), *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- f. [ECY 97-602](#), *Analytical Methods for Petroleum Hydrocarbons*.
- g. [EPA/600/R-93/100](#), *Methods for the Determination of Inorganic Substances in Environmental Samples*.
- h. [Peden, 1986](#), *Methods for Collection and Analysis of Precipitation*.
- i. [EPA-600/R-94/111](#), *Methods for the Determination of Metals in Environmental Samples, Supplement I*.

AEA	= alpha energy analysis
ASTM	= ASTM International
EPA	= U.S. Environmental Protection Agency
GC	= gas chromatography
GC-MS	= gas chromatography-mass spectrometry
GPC	= gas-flow proportional counter
ICP-AES	= inductively coupled plasma-atomic emission spectroscopy
ICP-MS	= inductively coupled plasma-mass spectrometry
LEPS	= low-energy photon spectroscopy
LSC	= liquid scintillation counting

## F7 Sample Preservation and Holding Times

Sample preservation and holding times are designed to ensure the analytical results generated from a sample are representative of the sample's source. Sample preservation is any method used to ensure the analyte of interest is not altered between the time the sample is acquired and the time it is analyzed. Sample preservation includes selecting the correct sample container material (such as plastic or glass), and may include cooling the sample to  $\leq 6^{\circ}\text{C}$ , adjusting the sample pH with acids or bases, or adding other chemicals (such as sodium bisulfite) to prevent oxidation of the analyte of interest. Typically, any

preservation chemicals are added to the sample container during container preparation prior to taking the container to the sample site.

Holding times are defined as the time from sample collection or sample extraction to sample analysis. An extraction holding time is the time from sample collection to sample extraction. Holding times are calculated from the date of sample collection as recorded on the sample's chain of custody. Analytes that may change quickly with time, such as coliform or hexavalent chromium, have short holding times while other analytes, such as acid-preserved metals and radionuclides, have much longer holding times.

Table F-7 lists the sample preservation and holding time requirements for the groundwater monitoring program. Upon receipt of a groundwater sample set, the analyzing laboratory inspects the contents of the sample set container, usually an ice chest, to ensure that the samples received reflect what is listed on the accompanying chains of custody. During the receipt inspection, the samples are usually checked for any anomalies, such as missing samples, broken sample bottles, or absent tamper tape. The as-received sample temperature is also usually checked. Samples that are received immediately from the field will not have had time to cool to a preservation temperature  $\leq 6^{\circ}\text{C}$ ; in this circumstance, the as-received condition of the samples is noted and normal processing of the samples for analysis proceeds. Either at the time of receipt, or immediately before sample preparation and analysis, the pH of samples that require pH adjustment is checked to ensure the sample was properly preserved. If the pH is not correct for the sample type (e.g., pH is greater than 2 for inductively coupled plasma [ICP] metals or is less than 12 for cyanide samples), then the laboratory notes the anomaly and may perform adjustment of the sample pH. Any anomalies noted during sample receiving or with sample preservation are reported to the Soil and Groundwater Remediation Project via Sample Issue Resolution requests. If the Project does not deem the anomaly will affect the sample results, the laboratory is instructed to proceed with the analysis. The Project may decide that the anomaly (e.g., a cyanide sample with a pH less than 12) could jeopardize the integrity of the sample results; in this instance, the laboratory will be instructed to cancel the sample analysis.

**Table F-7. Groundwater Sample Container, Preservative, and Holding Time Requirements**

Parameter	Container	Preservative	Holding Time	Source
<b>General Chemical Parameters</b>				
Alkalinity	G/P	Cool to ≤6 °C	14 days	40 CFR 136, Table II
Chemical oxygen demand	G/P	Cool to ≤6 °C; H <sub>2</sub> SO <sub>4</sub> to pH <2	28 days	40 CFR 136, Table II
Coliform	G/P	Cool to ≤10 °C; 0.0008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	8 hours	40 CFR 136, Table II
Dissolved oxygen	G	None	As soon as possible	40 CFR 136, Table II
Hydrogen ion (pH)	G/P	None	As soon as possible	40 CFR 136, Table II
Oil and grease / Hexane extractable material	G	Cool to ≤6 °C; HCl or H <sub>2</sub> SO <sub>4</sub> to pH <2	28 days	SW-846, Table 3-2
Specific conductance	G/P	None	28 days	40 CFR 136, Table II
Total dissolved solids	G/P	Cool to ≤6 °C	7 days	APHA/AWWA/WEF, 2012, SM 2540c
Total organic carbon	aG	Cool to ≤6 °C; HCl or H <sub>2</sub> SO <sub>4</sub> to pH <2	28 days	40 CFR 136, Table II
Total organic halides	G	Cool to ≤6 °C; H <sub>2</sub> SO <sub>4</sub> to pH <2	28 days	SW-846, Method 9020B
Total petroleum hydrocarbons	aGs	Cool to ≤6 °C; HCl or H <sub>2</sub> SO <sub>4</sub> to pH <2	14 days	SW-846, Table 4-1
Total petroleum hydrocarbons - diesel	aGs	Cool to ≤6 °C; HCl to pH<2	14 days before extraction, 40 days after extraction	ECY 97-602
Total petroleum hydrocarbons - gasoline	aG	Cool to ≤6 °C; HCl to pH<2	14 days	ECY 97-602
<b>Ammonia and Anions</b>				
Ammonia	G/P	Cool to ≤6 °C; H <sub>2</sub> SO <sub>4</sub> to pH <2	28 days	40 CFR 136, Table II
Cyanide	G/P	Cool to ≤6 °C; 50% NaOH to pH>12	14 days	SW-846, Table 3-2
Bromide, chloride, fluoride, sulfate	G/P	Cool to ≤6 °C	28 days	SW-846, Table 3-2
Nitrate, nitrite, phosphate	G/P	Cool to ≤6 °C	48 hours	SW-846, Table 3-2

**Table F-7. Groundwater Sample Container, Preservative, and Holding Time Requirements**

Parameter	Container	Preservative	Holding Time	Source
Sulfide	G/P	Cool to $\leq 6$ °C; zinc acetate and NaOH to pH >9	7 days	SW-846, Table 3-2
<i>Metals</i>				
Hexavalent chromium	G/P	Cool to $\leq 6$ °C	24 hours	SW-846, Table 3-2
Mercury	G/P	HNO <sub>3</sub> to pH <2	28 days	SW-846, Table 3-2
All other metals	G/P	HNO <sub>3</sub> to pH <2	6 months	SW-846, Table 3-2
<i>Volatile Organic Compounds</i>				
Volatile organic compounds	aGs	Cool to $\leq 6$ °C; HCl or H <sub>2</sub> SO <sub>4</sub> to pH <2	14 days	SW-846, Table 4-1
<i>Semivolatile Organic Compounds</i>				
Semivolatile organic compounds, Organochlorine pesticides and herbicides	aG / PTFE-lined cap	Cool to $\leq 6$ °C	7 days before extraction, 40 days after extraction	SW-846, Table 4-1
Phenols	aG / PTFE-lined cap	Cool to $\leq 6$ °C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7 days before extraction, 40 days after extraction	40 CFR 136, Table II
Polychlorinated biphenyls	aG / PTFE-lined cap	Cool to $\leq 6$ °C	None	SW-846, Table 4-1
Polychlorinated dibenzo-p-dioxins, Polychlorinated dibenzofurans	aG / PTFE-lined cap	Cool to $\leq 6$ °C	30 days before extraction, 45 days after extraction	SW-846, Methods 8280 & 8290
<i>Radiological Parameters</i>				
Gross alpha, gross beta	G/P	HNO <sub>3</sub> to pH <2	6 months	SW-846, Table 2-40(B)
Carbon-14, tritium	G	None	6 months	Laboratory procedure
Americium isotopics, Gamma spectroscopy radionuclides, Plutonium isotopics, Radium isotopics,	G/P	HNO <sub>3</sub> to pH <2	6 months	Laboratory procedure

**Table F-7. Groundwater Sample Container, Preservative, and Holding Time Requirements**

Parameter	Container	Preservative	Holding Time	Source
Strontium-90, Uranium isotopics				
Technetium-99	G/P	HCl or HNO <sub>3</sub> to pH<2	6 months	Laboratory procedure

[40 CFR 136](#), “Guidelines Establishing Test Procedures for the Analysis of Pollutants.”

APHA/AWWA/WEF, 2012, *Standard Methods For the Examination of Water and Wastewater*.

[ECY 97-602](#), *Analytical Methods for Petroleum Hydrocarbons*.

[SW-846](#), *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-A*.

aG = amber glass

aGs = amber glass with septum cap

G = glass

P = plastic

PTFE = polytetrafluorinatedethylene

SM = standard method

## F7.1 Sample Preservation

Of the 12,466 groundwater monitoring laboratory samples acquired during CY2014, only 26 samples, or 0.2% of all laboratory samples, were associated with sample preservation issues. Of the 26 samples with sample preservation issues, analyses of only 8 were cancelled. This indicates that incorrect sample preservation is not a major issue for the groundwater monitoring program. Table F-8 lists the preservation issues and the analytes affected for the CY2014 groundwater monitoring effort.

GEL reported an additional 110 samples as improperly preserved. Most of these samples were for metals or radiochemical constituents and were reported as having a pH greater than 2. The disposition of these samples was for laboratory personnel to adjust the pH and hold the sample for 24 hours before sample preparation and analysis to meet preservation requirements. However, neither TARL nor TASL were routinely reporting samples outside pH preservation requirements. GEL sample receiving personnel were using pH strips to determine proper pH preservation. Soil and Groundwater Remediation Project personnel requested that GEL examine its use of pH strips. Consequently, GEL personnel began checking the results of their pH strips with a pH meter and discovered that the strips were generating “false positives;” that is, the pH strips were indicating out-of-limit pH values when in fact the pH of the samples met preservation requirements. Groundwater monitoring project scientists and project coordinators determined that the addition of more preservative to those samples thought to be out of pH limits was of no consequence, and the results of those samples were accepted.

**Table F-8. Groundwater Sample Preservation Issues and Dispositions**

Preservation Issue / Analytes	Disposition / Number of Samples Affected				
	No Action - Report Results	Adjust pH and Report Results	Cancel Analysis	Filter and Report Results	Totals
<b>Totals</b>	<b>14</b>	<b>3</b>	<b>8</b>	<b>1</b>	<b>26</b>
<b>Incorrect pH</b>	—	<b>3</b>	<b>1</b>	—	<b>4</b>
Alkalinity	—	—	1	—	1
Strontium-90	—	3	—	—	3
<b>Incorrect Temperature*</b>	<b>14</b>	—	—	—	<b>14</b>
Alkalinity	2	—	—	—	2
IC Anions	2	—	—	—	2
ICP-AES (6010) Metals	4	—	—	—	4
ICP-MS (6020) Metals	2	—	—	—	2
GC-MS (8260) VOC	2	—	—	—	2
TOC	2	—	—	—	2
<b>Incorrect Preservative</b>	—	—	<b>7</b>	—	<b>7</b>
IC Anions	—	—	1	—	1
Technetium-99	—	—	1	—	1

**Table F-8. Groundwater Sample Preservation Issues and Dispositions**

Preservation Issue / Analytes	Disposition / Number of Samples Affected				
	No Action - Report Results	Adjust pH and Report Results	Cancel Analysis	Filter and Report Results	Totals
TOC	—	—	1	—	1
Total Dissolved Solids	—	—	2	—	2
Tritium	—	—	2	—	2
<b>Not Field Filtered</b>	—	—	—	<b>1</b>	<b>1</b>
Mercury	—	—	—	1	1

a. The 14 samples affected by temperatures greater than 6°C upon sample receipt were all delivered to TASL. The commercial carrier did not deliver the samples overnight as expected, and the delayed delivery allowed the samples to warm before the delivery was completed.

GC-MS = gas chromatography – mass spectrometry

IC = ion chromatography

ICP-AES = inductively coupled plasma – atomic emission spectroscopy

ICP-MS = inductively coupled plasma – mass spectrometry

TOC = total organic carbon

VOC = volatile organic compound

## F7.2 Holding Times

Table F-5 summarizes the number of sample results for each analytical method with missed holding times. Of the 147,457 groundwater monitoring laboratory results reported during CY2014, 787 analytical results, or 0.5% of the groundwater monitoring data set, were affected by missed holding times. This is not as good as CY 2013's 109 analytical results (0.08%) and is approximately the same as CY2012's 703 analytical results, or 0.5% of the groundwater monitoring data set with missed holding times. Table F-9 lists the reasons for those sample results documented by the Sample Issue Resolution (SIR) process. Most of the samples with missed holding times were analyzed within two times the holding time; groundwater monitoring project scientists and project coordinators deemed these results acceptable for the groundwater monitoring program.

With the closure of the WSCF laboratory, analytes with short holding times, especially hexavalent chromium and the ion-chromatography anions, were shipped to the off-site commercial laboratories for determination. The additional shipping time frequently resulted in missed holding times for those analytes. To avoid the flood of SIRs that would have otherwise been associated with all the missed holding times, Soil and Groundwater Remediation Project personnel instructed GEL and TASL to submit SIRs only for those short-holding time analytes that were analyzed outside two times the holding time. All missed holding times were to always be noted in the case narratives of the laboratory analytical reports.

Of the 787 analytical results with missed holding times, 685 were for nitrate, nitrite, sulfate, and phosphate (48-hour holding time), eight were for ammonium ion (28 day holding time), 16 were for hexavalent chromium (24-hour holding time), two were for mercury (28-day holding time), four for total

organic halides (TOX) (28-day holding time), 68 were for alkalinity (14-day holding time), two were for cyanide (14-day holding time), one for chloride (28-day holding time), and one for oil and grease (28-day holding time). By laboratory, GEL reported 296 results with missed holding times, TARL with none, TASL with 486, and WSCF with five.

**Table F-9. Missed Sample Holding Time Issues**

Missed Holding Time Issue	Number of Results*	Percentage of All Missed Holding Times
<b>Totals</b>	<b>289</b>	<b>100.0%</b>
Late sample delivery (insufficient time)	80	27.7%
Analyst error	59	20.4%
Late sample delivery (carrier)	54	18.7%
Instrument failure	38	13.1%
Dilution / Reanalysis	33	11.4%
Incorrect LIMS entry	16	5.5%
QC failure / Reanalysis	5	1.7%
Other laboratory issue	4	1.4%

\*The 289 results listed in this table are those documented by the Sample Issue Resolution process.

An explanation of the holding time issues follows:

- *Late sample delivery (insufficient time)*: This missed holding time reason covers delivery of a sample with insufficient or no time left to complete the analysis before the holding time expired. This issue affected five hexavalent chromium results, 70 nitrate/nitrite results, and five phosphate results. The primary cause of this issue was the shutdown of the WSCF facility which stopped receiving samples on May 5, 2014. Samples slated for analysis of short holding time analytes were then shipped overnight to the GEL and TASL laboratories. Consequently, those analytes with 24-hour (hexavalent chromium) and 48-hour (nitrate, nitrite, and phosphate) holding times were received with insufficient or no time available for sample preparation and analysis to meet the holding time requirements for those analytes. TARL began receiving groundwater samples for anion determinations during the fourth quarter of CY2014. With the addition of this capability near the Hanford Site, the anticipation is that fewer holding times for anions will be missed during CY2015.
- *Analyst error*: This issue covers missed holding times caused by the analyst failing to observe the sample holding time. Of the 59 results affected by this issue, 52 results were for alkalinity (including bicarbonate, carbonate and hydroxide), five results for ammonium ion, and one each for nitrate and nitrite.
- *Late Sample Delivery (carrier)*: This missed holding time reason covers late delivery of a sample because the commercial transportation carrier did not deliver the samples to the laboratory overnight as expected. All 54 results affected by this issue were for the short holding time anions nitrate, nitrite and phosphate.

- *Instrument failure*: This issue covers missed holding times caused by failure of an automated instrument to perform the analysis. Weather-caused power outages were the cause of some of the instrument failures. Of the 38 results affected by this issue, 36 were for nitrate/nitrite and two were for total organic halides.
- *Dilution / Reanalysis*: When an analyte exceeded the calibration range during analysis, the sample was diluted and reanalyzed after the holding time lapsed. All 33 results affected by this issue were for anions determined by ion chromatography: 31 for nitrate, nitrite, and phosphate, and one each for chloride and sulfate.
- *Incorrect LIMS entry*: This missed holding time reason covers incorrect entry of sample information into the laboratory's laboratory information management system. This issue affected 16 results reported for alkalinity, bicarbonate, carbonate, and hydroxide.
- *QC failure / Reanalysis*: This missed holding time reason covers samples that were reanalyzed after the holding lapsed because of the failure of one or more QC samples to meet QC requirements during the initial analysis. This reason affected three results for phosphate and two results for ammonium ion.
- *Other laboratory issue*: This issue covers miscellaneous laboratory issues that caused missed holding times. This issue affected two cyanide results and one result each for mercury and total organic halides.

## F8 Field Quality Control

This section discusses the CY2014 groundwater monitoring field QC data that exceeded the QC acceptance criteria listed in Table F-1. The types of field QC samples that are evaluated in this section are discussed in Section F-4.2.

### F8.1 Field Blanks

FBs are used to assess potential contamination associated with sampling and laboratory activities. Analytical results for the FBs are assessed against the acceptance limits listed in Table F-1. Overall, the percentage of acceptable FB results evaluated during this reporting period was 97.8% (compared to 98.2% for 2013 and 98.1% for 2012), indicating little problem with contamination during sampling and analysis.

FB results greater than the acceptance criterion of two times the MDL or MDA are identified as suspected contamination. For the common laboratory contaminants 2-butanone, acetone, methylene chloride, toluene, and phthalate esters, the limit is five times the MDL. Results for samples associated with FBs that are above these criteria are given a review qualifier of Q in the HEIS database to indicate potential contamination issues. Associated samples for blanks are defined in Section F-4.2. Table F-10 presents the FB results that exceeded QC limits and Table F-11 compares out-of-limit FBs with out-of-limit MBs that were analyzed in the same analytical batch.

**Table F-10. Field Blank Results Exceeding Quality Control Limits**

Constituent	Blank Type	Number of Results	Number Out of Limits	Percent Out of Limits	Range of QC Limits*	Range of Out-of-Limit Results
<b>Total Field Blanks Out = 325</b>						
<b>General Chemical Parameters: Total Out = 32</b>						
Alkalinity	FTB	55	10	18.2	1080 – 2900 ug/L	2000 – 126000 ug/L
Alkalinity	EB	30	2	6.7	1080 - 2900 ug/L	2000 - 10000 ug/L
Bicarbonate	FTB	30	3	10	1450 - 2900 ug/L	2100 - 2700 ug/L
Bi-carbonate alkalinity	EB	6	2	33.3	1080 - 2200 ug/L	2000 - 10000 ug/L
Bi-carbonate alkalinity	FTB	18	6	33.3	1080 - 2200 ug/L	2000 - 126000 ug/L
Total organic carbon	EB	6	1	16.7	200 - 660 ug/L	640 ug/L
Total organic halides	FTB	60	7	11.7	3.6 - 10 ug/L	3.9 - 16.7 ug/L
Total petroleum hydrocarbons - gasoline range	EB	3	1	33.3	20 - 100 ug/L	25 ug/L
<b>Ammonia and Anions: Total Out = 39</b>						
Ammonium ion	FTB	9	1	11.1	12.88 - 36.01 ug/L	40.14 ug/L
Chloride	FTB	94	11	11.7	40 - 268 ug/L	46 - 3500 ug/L
Chloride	EB	56	6	10.7	40 - 1340 ug/L	58 - 829 ug/L
Fluoride	EB	56	1	1.8	12.5 - 660 ug/L	210 ug/L
Nitrate	EB	56	4	7.1	31.3 - 2920 ug/L	62 - 221 ug/L
Nitrate	FTB	94	6	6.4	35.4 - 584 ug/L	37.2 - 13300 ug/L
Phosphate	EB	16	3	18.8	156 - 822 ug/L	260 - 334 ug/L
Sulfate	EB	56	2	3.6	62.5 - 2660 ug/L	329 - 378 ug/L
Sulfate	FTB	94	4	4.3	100 - 532 ug/L	257 - 18200 ug/L
Sulfide	FTB	4	1	25	66 - 166 ug/L	600 ug/L
<b>Metals: Total Out = 109</b>						
Aluminum	EB	58	2	3.4	20 - 40 ug/L	35.7 - 274 ug/L
Aluminum	FTB	55	1	1.8	25.8 - 150 ug/L	84.7 ug/L
Antimony	EB	81	1	1.2	0.6 - 40 ug/L	10 ug/L

**Table F-10. Field Blank Results Exceeding Quality Control Limits**

Constituent	Blank Type	Number of Results	Number Out of Limits	Percent Out of Limits	Range of QC Limits*	Range of Out-of-Limit Results
Barium	EB	81	4	4.9	0.4 - 8 ug/L	0.52 - 0.8 ug/L
Boron	FTB	54	4	7.4	8 - 40 ug/L	23.2 - 39.4 ug/L
Boron	EB	57	3	5.3	4 - 20 ug/L	26 - 114 ug/L
Calcium	EB	78	1	1.3	100 - 108.4 ug/L	163 ug/L
Calcium	FTB	145	5	3.4	100 - 500 ug/L	124 - 2600 ug/L
Chromium	FTB	149	1	0.7	0.4 - 20 ug/L	1.57 ug/L
Cobalt	EB	81	2	2.5	0.1 - 8 ug/L	0.7 - 1.4 ug/L
Copper	EB	81	4	4.9	0.2 - 8 ug/L	0.456 - 1.2 ug/L
Copper	FTB	139	2	1.4	0.4 - 8 ug/L	0.96 - 1.96 ug/L
Hexavalent chromium	EB	53	2	3.8	1.5 - 8 ug/L	3.5 - 4.3 ug/L
Hexavalent chromium	FTB	120	7	5.8	1.5 - 8 ug/L	1.8 - 7.6 ug/L
Iron	EB	78	1	1.3	25.6 - 80 ug/L	25.7 ug/L
Lead	EB	64	1	1.6	0.1 - 1 ug/L	0.352 ug/L
Manganese	EB	81	7	8.6	0.2 - 8 ug/L	0.47 - 4.8 ug/L
Manganese	FTB	139	3	2.2	0.4 - 10 ug/L	0.73 - 24.4 ug/L
Molybdenum	EB	58	1	1.7	0.1 - 2 ug/L	0.264 ug/L
Nickel	EB	81	14	17.3	0.2 - 20 ug/L	0.408 - 6.2 ug/L
Nickel	FTB	139	3	2.2	0.4 - 20 ug/L	2.68 - 3.11 ug/L
Potassium	FXR	1	1	100	100 ug/L	159 ug/L
Silver	EB	81	6	7.4	0.1 - 10 ug/L	0.166 - 0.404 ug/L
Silver	FTB	139	1	0.7	0.2 - 10 ug/L	2.3 ug/L
Sodium	FTB	145	3	2.1	200 - 1000 ug/L	525 - 1310 ug/L
Strontium	EB	74	7	9.5	0.12 - 16 ug/L	0.27 - 1.37 ug/L
Strontium	FTB	86	5	5.8	0.12 - 20 ug/L	0.7 - 1.19 ug/L
Tin	EB	58	2	3.4	0.1 - 2.2 ug/L	0.242 - 3 ug/L
Tin	FTB	55	5	9.1	0.2 - 10 ug/L	2.5 - 4 ug/L
Uranium	EB	70	2	2.9	0.1 - 0.49 ug/L	1.2 - 374 ug/L
Uranium	FTB	83	1	1.2	0.1 - 0.67 ug/L	3.84 ug/L

Table F-10. Field Blank Results Exceeding Quality Control Limits

Constituent	Blank Type	Number of Results	Number Out of Limits	Percent Out of Limits	Range of QC Limits*	Range of Out-of-Limit Results
Zinc	EB	81	2	2.5	4 - 16.6 ug/L	15 - 21.5 ug/L
Zinc	FTB	139	5	3.6	6.6 - 35 ug/L	12 - 31.1 ug/L
<b><i>Volatile Organic Compounds: Total Out = 132</i></b>						
Acetone	FXR	227	5	2.2	1.7 - 25 ug/L	1.8 - 3.3 ug/L
Carbon tetrachloride	FXR	227	1	0.4	0.26 - 2 ug/L	2.7 ug/L
Chlorobenzene	FTB	35	2	5.7	0.3 - 2 ug/L	0.38 - 0.69 ug/L
Methylene chloride	EB	10	1	10	1.35 - 8 ug/L	6.3 ug/L
Methylene chloride	FTB	35	12	34.3	1.35 - 13.5 ug/L	2.2 - 130 ug/L
Methylene chloride	FXR	227	110	48.5	1.35 - 8 ug/L	1.4 - 67 ug/L
Trichloroethene	FXR	227	1	0.4	0.5 - 2 ug/L	0.62 ug/L
<b><i>Semivolatile Organic Compounds: Total Out = 0</i></b>						
<b><i>Radiochemical Parameters: Total Out = 13</i></b>						
Americium-241	FTB	4	1	25	0.098 - 0.454 pCi/L	0.11 pCi/L
Gross beta	FTB	39	2	5.1	2.62 - 7.86 pCi/L	7.1 - 17 pCi/L
Gross beta	EB	21	1	4.8	3.44 - 30 pCi/L	5.6 pCi/L
Iodine-129	FTB	24	1	4.2	0.286 - 1.846 pCi/L	3.38 pCi/L
Selenium-79	FTB	2	1	50	24 - 29.8 pCi/L	34.8 pCi/L
Strontium-90	EB	18	1	5.6	0.81 - 3.88 pCi/L	1.17 pCi/L
Strontium-90	FTB	38	3	7.9	0.592 - 3.9 pCi/L	1.3 - 111 pCi/L
Technetium-99	FTB	38	2	5.3	11.2 - 24 pCi/L	15 - 60.7 pCi/L
Technetium-99	EB	16	1	6.2	11.88 - 29.4 pCi/L	150 pCi/L

\*Because method detection limits are specific to the laboratory and may change during the reporting period, the limits are presented as a range. However, each result was evaluated according to the method detection limit in effect at the time the sample was analyzed.

EB = equipment blank

FTB = full trip blank

FXR = field transfer blank

QC = quality control

**Table F-11. Out-of-Limit Field Blanks Compared with Out-of-Limit Method Blanks**

Sample Number	Sample Date	Well Name	FB Type	Constituent	Lab	Method	Analysis Batch Number	Field Blank Result	Method Blank Result	Units	FB Lab Qualifier *
<i>General Chemical Parameters</i>											
B2WDV4	5/15/2014	199-D5-39	FTB	Alkalinity	TASL	310.1_ALKALINITY	123128	2,000	1,250	µg/L	BC
B2WDX0	5/15/2014	199-D5-97	EB	Alkalinity	TASL	310.1_ALKALINITY	123128	2,000	1,250	µg/L	
B2X9F7	8/6/2014	199-D5-157	FTB	Alkalinity	TASL	310.1_ALKALINITY	137048	122,000	2,500	µg/L	N
B2XD07	9/4/2014	199-D5-97	EB	Alkalinity	TASL	310.1_ALKALINITY	142855	10,000	1,250	µg/L	
B2XK04	9/23/2014	299-E25-2	FTB	Alkalinity	TASL	310.1_ALKALINITY	148960	126,000	2,500	µg/L	
B2Y529	10/1/2014	199-D5-158-3	FTB	Alkalinity	TASL	310.1_ALKALINITY	148963	10,000	1,250	µg/L	
B2XW48	10/28/2014	199-D8-96	FTB	Alkalinity	TASL	310.1_ALKALINITY	153306	82,000	1,750	µg/L	
B2Y814	10/31/2014	199-H3-6	FTB	Alkalinity	TASL	310.1_ALKALINITY	156153	64,000	1,250	µg/L	
B2YHC3	12/16/2014	299-E27-24	FTB	Alkalinity	TASL	310.1_ALKALINITY	164573	10,000	1,250	µg/L	C
B2WDV4	5/15/2014	199-D5-39	FTB	Bi-carbonate alkalinity	TASL	310.1_ALKALINITY	123128	2,000	1,250	µg/L	BC
B2WDX0	5/15/2014	199-D5-97	EB	Bi-carbonate alkalinity	TASL	310.1_ALKALINITY	123128	2,000	1,250	µg/L	
B2X9F7	8/6/2014	199-D5-157	FTB	Bi-carbonate alkalinity	TASL	310.1_ALKALINITY	137048	122,000	2,500	µg/L	N
B2XD07	9/4/2014	199-D5-97	EB	Bi-carbonate alkalinity	TASL	310.1_ALKALINITY	142855	10,000	1,250	µg/L	
B2XK04	9/23/2014	299-E25-2	FTB	Bi-carbonate alkalinity	TASL	310.1_ALKALINITY	148960	126,000	2,500	µg/L	
B2Y529	10/1/2014	199-D5-158-3	FTB	Bi-carbonate alkalinity	TASL	310.1_ALKALINITY	148963	10,000	1,250	µg/L	

**Table F-11. Out-of-Limit Field Blanks Compared with Out-of-Limit Method Blanks**

Sample Number	Sample Date	Well Name	FB Type	Constituent	Lab	Method	Analysis Batch Number	Field Blank Result	Method Blank Result	Units	FB Lab Qualifier *
B2XW48	10/28/2014	199-D8-96	FTB	Bi-carbonate alkalinity	TASL	310.1_ALKALINITY	153306	82,000	1,750	µg/L	
B2Y814	10/31/2014	199-H3-6	FTB	Bi-carbonate alkalinity	TASL	310.1_ALKALINITY	156153	64,000	1,250	µg/L	
<b><i>Ammonia and Anions</i></b>											
B2WD21	5/12/2014	699-38-70B	EB	Chloride	TASL	300.0_ANIONS_IC	122210	70	54	µg/L	BC
B2WJW3	5/9/2014	199-K-119A	EB	Chloride	TASL	300.0_ANIONS_IC	125000	99	37	µg/L	BC
B2X9K7	8/6/2014	199-D5-157-7	FTB	Chloride	TASL	300.0_ANIONS_IC	137142	46	64	µg/L	BC
B2Y7L1	11/6/2014	199-D5-34	FTB	Chloride	TASL	300.0_ANIONS_IC	156814	350	151	µg/L	BND
B2YFB5	11/6/2014	199-D5-155-7	FTB	Chloride	TASL	300.0_ANIONS_IC	156814	120	151	µg/L	BDN
B2Y990	11/23/2014	199-K-125A	EB	Chloride	TARL	300.0_ANIONS_IC	4327012	202	197	µg/L	CB
B2YLH1	12/4/2014	299-E27-155	FTB	Chloride	TARL	300.0_ANIONS_IC	4338059	301	140	µg/L	DCB
B2Y8X6	11/21/2014	699-98-51	EB	Nitrate	TARL	300.0_ANIONS_IC	4325081	168	164	µg/L	CB
B2YMF8	12/5/2014	699-S6-E4E	FTB	Nitrate	TARL	300.0_ANIONS_IC	4339061	168	75	µg/L	DCB
B2Y8X6	11/21/2014	699-98-51	EB	Sulfate	TARL	300.0_ANIONS_IC	4325081	378	391	µg/L	CB
B2YMF8	12/5/2014	699-S6-E4E	FTB	Sulfate	TARL	300.0_ANIONS_IC	4339061	266	146	µg/L	DCB
B2YCC8	12/11/2014	AT-D-2-M	FTB	Sulfate	TARL	300.0_ANIONS_IC	4346034	455	457	µg/L	DCB
B2PHW4	1/23/2014	699-44-64	FTB	Sulfide	TASL	9034_SULFIDE	102149	600	100	µg/L	B
<b><i>Metals</i></b>											
B2XD07	9/4/2014	199-D5-97	EB	Aluminum	TASL	6020_METALS_ICPMS	146348	274	19	µg/L	

F-32

DOE/RL-2015-07, REV 0

**Table F-11. Out-of-Limit Field Blanks Compared with Out-of-Limit Method Blanks**

Sample Number	Sample Date	Well Name	FB Type	Constituent	Lab	Method	Analysis Batch Number	Field Blank Result	Method Blank Result	Units	FB Lab Qualifier *
B2XD07	9/4/2014	199-D5-97	EB	Barium	TASL	6020_METALS_ICPMS	146348	0.52	0.56	µg/L	BC
B2XD13	9/4/2014	199-D5-97	EB	Barium	TASL	6020_METALS_ICPMS	146348	0.72	0.56	µg/L	BC
B2XH67	9/29/2014	199-N-188	EB	Barium	TASL	6020_METALS_ICPMS	151561	0.53	0.85	µg/L	BC
B2XH73	9/29/2014	199-N-188	EB	Barium	TASL	6020_METALS_ICPMS	151561	0.80	0.85	µg/L	BC
B2X9F7	8/6/2014	199-D5-157	FTB	Calcium	TASL	6010_METALS_ICP_TR	137547	2,600	62	µg/L	
B2X9F7	8/6/2014	199-D5-157	FTB	Calcium	TASL	6010_METALS_ICP_TR	137547	2,600	141	µg/L	
B2X9F7	8/6/2014	199-D5-157	FTB	Calcium	TASL	6010_METALS_ICP_TR	137547	2,600	447	µg/L	
B2XD07	9/4/2014	199-D5-97	EB	Calcium	TASL	6010_METALS_ICP_TR	145653	163	69	µg/L	BC
B2XK04	9/23/2014	299-E25-2	FTB	Calcium	TASL	6010_METALS_ICP_TR	150308	197	67	µg/L	BC
B2XK04	9/23/2014	299-E25-2	FTB	Calcium	TASL	6010_METALS_ICP_TR	150308	197	80	µg/L	BC
B2XK04	9/23/2014	299-E25-2	FTB	Calcium	TASL	6010_METALS_ICP_TR	150308	197	112	µg/L	BC
B2XD07	9/4/2014	199-D5-97	EB	Copper	TASL	6020_METALS_ICPMS	146348	1.20	0.54	µg/L	C
B2YLF7	12/4/2014	299-E27-155	FTB	Copper	TASL	6020_METALS_ICPMS	169082	0.96	0.67	µg/L	BC
B2WBJ7	5/21/2014	299-W14-13	FTB	Manganese	TASL	6020_METALS_ICPMS	127042	0.91	0.95	µg/L	BC
B2XD07	9/4/2014	199-D5-97	EB	Manganese	TASL	6020_METALS_ICPMS	146348	4.80	0.30	µg/L	
B2XD13	9/4/2014	199-D5-97	EB	Manganese	TASL	6020_METALS_ICPMS	146348	0.53	0.30	µg/L	BC
B2YLF7	12/4/2014	299-E27-155	FTB	Manganese	TASL	6020_METALS_ICPMS	168946	24	0.26	µg/L	
B2YLF7	12/4/2014	299-E27-155	FTB	Manganese	TASL	6020_METALS_ICPMS	168946	24	0.45	µg/L	
B2YLF7	12/4/2014	299-E27-155	FTB	Manganese	TASL	6020_METALS_ICPMS	168946	24	0.49	µg/L	

Table F-11. Out-of-Limit Field Blanks Compared with Out-of-Limit Method Blanks

Sample Number	Sample Date	Well Name	FB Type	Constituent	Lab	Method	Analysis Batch Number	Field Blank Result	Method Blank Result	Units	FB Lab Qualifier *
B2Y6D7	11/5/2014	299-E33-339	FTB	Silver	TASL	6010_METALS_ICP_TR	160105	2.3	1.0	µg/L	BC
B2XDR4	9/8/2014	699-S6-E4L	EB	Strontium	TASL	6010_METALS_ICP_TR	146340	0.60	0.60	µg/L	BC
B2XD07	9/4/2014	199-D5-97	EB	Strontium	TASL	6020_METALS_ICPMS	146348	0.77	0.74	µg/L	BC
B2XD13	9/4/2014	199-D5-97	EB	Strontium	TASL	6020_METALS_ICPMS	146348	1.20	0.74	µg/L	BC
B2XK04	9/23/2014	299-E25-2	FTB	Strontium	TASL	6010_METALS_ICP_TR	150308	0.70	0.90	µg/L	BC
B2XK08	9/23/2014	299-E25-2	FTB	Strontium	TASL	6010_METALS_ICP_TR	150308	0.80	0.90	µg/L	BC
B2YLF7	12/4/2014	299-E27-155	FTB	Strontium	TASL	6020_METALS_ICPMS	168946	0.76	0.08	µg/L	B
B2YLF7	12/4/2014	299-E27-155	FTB	Strontium	TASL	6020_METALS_ICPMS	168946	0.76	0.14	µg/L	B
B2WNJ7	6/16/2014	199-B2-14	FTB	Tin	TASL	6020_METALS_ICPMS	130554	2.6	1.4	µg/L	C
B2WNK2	6/16/2014	199-B2-14	FTB	Tin	TASL	6020_METALS_ICPMS	130554	3.6	1.4	µg/L	C
B2YLF7	12/4/2014	299-E27-155	FTB	Tin	TASL	6020_METALS_ICPMS	168946	2.8	1.6	µg/L	C
B2YLF7	12/4/2014	299-E27-155	FTB	Tin	TASL	6020_METALS_ICPMS	168946	2.8	1.6	µg/L	C
B2XDD3	9/15/2014	299-E27-155	EB	Uranium	TARL	UTOT_KPA	4265051	374	1.4	µg/L	
B2XK04	9/23/2014	299-E25-2	FTB	Zinc	TASL	6010_METALS_ICP_TR	150308	23	8.5	µg/L	C
B2YH99	12/4/2014	299-E27-155	FTB	Zinc	TASL	6010_METALS_ICP_TR	167928	24	11	µg/L	C
B2YH99	12/4/2014	299-E27-155	FTB	Zinc	TASL	6010_METALS_ICP_TR	167928	24	24	µg/L	C
B2YH99	12/4/2014	299-E27-155	FTB	Zinc	TASL	6010_METALS_ICP_TR	167928	24	24	µg/L	C
<b>Volatile Organic Compounds</b>											
B2R201	5/21/2014	199-K-107A	FXR	Trichloroethene	GEL	8260_VOA_GCMS	1391711	0.62	0.65	µg/L	BJ

**Table F-11. Out-of-Limit Field Blanks Compared with Out-of-Limit Method Blanks**

Sample Number	Sample Date	Well Name	FB Type	Constituent	Lab	Method	Analysis Batch Number	Field Blank Result	Method Blank Result	Units	FB Lab Qualifier *
---------------	-------------	-----------	---------	-------------	-----	--------	-----------------------	--------------------	---------------------	-------	--------------------

\* See Table F-3 for the explanation of the laboratory data quality flags.

EB = equipment blank

FB = field blank

FTB = full trip blank

FXR = field transfer blank

GEL = GEL laboratory

TARL = TestAmerica Richland laboratory

TASL = TestAmerica St. Louis laboratory

WSCF = Waste Sampling and Characterization Facility

The remainder of the FB discussion in this section provides additional context for the information in Tables F-10 and F-11.

For CY2014, 459 FB sets were obtained consisting of 959 samples that were analyzed to generate 15,115 sample results of which 325 (2.2 %) exceeded QC limits. By blank type, 72 EB sets were acquired consisting of 217 EB samples; these samples yielded 3,648 results of which 97.6% met the acceptance criteria. For FTBs, 159 blank sets were acquired consisting of 514 samples that yielded 6,813 analytical results of which 98.3% met the acceptance criteria. For FXRs, 228 blank samples yielded 4,654 analytical results of which 97.5% met the acceptance criteria.

By compound class, the 483 general chemical parameter FB results yielded 32 results (6.6%) that exceeded QC limits, including 12 alkalinity, three bicarbonate, eight bi-carbonate alkalinity, one TOC, seven TOX, and one total petroleum hydrocarbons-gasoline range measurements. Of the 849 ammonia/anion results, 39 (4.6%) exceeded QC limits, including one ammonium ion, 17 chloride, one fluoride, 10 nitrate, three phosphate, six sulfate, and one sulfide results.

Of the 5,359 FB metals results for CY2014, 109 (2.0%) exceeded QC limits. Nickel was the worst offender with 17 results exceeding the acceptance criterion followed by strontium (12 results), and manganese (10 results). The remaining 70 out-of-limit results were scattered among 18 other metals. Fifteen blank samples (B2V633, B2XD13, B2XH67, B2XD07, B2WDV4, B2YLF7, B2V630, B2XH73, B2VNY0, B2WDX0, B2XWT1, B2WP77, B2VNX4, B2W0F5, and B2W0F9) had at least five metal analytes that exceeded the acceptance criterion. FBs with out-of-limits metal results are frequently the result of a mix-up between the actual blank sample and a groundwater sample either in the field or in the laboratory.

CY2014 groundwater monitoring FBs yielded 6,421 VOC results. Of these results, 132 (2.1%) exceeded QC limits and included 123 methylene chloride results. The remaining VOC analytes and the number of results out of limits were acetone (5), carbon tetrachloride (1), chlorobenzene (2), and trichloroethene (1). During CY2012, a study of VOC contamination in groundwater FBs determined that the deionized water used to generate the FBs is the most likely source of the methylene chloride and to a lesser extent, carbon tetrachloride and chloroform found in the FBs (SGW-52194). The same study also concluded that the appearance of acetone, bromomethane, carbon disulfide, chloromethane, tetrachloroethene, and toluene in laboratory MBs indicates that these volatile organic analytes may be introduced as contaminants during laboratory sample preparation and analysis and may appear as spurious analytes in groundwater samples. Corrective actions to decrease the appearance of spurious organic compounds in groundwater monitoring FBs and samples have been initiated, but are yet to be completed.

Of the 1,420 SVOC results, none exceeded QC limits. Of the 583 radiochemical parameter results, 13 (2.2%) exceeded QC limits. The 13 out-of-limit results were distributed over six radiochemical parameters.

Table F-11 compares out-of-limit FB results with out-of-limit MB results. Many of the table entries show that the FB and MB results are similar in value indicating that the source of FB contamination is more likely caused by laboratory sample handling and preparation and is not the result of sample bottle preparation and sample collection activities. One clear exception to this statement is sample alkalinity; field sample preparation and handling appears to be the primary cause of sample contamination for that analyte.

## F8.2 Field Duplicate Samples

Field duplicate samples are replicate groundwater samples sent to the same laboratory and are used to assess field sampling and laboratory measurement precision. According to Table F-1, the results of field duplicates must have a precision less than or equal to 20% as measured by the RPD (Equation F-1). Field duplicates with at least one result greater than five times the MDL or MDA were evaluated. Field duplicate results that have an RPD greater than 20% are given a review qualifier of Q in the HEIS *RESULT* table to indicate potential precision issues. Field duplicate values with a review qualifier of Y were included in the assessment of duplicate precision.

For CY2014, 210 duplicate sample sets were acquired consisting of 715 sample pairs. These 715 sample pairs yielded 9,805 pairs of results of which 3,008 result pairs (30.7%) met the evaluation criterion. Of these 3,008 result pairs, 2,859 (95.0%) were acceptable, indicating reasonable field sampling and intra-laboratory precision. Table F-12 presents the duplicate results that exceeded QC limits. For comparison, the CY 2013 percentage of acceptable duplicate results was 95.2%, and the CY2012 percentage of acceptable duplicate results was 94.2%.

Metals had the largest number of duplicate result failures with 91 data pairs exceeding the RPD criterion of 20%. Historically, many of the out-of-limit duplicates for metals were attributed to unfiltered samples in which suspended solids in the samples tend to cause discrepancies between result pairs. However, for CY2014, the metals duplicate result failures occurred in almost as many filtered samples as unfiltered samples. This may indicate possible sample swaps either in the field or in the laboratory, a sample contamination event that affected one of the duplicate pair but not the other, or a dilution error during sample preparation.

**Table F-12. Field Duplicates Exceeding Quality Control Limits**

Constituent	Laboratory	Number of Duplicates	Number of Duplicates Evaluated <sup>a</sup>	Number Out of Limits <sup>b</sup>	Percent Out of Limits	Range of Out-of-Limit RPD <sup>c</sup>
<i>Total Field Duplicate Results Out = 149</i>						
<i>General Chemical Parameters: Total Out = 9</i>						
Alkalinity	TASL	36	36	3	8.3	21.4 - 27.4
Bi-carbonate alkalinity	TASL	33	33	3	9.1	21.4 - 27.4
Chemical Oxygen Demand	TASL	1	1	1	100	114.3
Total dissolved solids	TASL	2	2	1	50	196
Total petroleum hydrocarbons - diesel range	TASL	5	1	1	100	159.3
<i>Ammonia and Anions: Total Out = 12</i>						
Ammonium ion	GEL	1	1	1	100	85.2
Chloride	TASL	40	40	1	2.5	61.2
Cyanide	TASL	7	5	1	20	194.4

Table F-12. Field Duplicates Exceeding Quality Control Limits

Constituent	Laboratory	Number of Duplicates	Number of Duplicates Evaluated <sup>a</sup>	Number Out of Limits <sup>b</sup>	Percent Out of Limits	Range of Out-of-Limit RPD <sup>c</sup>
Fluoride	TASL	40	37	3	8.1	20.7 - 26.3
Fluoride	WSCF	43	16	1	6.2	28.3
Nitrate	GEL	51	51	1	2	21.2
Nitrate	TASL	40	40	1	2.5	62.4
Nitrate	WSCF	43	43	1	2.3	23.2
Phosphate	TASL	5	2	1	50	50
Sulfate	TASL	40	40	1	2.5	63.6
<b>Metals: Total Out = 91</b>						
Aluminum	GEL	28	2	2	100	55.6 - 130.1
Arsenic	WSCF	86	24	4	16.7	21.2 - 25.7
Barium	GEL	78	78	1	1.3	36.7
Barium	TASL	83	77	1	1.3	29.2
Barium	WSCF	74	73	3	4.1	22.3 - 31.8
Boron	TASL	25	4	1	25	23.3
Calcium	WSCF	68	68	1	1.5	31.9
Chromium	GEL	80	53	2	3.8	27.8 - 51.3
Chromium	TASL	91	49	1	2	33.9
Chromium	WSCF	74	35	3	8.6	23.8 - 151.2
Cobalt	GEL	78	2	2	100	134 - 145.9
Cobalt	WSCF	74	3	1	33.3	139
Copper	GEL	78	6	4	66.7	36.8 - 79.2
Copper	TASL	83	7	5	71.4	21.3 - 168.2
Copper	WSCF	74	13	8	61.5	35.7 - 99.5
Hexavalent chromium	TARL	106	55	6	10.9	33.1 - 116.4
Hexavalent chromium	WSCF	30	22	1	4.5	23.8
Iron	GEL	70	10	2	20	96.1 - 131.8
Iron	TASL	83	21	6	28.6	23.9 - 52
Lead	TASL	33	5	1	20	163.6

Table F-12. Field Duplicates Exceeding Quality Control Limits

Constituent	Laboratory	Number of Duplicates	Number of Duplicates Evaluated <sup>a</sup>	Number Out of Limits <sup>b</sup>	Percent Out of Limits	Range of Out-of-Limit RPD <sup>c</sup>
Magnesium	WSCF	68	68	1	1.5	28.4
Manganese	GEL	78	14	5	35.7	21.6 - 80.6
Manganese	TASL	83	17	3	17.6	42.5 - 68.2
Manganese	WSCF	74	14	4	28.6	21.2 - 188.7
Molybdenum	WSCF	24	20	1	5	20.2
Nickel	GEL	78	8	1	12.5	56.5
Nickel	TASL	83	15	2	13.3	27.1 - 75.2
Nickel	WSCF	74	17	2	11.8	25.7 - 26
Potassium	WSCF	68	68	1	1.5	39.1
Silver	WSCF	74	2	1	50	58
Strontium	WSCF	57	57	4	7	23.8 - 31.6
Tin	TASL	25	1	1	100	76.5
Tin	WSCF	20	1	1	100	98.5
Uranium	TASL	25	23	1	4.3	29.8
Uranium	WSCF	37	37	4	10.8	21.1 - 64.9
Vanadium	GEL	70	48	1	2.1	20.5
Zinc	TASL	83	3	1	33.3	124.2
Zinc	WSCF	74	3	2	66.7	88.4 - 180
<b><i>Volatile Organic Compounds: Total Out = 2</i></b>						
Carbon tetrachloride	WSCF	16	7	2	28.6	26.1 - 35.3
<b><i>Semivolatile Organic Compounds: Total Out = 0</i></b>						
<b><i>Radiochemical Parameters: Total Out = 35</i></b>						
Gross alpha	GEL	22	4	1	25	30.9
Gross alpha	WSCF	22	3	2	66.7	38.2 - 78.3
Gross beta	GEL	22	17	5	29.4	23.9 - 30.7
Gross beta	TARL	28	20	5	25	24.5 - 32.4
Gross beta	WSCF	28	15	6	40	23.4 - 66.7
Iodine-129	TARL	33	11	6	54.5	22.8 - 173.6

**Table F-12. Field Duplicates Exceeding Quality Control Limits**

Constituent	Laboratory	Number of Duplicates	Number of Duplicates Evaluated <sup>a</sup>	Number Out of Limits <sup>b</sup>	Percent Out of Limits	Range of Out-of-Limit RPD <sup>c</sup>
Strontium-90	GEL	20	7	1	14.3	27.6
Technetium-99	WSCF	22	15	1	6.7	26.7
Tritium	GEL	29	22	1	4.5	33.9
Tritium	WSCF	33	16	2	12.5	35.9 - 64.6
Uranium-233/234	WSCF	6	5	1	20	31.6
Uranium-234	GEL	2	2	1	50	23.7
Uranium-235	WSCF	6	3	2	66.7	29.9 - 41.9
Uranium-238	WSCF	6	5	1	20	34.5

a. Duplicates with at least one result five times greater than the method detection limit or minimum detectable activity were evaluated.

b. Duplicate control limit is a relative percent difference less than or equal to 20%.

c. In cases where a non-detected result was compared with a measured value, the method detection limit or minimum detectable activity was used for the non-detected concentration.

GEL = GEL Laboratory

RPD = relative percent difference

TARL = TestAmerica Richland Laboratory

TASL = TestAmerica St. Louis

WSCF = Waste Sampling and Characterization Facility

### F8.3 Quadruplicate Total Organic Carbon and Total Organic Halides Samples

TOC and TOX are classified as RCRA indicator analytes, and the samples for these analytes are usually taken in quadruplicate ([40 CFR 265.92](#)). For these analytes, the %RSD of the quadruplicate results was determined as described in Section F-4.2 and compared to a precision limit of 20%. Field quadruplicate sample results are evaluated only if at least one result is at least five times the laboratory MDL.

For TOC, 209 quadruplicate sample sets were taken. Of these 209 sample sets, 22 sets (10.5%) met the evaluation criterion and of these, only one set exceeded the precision criterion of 20% with a %RSD of 27.2%. This represents reasonable reproducibility for TOC samples. Table F-13 presents the quadruplicate sample sets that exceeded QC limits. One possible explanation for these failures may be inconsistent removal of inorganic carbon (typically present as bicarbonate or carbonate) from the sample prior to the determination of organic carbon in the sample. If inorganic carbon is not consistently and completely removed from the sample before determining organic carbon, the apparent concentration of organic carbon is likely to vary across a set of quadruplicate samples.

For TOX, 200 quadruplicate sample sets were taken. Of these 200 sample sets, 21 sets (10.5%) met the evaluation criterion and of these, six (28.6%) exceeded the 20% RSD criterion. One possible explanation for these failures may be inconsistent rinsing of inorganic chloride from the sample prior to the

determination of organic halides in the sample. If inorganic chloride is not consistently and completely removed from the sample before determining organic halides, the apparent concentration of organic halides is likely to vary across a set of quadruplicate samples.

**Table F-13. Total Organic Carbon and Total Organic Halide Quadruplicate Results Exceeding Quality Control Limits.**

Well Name	Lab	RL µg/L	Result 1 µg/L		Result 2 µg/L		Result 3 µg/L		Result 4 µg/L		%RSD*
<b>Total Organic Carbon: Total Out = 1</b>											
299-E17-14	WSCF	100	542	—	400	—	299	B	335	—	27.2
<b>Total Organic Halides: Total Out = 6</b>											
299-E17-19	TASL	1.8	2.6	B	2.7	B	12.6	—	4.3	B	85.8
299-E25-19	TASL	1.8	9.5	—	5.0	—	7.2	—	6.0	—	28.0
299-E25-47	TASL	1.8	9.8	—	8.8	—	9.6	—	5.2	—	25.7
299-E27-17	TASL	1.8	6.5	—	9.4	—	4.4	B	4.9	B	35.8
299-E32-5	TASL	1.8	5.8	—	9.5	—	6.4	—	5.5	—	27.0
299-E32-7	TASL	1.8	5.0	—	1.8	UN	16.9	—	14.4	—	76.3

\*The percent RSD was compared to the field duplicate relative percent difference limit of 20%.

Laboratory qualifier flags:

B = analyte detected between the reporting limit and the estimated quantitation limit (WSCF)

U = analyte not detected above the reporting limit

X = greater than 10% breakthrough detected between first and second adsorption columns (WSCF TOX)

RL = reporting limit

%RSD = percent relative standard deviation

TOX = total organic halide

WSCF = Waste Sampling and Characterization Facility

## F8.4 Field Split Samples

Field split samples are duplicate samples that are sent to two different laboratories to allow interlaboratory comparisons of analytical results. These interlaboratory comparisons are used to evaluate the performance of the laboratories, to determine the extent of any analytical problems, and to confirm out-of-trend results. According to Table F-1, the precision acceptance criterion for field splits is an RPD less than or equal to 20%. Only those field split results pairs with at least one result greater than five times the MDLs or MDAs of both laboratories were evaluated. If the laboratory reported an estimated quantitation limit instead of an MDL, the evaluation criterion was one times the estimated quantitation limit instead of five times the MDL. For TOC and TOX split samples, a matching set of quadruplicate samples was submitted to each of the two laboratories. To evaluate the interlaboratory reproducibility for TOC and TOX, an average result was first calculated for each laboratory's quadruplicate sample set, and then the average values from the two laboratories were used to calculate the RPD.

For CY2014, 67 field split sample sets consisting of 242 sample pairs yielded 2,961 pairs of field split data. Of the 2,961 data pairs, 813 pairs (27.5%) met the evaluation criterion. For the evaluated field splits, 738 pairs (90.8%) met the 20% RPD criterion. For comparison, the percentage of pairs within the limit was 86.8% for CY2013 and 86.4% for CY2012. Table F-14 summarizes the results for field splits that exceeded the 20% RPD limit.

**Table F-14. Field Splits Exceeding Quality Control Limits**

Constituent	Total Number of Splits	Number of Splits Evaluated <sup>a</sup>	Number Out of Limits	Percent Out of Limits	Range of Out-of-Limit Relative Percent Difference <sup>b</sup>
<b>Total Field Split Results Out = 75</b>					
<b>General Chemical Parameters: Total Out = 2</b>					
Oil and grease	1	1	1	100	157
Total petroleum hydrocarbons - diesel range	4	1	1	100	60
<b>Ammonia and Anions: Total Out = 13</b>					
Chloride	41	41	3	7.3	27.4 - 58.7
Fluoride	41	21	6	28.6	20.4 - 86
Nitrate	41	40	2	5	20.8 - 57.5
Sulfate	41	41	2	4.9	34.9 - 74.6
<b>Metals: Total Out = 47</b>					
Aluminum	21	2	2	100	73.1 - 131.7
Barium	89	83	3	3.6	21.6 - 33.2
Boron	21	3	2	66.7	158.8 - 169.7
Calcium	81	81	1	1.2	23.4
Chromium	89	28	1	3.6	35.8

Table F-14. Field Splits Exceeding Quality Control Limits

Constituent	Total Number of Splits	Number of Splits Evaluated <sup>a</sup>	Number Out of Limits	Percent Out of Limits	Range of Out-of-Limit Relative Percent Difference <sup>b</sup>
Cobalt	89	1	1	100	172.3
Copper	89	4	1	25	44.1
Hexavalent chromium	32	11	5	45.5	20.7 - 195.6
Iron	81	10	5	50	65 - 180.1
Lead	21	1	1	100	70
Magnesium	81	81	1	1.2	61.8
Manganese	89	10	2	20	83.8 - 164.7
Molybdenum	21	2	2	100	22.5 - 35.1
Nickel	89	11	6	54.5	27.5 - 175.8
Potassium	81	67	1	1.5	99
Sodium	81	81	1	1.2	35
Strontium	73	73	2	2.7	20.4 - 23.9
Tin	21	1	1	100	139.4
Uranium	46	40	8	20	20.1 - 36.8
Zinc	89	1	1	100	170.8
<b><i>Volatile Organic Compounds: Total Out = 2</i></b>					
Trichloroethene	13	3	2	66.7	29.3 - 33.1
<b><i>Semivolatile Organic Compounds: Total Out = 0</i></b>					
<b><i>Radiochemical Parameters: Total Out = 11</i></b>					
Gross beta	19	8	4	50	22 - 41.2
Strontium-90	27	10	3	30	25 - 28.7
Tritium	32	18	3	16.7	143 - 184.6
Uranium-238	1	1	1	100	27.1

a. Splits sample results were evaluated when at least one result was greater than five times the method detection limit or minimum detectable activity of both laboratories. In cases where a non-detected result was compared with a measured value, the method detection limit or minimum detectable activity was used as the non-detected result.

b. Split control limit is a relative percent difference less than or equal to 20%.

The metals analyses constituted 60% of the total split failures. The majority of these failures occurred on unfiltered samples; hence, the variability of suspended solids in the samples is a likely cause of discrepancies in the results for non-filtered samples. Other possible causes for the discrepancies are samples swapped either in the field or in the laboratory and possible dilution errors at the time of analysis.

After the metals analyses, the ammonia/anions and radiochemical results each accounted for 32% of the split sample failures. For ammonia and anions, split failures were for chloride (3), fluoride (6), nitrate and sulfate with two each.

For the radiochemical parameters, the majority of the splits failures were posted for gross beta (four), strontium-90 and tritium (3 each), and uranium-238 with one failure. The four gross beta failures were between TARL and WSCF and did not show any consistent bias between the two laboratories.

For the two remaining analyte classes, VOCs had two split pair failures, or 2.7% of the total failures. The four failures were for trichloroethene and were between TASL and WSCF; no consistent bias was detected between the two laboratories. No split pair results passed the evaluation criterion for the semivolatile organic compounds. General chemical parameters also had two split pair failures, or 2.7% of the total failures. The two failures were for oil and grease and TPH-diesel range.

## F9 Laboratory Quality Control

This section discusses the CY2014 groundwater monitoring laboratory batch QC data that exceeded the QC acceptance criteria listed in Table F-1. The types of laboratory QC samples that are evaluated in this section are discussed in Section F-4.3. Table F-15 summarizes the laboratory QC data by laboratory, and Table F-16 summarizes the laboratory QC data by analyte class. Overall, the laboratory QC data indicate that laboratory analytical measurements for the groundwater monitoring program are produced within the QC limits of Table F-1. Of the 111,731 laboratory batch QC measurements reported with groundwater monitoring results, 98.1% of the measurements met the groundwater monitoring QC requirements; this is comparable to the 98.5% reported for CY2013. When the laboratories detect failures in batch QC samples, the laboratories usually apply a QC laboratory qualifier to the data as noted in Table F-3.

**Table F-15. Laboratory Quality Control Results by Laboratory**

QC Parameter	GEL	TARL	TASL	WSCF	Total
Total Laboratory QC Results	42,023	4,409	41,404	23,895	111,731
Laboratory QC Results Out	610	129	975	379	2,093
Laboratory QC Results Out Percent	1.5%	2.9%	2.4%	1.6%	1.9%
Method Blanks Total	10,470	1,503	8,500	6,654	27,127
Method Blanks Out	163	36	514	45	758
Method Blanks Out Percent	1.6%	2.4%	6.0%	0.7%	2.8%
Lab Control Samples Total	9,048	1,313	10,077	4,503	24,941
Lab Control Samples Out Low	10	3	1	8	22
Lab Control Samples Out High	13	3	113	17	146
Lab Control Samples Out Percent	0.3%	0.5%	1.1%	0.6%	0.7%

**Table F-15. Laboratory Quality Control Results by Laboratory**

<b>QC Parameter</b>	<b>GEL</b>	<b>TARL</b>	<b>TASL</b>	<b>WSCF</b>	<b>Total</b>
Lab Control Sample Duplicates Total	117	0	2,017	1	2,135
Lab Control Sample Duplicates Out	5	0	22	0	27
Lab Control Sample Duplicates Out Percent	4.3%	-	1.1%	0.0%	1.3%
Matrix Spikes Total	12,782	801	11,079	6,077	30,739
Matrix Spikes Out Low	204	7	130	100	441
Matrix Spikes Out High	148	6	123	56	333
Matrix Spikes Out Percent	2.8%	1.6%	2.3%	2.6%	2.5%
Matrix Spike Duplicates Total	5,706	206	5,053	2,938	13,903
Matrix Spike Duplicates Out	43	0	29	83	155
Matrix Spike Duplicates Out Percent	0.8%	0.0%	0.6%	2.8%	1.1%
Sample Duplicates Total	892	586	563	189	2,230
Sample Duplicates Out	19	74	4	6	103
Sample Duplicates Out Percent	2.1%	12.6%	0.7%	3.2%	4.6%
Surrogates Total	3,008	0	4,115	3,194	10,317
Surrogates Out Low	4	0	13	20	37
Surrogates Out High	1	0	26	39	66
Surrogates Out Percent	0.2%	-	0.9%	1.8%	1.0%
Surrogate Duplicates Total	0	0	0	339	339
Surrogate Duplicates Out	0	0	0	5	5
Surrogate Duplicates Out Percent	-	-	-	1.5%	1.5%

GEL = GEL Laboratory

QC = quality control

TARL = TestAmerica Richland Laboratory

TASL = TestAmerica St. Louis

WSCF = Waste Sampling and Characterization Facility

Table F-16. Laboratory Quality Control Results by Analyte Class

Quality Control Parameter	General Chemical Parameters	Ammonia / Anions	Metals	Volatile Organic Compounds	Semivolatile Organic Compounds	Radiochemical Parameters	Total
Total Laboratory QC Results	3,273	9,822	50,901	30,423	13,098	4,214	111,731
Laboratory QC Results Out	174	450	700	399	313	57	2,093
Laboratory QC Results Out Percent	5.3%	4.6%	1.4%	1.3%	2.4%	1.4%	1.9%
Method Blanks Total	889	2,563	11,682	6,179	3,729	2,085	27,127
Method Blanks Out	123	84	533	7	0	11	758
Method Blanks Out Percent	13.8%	3.3%	4.6%	0.1%	0.0%	0.5%	2.8%
Lab Control Samples Total	742	2,589	11,846	6,731	1,703	1,330	24,941
Lab Control Samples Out Low	9	0	1	3	4	5	22
Lab Control Samples Out High	2	5	9	23	101	6	146
Lab Control Samples Out Percent	1.5%	0.2%	0.1%	0.4%	6.2%	0.8%	0.7%
Lab Control Sample Duplicates Total	14	-	70	1,975	76	-	2,135
Lab Control Sample Duplicates Out	-	-	-	22	5	-	27
Lab Control Sample Duplicates Out Percent	0.0%	-	0.0%	1.1%	6.6%	-	1.3%
Matrix Spikes Total	789	3,002	18,063	5,896	2,640	349	30,739
Matrix Spikes Out Low	24	124	76	198	18	1	441

Table F-16. Laboratory Quality Control Results by Analyte Class

Quality Control Parameter	General Chemical Parameters	Ammonia / Anions	Metals	Volatile Organic Compounds	Semivolatile Organic Compounds	Radiochemical Parameters	Total
Matrix Spikes Out High	3	192	41	36	58	3	333
Matrix Spikes Out Percent	3.4%	10.5%	0.6%	4.0%	2.9%	1.1%	2.5%
Matrix Spike Duplicates Total	190	514	8,865	2,948	1,320	66	13,903
Matrix Spike Duplicates Out	6	0	15	57	76	1	155
Matrix Spike Duplicates Out Percent	3.2%	0.0%	0.2%	1.9%	5.8%	1.5%	1.1%
Sample Duplicates Total	316	1,154	375	1	-	384	2,230
Sample Duplicates Out	3	45	25	-	-	30	103
Sample Duplicates Out Percent	0.9%	3.9%	6.7%	0.0%	-	7.8%	4.6%
Surrogates Total	324	0	0	6,575	3,418	0	10,317
Surrogates Out Low	4	0	0	0	33	0	37
Surrogates Out High	0	0	0	48	18	0	66
Surrogates Out Percent	1.2%	-	-	0.7%	1.5%	-	1.0%
Surrogate Duplicates Total	9	0	0	118	212	0	339
Surrogate Duplicates Out	0	0	0	5	0	0	5
Surrogate Duplicates Out Percent	0.0%	-	-	4.2%	0.0%	-	1.5%

F-47

DOE/RL-2015-07, REV 0

## F9.1 Laboratory Method Blanks

Laboratory MBs are used to assess potential contamination associated with laboratory sample preparation and analysis. Of the 27,127 laboratory MB results evaluated for CY2014, 97.2% met the QC criteria outlined in Table F-1 indicating little problem with laboratory contamination. This is poorer than the 98.1% reported for CY 2013 and the 98.5% reported for CY2012.

Evaluation of MB results was based on the MB QC limits listed in Table F-1. For the common laboratory contaminants 2-butanone, acetone, methylene chloride, phthalate esters, and toluene, the QC limit is five times the MDL. The laboratories flag results associated with out-of-limit blank results in the laboratory qualifier field in the HEIS database as described in Table F-3. For inorganic analytes (including the indicator analytes TOC and TOX), results associated with an out-of-limit MB are flagged with a C. For organic analytes, results associated with an out-of-limit MB are flagged with a B. The laboratory may not flag the groundwater sample result if the analyte concentration in the MB is less than 5% of the concentration of the analyte in a groundwater sample analyzed in the same batch. Table F-17 summarizes the CY2014 out-of-limit MB results.

In CY2014, by laboratory, TASL had the lowest success rate of 93.0% for the 7,360 MB results reported by that laboratory. TASL reported 115 general chemical parameter MB failures. For the anions, TASL reported 56 MB failures. For the metals, TASL reported 338 out-of-limit MBs. TASL reported five VOC MB failures. No SVOC failures were reported by any laboratory.

The TARK laboratory's success rate for MBs was 97.6%. Most of the MB failures were for the anions.

The remaining laboratories reported MB success rates greater than 98%.

By analyte category, general chemical parameters had the lowest MB success rate at 86.2% with 123 MB failures. Metals had the next lowest success rate at 95.4% with 533 failed MBs. Anions had the next lowest success rate at 96.7% with 84 failed MBs. The remaining analyte classes had MB success rates greater than 99%.

**Table F-17. Method Blank Out-of-Limit Results**

Constituent	Laboratory	Number of Results	Number Out of Limits	Percent Out of Limits	Range of QC Limits <sup>a</sup>	Range of Out-of-Limit Results
<i>Total Method Blanks Out = 758</i>						
<i>General Chemical Parameters: Total Out = 123</i>						
Alkalinity	TASL	56	55	98.2	140 – 270 ug/L	250 – 3750 ug/L
Bi-carbonate alkalinity	TASL	55	54	98.2	140 - 270 ug/L	250 - 3750 ug/L
Dissolved organic carbon	TASL	6	2	33.3	470 ug/L	605 - 723 ug/L
Total dissolved solids	TASL	5	1	20	3500 ug/L	6000 ug/L
Total dissolved solids	WSCF	6	1	16.7	10000 ug/L	21000 ug/L
Total organic carbon	GEL	55	2	3.6	330 ug/L	354 - 415 ug/L
Total organic carbon	TASL	28	3	10.7	270 - 350 ug/L	313 - 495 ug/L
Total organic carbon	WSCF	33	1	3	45 ug/L	47.9 ug/L
Total organic halides	GEL	55	2	3.6	3.33 ug/L	3.46 - 5.18 ug/L
Total petroleum hydrocarbons - diesel range	GEL	21	2	9.5	50 - 200 ug/L	75.7 - 89 ug/L
<i>Ammonia and Anions: Total Out = 84</i>						
Ammonium ion	GEL	21	6	28.6	18.0 ug/L	21.3 - 43.2 ug/L
Ammonium ion	TASL	11	2	18.2	10.7 ug/L	125 - 35.0 ug/L
Chloride	GEL	159	1	0.6	67 ug/L	75.6 ug/L
Chloride	TARL	31	5	16.1	50 - 200 ug/L	140 - 250 ug/L
Chloride	TASL	140	41	29.3	20 ug/L	20.9 - 151 ug/L
Cyanide	TASL	26	4	15.4	1.5 - 2.9 ug/L	2.25 - 29.99 ug/L
Fluoride	TARL	31	2	6.5	12.5 - 50 ug/L	26 - 51 ug/L
Fluoride	TASL	122	1	0.8	10 ug/L	23.7 ug/L

**Table F-17. Method Blank Out-of-Limit Results**

Constituent	Laboratory	Number of Results	Number Out of Limits	Percent Out of Limits	Range of QC Limits <sup>a</sup>	Range of Out-of-Limit Results
Nitrate	TARL	31	6	19.4	31.253208 - 110.67 ug/L	66.402 - 163.7916 ug/L
Phosphate	TASL	37	5	13.5	78 ug/L	174 - 286 ug/L
Sulfate	TARL	32	8	25	62.5 - 250 ug/L	129 - 457 ug/L
Sulfate	TASL	139	1	0.7	50 ug/L	52.8 ug/L
Sulfide	TASL	10	2	20	83 - 2000 ug/L	100 ug/L
<b>Metals: Total Out = 533</b>						
Aluminum	TASL	85	10	11.8	12.9 ug/L	12.97 - 23.63 ug/L
Antimony	GEL	234	23	9.8	1 - 3.5 ug/L	1.05 - 8.86 ug/L
Antimony	TASL	196	8	4.1	1.7 - 4 ug/L	1.72 - 3.25 ug/L
Arsenic	GEL	239	14	5.9	1.7 - 5 ug/L	1.76 - 9.68 ug/L
Arsenic	TASL	200	9	4.5	1.2 - 2 ug/L	1.9 - 4.1 ug/L
Barium	GEL	232	3	1.3	0.6 - 1 ug/L	1.18 - 2.62 ug/L
Barium	TASL	195	14	7.2	0.22 - 4 ug/L	0.248 - 4.49 ug/L
Barium	WSCF	99	1	1	0.2 - 4 ug/L	0.209 ug/L
Beryllium	GEL	165	1	0.6	0.2 - 1 ug/L	1.09 ug/L
Beryllium	TASL	142	1	0.7	0.28 - 0.61 ug/L	0.3 ug/L
Boron	GEL	98	1	1	4 ug/L	4.44 ug/L
Boron	TASL	91	12	13.2	7.2 - 10 ug/L	7.4 - 27.6 ug/L
Cadmium	GEL	231	1	0.4	0.11 - 1 ug/L	2.45 ug/L
Cadmium	TASL	195	5	2.6	0.1 - 0.91 ug/L	0.116 - 0.4 ug/L
Calcium	TASL	166	53	31.9	54.2 - 106 ug/L	54.3 - 478 ug/L

**Table F-17. Method Blank Out-of-Limit Results**

Constituent	Laboratory	Number of Results	Number Out of Limits	Percent Out of Limits	Range of QC Limits <sup>a</sup>	Range of Out-of-Limit Results
Calcium	WSCF	61	2	3.3	50 ug/L	82.9 - 179 ug/L
Chromium	GEL	234	3	1.3	1 - 2 ug/L	2.05 - 2.77 ug/L
Chromium	TASL	213	4	1.9	1 - 3.4 ug/L	1.27 - 1.66 ug/L
Chromium	WSCF	99	2	2	0.1 - 5 ug/L	0.123 - 0.371 ug/L
Cobalt	GEL	232	2	0.9	0.1 - 1 ug/L	0.136 - 1.15 ug/L
Cobalt	TASL	196	1	0.5	0.22 - 4.9 ug/L	0.388 ug/L
Copper	GEL	232	4	1.7	0.35 - 3 ug/L	0.351 - 5.61 ug/L
Copper	TASL	196	22	11.2	0.45 - 4.6 ug/L	0.464 - 256.9 ug/L
Hexavalent chromium	GEL	18	1	5.6	3 ug/L	3.47 ug/L
Hexavalent chromium	TARL	341	4	1.2	1.5 - 8 ug/L	1.6 - 2.1 ug/L
Iron	GEL	162	6	3.7	30 ug/L	31.2 - 62 ug/L
Iron	TASL	144	14	9.7	12.8 - 28.2 ug/L	13.7 - 34.7 ug/L
Iron	WSCF	61	1	1.6	40 ug/L	44.5 ug/L
Lead	TASL	103	9	8.7	0.17 - 0.6 ug/L	0.182 - 1.1 ug/L
Lead	WSCF	47	1	2.1	0.05 - 25 ug/L	0.138 ug/L
Manganese	GEL	231	1	0.4	1 - 2 ug/L	2.66 ug/L
Manganese	TASL	195	33	16.9	0.25 - 3.3 ug/L	0.258 - 1.4 ug/L
Mercury	TASL	16	2	12.5	0.06 ug/L	0.0886 - 0.124 ug/L
Molybdenum	GEL	120	2	1.7	0.165 - 2 ug/L	0.189 - 0.204 ug/L
Nickel	TASL	196	4	2	0.4 - 13.3 ug/L	0.459 - 3.53 ug/L
Potassium	GEL	165	22	13.3	50 ug/L	51.3 - 104 ug/L

**Table F-17. Method Blank Out-of-Limit Results**

Constituent	Laboratory	Number of Results	Number Out of Limits	Percent Out of Limits	Range of QC Limits <sup>a</sup>	Range of Out-of-Limit Results
Potassium	WSCF	61	11	18	250 ug/L	252 - 646 ug/L
Selenium	TASL	85	6	7.1	1.6 ug/L	1.7 - 3.11 ug/L
Silver	GEL	232	2	0.9	0.2 - 1 ug/L	1.41 - 3.41 ug/L
Silver	TASL	194	4	2.1	0.77 - 6 ug/L	1 - 1.2 ug/L
Sodium	GEL	164	7	4.3	100 ug/L	101 - 331 ug/L
Sodium	TASL	163	4	2.5	105 - 324 ug/L	148.4 - 2300 ug/L
Sodium	WSCF	61	17	27.9	100 ug/L	102 - 338 ug/L
Strontium	GEL	176	1	0.6	1 - 2 ug/L	1.67 ug/L
Strontium	TASL	152	42	27.6	0.06 - 0.54 ug/L	0.07 - 0.9 ug/L
Thorium	GEL	100	6	6	0.383 ug/L	0.437 - 1.38 ug/L
Tin	GEL	100	4	4	1 ug/L	1.15 - 6.07 ug/L
Tin	TASL	84	21	25	1 - 1.1 ug/L	1.11 - 3.81 ug/L
Uranium	GEL	135	6	4.4	0.067 - 1.16 ug/L	0.068 - 0.396 ug/L
Uranium	TARL	52	3	5.8	0.00832 - 0.0835 ug/L	0.177 - 3.82 ug/L
Uranium	TASL	86	1	1.2	0.23 ug/L	0.364 ug/L
Vanadium	GEL	162	2	1.2	1 ug/L	1.04 - 1.1 ug/L
Vanadium	TASL	135	2	1.5	2.4 - 4.4 ug/L	4.5 - 5.2 ug/L
Zinc	GEL	231	34	14.7	3.3 - 3.5 ug/L	3.39 - 8.62 ug/L
Zinc	TASL	198	57	28.8	5.2 - 8.3 ug/L	6.1 - 70.22 ug/L
Zinc	WSCF	99	7	7.1	2 - 5 ug/L	2.8 - 10.5 ug/L
<i>Volatile Organic Compounds: Total Out = 7</i>						

**Table F-17. Method Blank Out-of-Limit Results**

Constituent	Laboratory	Number of Results	Number Out of Limits	Percent Out of Limits	Range of QC Limits <sup>a</sup>	Range of Out-of-Limit Results
1,1-Dichloroethene	TASL	60	1	1.7	0.08 ug/L	0.0848 ug/L
Acetone <sup>b</sup>	TASL	60	2	3.3	1.7 ug/L	1.88 - 2.13 ug/L
Methacrylonitrile	TASL	17	1	5.9	0.5 ug/L	0.686 ug/L
Tetrahydrofuran	GEL	44	1	2.3	1.5 - 50 ug/L	1.72 ug/L
Trichloroethene	GEL	78	1	1.3	0.3 - 5 ug/L	0.65 ug/L
Trichloromonofluoromethane	TASL	17	1	5.9	0.11 ug/L	0.243 ug/L
<i>Semivolatile Organic Compounds: Total Out = 0</i>						
<i>Radiochemical Parameters: Total Out = 11</i>						
Gross beta	TARL	67	2	3	3.22 - 4.2 pCi/L	4.09 - 8.35 pCi/L
Strontium-90	GEL	35	2	5.7	1.068 - 8.06 pCi/L	1.54 - 2.78 pCi/L
Strontium-90	TARL	83	5	6	0.616 - 2.12 pCi/L	0.861 - 3.95 pCi/L
Uranium-233/234	WSCF	13	1	7.7	0.076 - 42 pCi/L	0.082 pCi/L
Uranium-238	TARL	9	1	11.1	0.0772 - 0.772 pCi/L	0.622 pCi/L

a. For general chemical parameters, ammonia and anions, metals, and volatile organic compounds, the quality control limit for method blanks is the method detection limit. For semivolatile organic compounds, the quality control limit is twice the method detection limit. For radiochemical constituents, the quality control limit is twice the minimum detectable activity.

b. The quality control limit for this analyte is five times the method detection limit.

GEL = GEL Laboratory

QC = quality control

TARL = TestAmerica Richland Laboratory

TASL = TestAmerica St. Louis

WSCF = Waste Sampling and Characterization Facility

## F9.2 Laboratory Control Samples and Laboratory Control Sample Duplicates

LCS recoveries give a measure of the accuracy of an analytical result, and the LCS duplicate RPD gives a measure of the repeatability of the analytical result. Laboratories may apply a laboratory qualifier of O or X and an accompanying explanatory note when LCS recoveries or LCSD RPDs are outside QC limits. LCS results were available across all the analyte categories while LCSD results were available primarily for VOCs and SVOCs.

Overall, 99.3% of the percent recoveries for the 24,941 reported LCSs and 99.6% of the RPDs for the 3,711 reported LCSDs met the QC criteria cited in Table F-1. This is comparable to the acceptance rates of 99.4% for LCS percent recoveries and 99.1% of the RPDs for the LCSD RPDs during CY2013 and the acceptance rates of 99.2% for LCS percent recoveries and 99.3% for LCSD RPDs during CY2012. These success rates for percent recoveries and RPDs provide assurance that the analytical measurement processes are in good control and are producing results with sufficient accuracy and precision to meet the needs of the groundwater monitoring program. Table F-18 summarizes the CY2014 out-of-limits LCS and LCSD results.

**Table F-18. Laboratory Control Sample Out-of-Limit Results**

Constituent	Laboratory	Number of LCS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of LCSD	Percent RPD Out of Limit
<b>General Chemical Parameters: Recovery Limits = 80% - 120%, RPD Limit = 20%<sup>b</sup></b>						
Chemical oxygen demand	TASL	4	0	25	0	0
Total petroleum hydrocarbons - diesel range	GEL	20	15	0	0	0
Total petroleum hydrocarbons - diesel range	TASL	18	0	5.6	1	0
Total petroleum hydrocarbons - kerosene range	GEL	8	75	0	4	0
<b>Ammonia and Anions: Recovery Limits = 80% - 120%, RPD Limit = 20%<sup>b</sup></b>						
Ammonium ion	TASL	11	0	18.2	0	0
Nitrite	TASL	123	0	0.8	0	0
Phosphate	GEL	62	0	3.2	0	0
<b>Metals: Recovery Limits = 80% - 120%, RPD Limit = 20%<sup>b</sup></b>						
Calcium	TASL	166	0	2.4	0	0
Hexavalent chromium	TARL	355	0	0.3	0	0
Potassium	TASL	163	0	0.6	0	0
Silver	WSCF	99	1	1	0	0
Sodium	TASL	163	0	0.6	0	0

Table F-18. Laboratory Control Sample Out-of-Limit Results

Constituent	Laboratory	Number of LCS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of LCSD	Percent RPD Out of Limit
Zinc	WSCF	99	0	1	0	0
<i>Volatile Organic Compounds: Recovery and RPD Limits = Laboratory Specific (Statistically Derived)</i>						
1,1,1-Trichloroethane	TASL	119	0	6.7	59	0
1,1,2,2-Tetrachloroethane	WSCF	21	4.8	0	0	0
1,1-Dichloroethene	TASL	119	0	0.8	59	0
1,2-Dibromo-3-chloropropane	TASL	33	0	0	16	6.2
1,2-Dichloropropane	WSCF	21	4.8	0	0	0
1-Butanol	TASL	93	0	0	46	8.7
2-Butanone	TASL	119	0	0	59	5.1
2-Hexanone	TASL	33	0	0	16	12.5
4-Methyl-2-pentanone	TASL	119	0	0	59	1.7
Acetone	GEL	67	0	3	0	0
Acetone	TASL	119	0	0	59	3.4
Acrolein	GEL	16	0	6.2	0	0
Carbon disulfide	TASL	119	0	2.5	59	0
Carbon disulfide	WSCF	39	2.6	2.6	0	0
Carbon tetrachloride	TASL	119	0	0.8	59	0
Chloroprene	GEL	16	0	18.8	0	0
Isobutyl alcohol	TASL	31	0	3.2	15	26.7
Methyl methacrylate	TASL	33	0	0	16	6.2
Methylene chloride	TASL	119	0	0	59	1.7
Tetrachloroethene	TASL	119	0	0.8	59	0
Tetrahydrofuran	TASL	93	0	0	46	4.3
trans-1,2-Dichloroethylene	TASL	93	0	0	46	2.2
Vinyl chloride	TASL	119	0	0.8	59	0
<i>Semivolatile Organic Compounds: Recovery and RPD Limits = Laboratory Specific (Statistically Derived)</i>						
2,4,5-Trichlorophenol	TASL	10	0	70	0	0
2,4,6-Trichlorophenol	TASL	10	0	70	0	0

Table F-18. Laboratory Control Sample Out-of-Limit Results

Constituent	Laboratory	Number of LCS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of LCSD	Percent RPD Out of Limit
2,4-Dichlorophenol	TASL	13	0	69.2	0	0
2,4-Dimethylphenol	WSCF	22	4.5	0	0	0
2,4-Dinitrophenol	TASL	10	0	10	0	0
2,4-Dinitrotoluene	TASL	7	0	14.3	0	0
2,6-Dinitrotoluene	TASL	6	0	16.7	0	0
2-Chlorophenol	TASL	10	0	20	0	0
2-Methylnaphthalene	TASL	6	0	16.7	0	0
2-Methylphenol (cresol, o-)	TASL	13	0	30.8	0	0
2-Methylphenol (cresol, o-)	WSCF	23	4.3	0	0	0
2-Nitroaniline	TASL	6	0	16.7	0	0
2-Nitrophenol	TASL	13	0	38.5	0	0
3,3'-Dichlorobenzidine	TASL	6	0	33.3	0	0
3+4 Methylphenol (cresol, m+p)	TASL	13	0	23.1	0	0
3-Nitroaniline	TASL	6	0	50	0	0
4,4'-DDD (Dichlorodiphenyldichloroethane)	TASL	11	0	18.2	2	0
4,4'-DDE (Dichlorodiphenyldichloroethylene)	TASL	11	0	9.1	2	0
4-Chloro-3-methylphenol	TASL	10	0	40	0	0
4-Chloroaniline	TASL	6	0	66.7	0	0
4-Chlorophenylphenyl ether	TASL	6	0	16.7	0	0
4-Nitroaniline	TASL	6	0	33.3	0	0
4-Nitrophenol	GEL	9	11.1	0	0	0
4-Nitrophenol	TASL	10	0	40	0	0
Benzo(a)pyrene	GEL	7	0	0	1	100
Benzo(ghi)perylene	GEL	7	0	0	1	100
Benzo(k)fluoranthene	GEL	7	0	0	1	100
Bis(2-ethylhexyl) phthalate	TASL	10	0	20	0	0
Bis(2-ethylhexyl) phthalate	WSCF	16	0	43.8	0	0

Table F-18. Laboratory Control Sample Out-of-Limit Results

Constituent	Laboratory	Number of LCS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of LCSD	Percent RPD Out of Limit
Butylbenzylphthalate	TASL	6	0	33.3	0	0
Chrysene	TASL	7	0	14.3	0	0
Delta-BHC	TASL	11	0	9.1	2	0
Dibenz[a,h]anthracene	GEL	7	0	0	1	100
Dibenz[a,h]anthracene	TASL	7	0	14.3	0	0
Diethylphthalate	TASL	6	0	33.3	0	0
Dimethyl phthalate	TASL	6	0	50	0	0
Di-n-butylphthalate	WSCF	10	0	20	0	0
Di-n-octylphthalate	TASL	6	0	16.7	0	0
Di-n-octylphthalate	WSCF	10	0	10	0	0
Endrin	GEL	5	0	40	1	0
Fluorene	TASL	7	0	14.3	0	0
Heptachlor	TASL	11	0	9.1	2	0
Indeno(1,2,3-cd)pyrene	GEL	7	0	0	1	100
Isophorone	TASL	6	0	16.7	0	0
Methoxychlor	GEL	5	0	60	1	0
Methoxychlor	TASL	11	0	9.1	2	0
Naphthalene	TASL	11	0	9.1	0	0
Phenol	TASL	13	7.7	15.4	0	0
Pyrene	TASL	7	0	14.3	0	0
<b>Radiochemical Parameters: Recovery Limits = 70% - 130%, RPD Limit = 20%<sup>b</sup></b>						
Cobalt-60	TARL	47	2.1	0	0	0
Gross alpha	WSCF	53	3.8	0	0	0
Iodine-129	TARL	62	1.6	0	0	0
Neptunium-237	TARL	5	0	20	0	0
Uranium-233/234	TARL	9	0	11.1	0	0
Uranium-235	TARL	3	33.3	0	0	0
Uranium-238	WSCF	13	0	30.8	0	0

**Table F-18. Laboratory Control Sample Out-of-Limit Results**

Constituent	Laboratory	Number of LCS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of LCSD	Percent RPD Out of Limit
-------------	------------	----------------------------	--------------------------	---------------------------	----------------	--------------------------

a. Includes both laboratory control samples and laboratory control sample duplicates.

b. Laboratory-specific limits were used if provided. Otherwise the stated limits were used to evaluate LCS/LCSDs.

LCS = laboratory control sample

LCSD = laboratory control sample duplicate

RPD = relative percent difference

GEL = GEL Laboratory

TARL = TestAmerica Richland Laboratory

TASL = TestAmerica St. Louis Laboratory

WSCF = Waste Sampling and Characterization Facility

In CY2014, for all four reporting laboratories, greater than 99% of their LCS recoveries met QC recovery criteria. For the LCSDs, WSCF and TARL met the RPD QC requirement for 100% of that laboratory's LCSD results. Of the 2,561 LCSD results TASL reported, 99.5% met RPD requirements; of the 243 LCSD results GEL reported, 98% met RPD requirements. These LCS and LCSD results indicate sufficient method control, analytical accuracy, and analytical repeatability to meet the data needs for the groundwater monitoring program.

### F9.3 Matrix Spikes and Matrix Spike Duplicates

Matrix spikes provide a measure of the accuracy of an analytical result and are used to determine if sample matrix effects may have affected analytical results. MSDs give a measure of the repeatability of the analytical result. Only those samples that were spiked at a level at least one-fourth of the sample concentration were evaluated. For MS recovery failures, the laboratories apply a laboratory qualifier of N for non-gas chromatography – mass spectrometry methods, and a laboratory qualifier of T for gas chromatography – mass spectrometry methods. MS and MSD results were available across all the analyte categories although the MSD RPD data for the radiochemical parameters are limited to gross alpha and gross beta analyses from GEL. In this discussion, the set of MS recoveries also includes recoveries for MSDs.

Of the 31,805 MS results reported for CY2014, 30,739 (96.6%) met the evaluation criterion. Of the 30,739 evaluated MS results, 97.5% met the percent recovery QC criteria cited in Table F-1. Of the 14,419 MS/MSD pairs reported, 13,903 (96.4%) met the evaluation criterion; of the 13,903 evaluated pairs, 98.9% met the RPD QC criteria of Table F-1. These success rates for percent recoveries and RPDs are similar to those for the LCS and LCSD QC and provide additional assurance that the laboratories are producing data with sufficient accuracy and precision to meet the needs of the groundwater monitoring program. By comparison, 97.8% of the percent recoveries and 99.1% of the RPDs met QC criteria in CY 2013, and 99.2% of the percent recoveries and 99.4% of the RPDs met QC criteria in CY2012. Table F-19 summarizes the CY2014 out-of-limits MS and MSD results.

Table F-19. Matrix Spike Out-of-Limit Results

Constituent	Laboratory	Number of MS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of MSD	Percent RPD Out of Limit
<b>General Chemistry Parameters: Recovery Limits = 75% - 125%, RPD Limit = 20%<sup>b</sup></b>						
Alkalinity	TASL	54	5.6	0	0	0
Bi-carbonate alkalinity	TASL	46	4.3	0	0	0
Chemical oxygen demand	TASL	3	0	66.7	0	0
Oil and grease	GEL	1	100	0	0	0
Total organic halides	GEL	51	2	0	0	0
Total organic halides	TASL	37	2.7	2.7	0	0
Total organic halides	WSCF	140	0.7	0	70	1.4
Total petroleum hydrocarbons - diesel range	GEL	40	35	0	20	15
Total petroleum hydrocarbons - diesel range	TASL	33	0	0	17	11.8
Total petroleum hydrocarbons - gasoline range	WSCF	4	25	0	2	0
<b>Ammonia and Anions: Recovery Limits = 75% - 125%, RPD Limit = 20%<sup>b</sup></b>						
Ammonium ion	GEL	21	9.5	19	0	0
Ammonium ion	TASL	11	0	90.9	0	0
Bromide	TASL	23	0	4.3	1	0
Chloride	GEL	173	0	23.7	0	0
Chloride	TASL	163	0.6	8.6	7	0
Chloride	WSCF	174	10.9	4	87	0
Cyanide	GEL	29	3.4	0	0	0
Fluoride	GEL	171	0.6	1.2	0	0
Fluoride	TASL	149	0	6.7	4	0
Fluoride	WSCF	206	1.5	0.5	103	0
Nitrate	GEL	171	0	17	0	0
Nitrate	TASL	155	1.3	3.9	7	0
Nitrate	WSCF	184	2.7	0.5	92	0
Nitrite	GEL	171	0.6	1.2	0	0
Nitrite	TARL	31	9.7	9.7	0	0
Nitrite	TASL	148	44.6	4.1	4	0
Nitrite	WSCF	206	0	1.5	103	0

Table F-19. Matrix Spike Out-of-Limit Results

Constituent	Laboratory	Number of MS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of MSD	Percent RPD Out of Limit
Phosphate	GEL	50	12	0	0	0
Phosphate	TARL	2	50	0	0	0
Phosphate	TASL	40	20	32.5	1	0
Sulfate	GEL	172	0	19.8	0	0
Sulfate	TASL	153	2	1.3	5	0
Sulfate	WSCF	97	2.1	1	48	0
Sulfide	TASL	10	0	20	0	0
<b>Metals: Recovery Limits = 75% - 125%, RPD Limit = 20%<sup>b</sup></b>						
Antimony	WSCF	124	1.6	0	62	1.6
Barium	WSCF	126	0.8	0	63	0
Beryllium	GEL	265	0	0.8	132	0
Beryllium	WSCF	88	0	0	44	2.3
Boron	GEL	185	0	1.1	92	0
Boron	TASL	160	0	1.2	80	0
Boron	WSCF	44	4.5	2.3	22	4.5
Calcium	GEL	57	5.3	7	28	0
Calcium	TASL	114	3.5	1.8	58	0
Calcium	WSCF	112	8.9	0	56	0
Copper	GEL	397	0.5	0	198	0
Hexavalent chromium	TARL	529	0.6	0	206	0
Hexavalent chromium	WSCF	118	5.1	1.7	0	0
Iron	GEL	325	0.3	0	162	0.6
Iron	WSCF	118	0	0.8	59	1.7
Lead	WSCF	56	1.8	0	28	0
Magnesium	GEL	284	0.4	0.7	141	0.7
Magnesium	TASL	308	2.3	0.3	155	0.6
Magnesium	WSCF	122	0.8	0	61	0
Molybdenum	WSCF	52	3.8	0	26	7.7
Potassium	GEL	328	0.3	0.6	163	0.6
Potassium	TASL	310	0	0.3	156	0.6
Selenium	TASL	149	1.3	0	75	0

Table F-19. Matrix Spike Out-of-Limit Results

Constituent	Laboratory	Number of MS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of MSD	Percent RPD Out of Limit
Silver	GEL	399	0.5	0	199	0
Sodium	GEL	199	0.5	0	99	1
Sodium	TASL	271	3	3.7	136	0.7
Sodium	WSCF	106	2.8	0	53	0
Strontium	GEL	186	1.6	3.8	91	0
Strontium	WSCF	90	1.1	0	45	0
Thallium	WSCF	42	2.4	0	21	0
Tin	WSCF	42	4.8	0	21	4.8
Uranium	GEL	222	0.5	0	93	0
Uranium	TARL	48	0	2.1	0	0
Uranium	WSCF	84	1.2	0	42	0
Zinc	GEL	394	1	0.3	196	0.5
<b><i>Volatile Organic Compounds: Recovery and RPD Limits = Laboratory Specific (Statistically Derived)</i></b>						
1,1,1-Trichloroethane	WSCF	72	2.8	2.8	36	5.6
1,1,2,2-Tetrachloroethane	WSCF	18	5.6	11.1	9	11.1
1,1,2-Trichloroethane	TASL	106	0.9	0	53	0
1,1,2-Trichloroethane	WSCF	72	1.4	2.8	36	8.3
1,1-Dichloroethane	WSCF	72	2.8	2.8	36	5.6
1,1-Dichloroethene	GEL	74	1.4	0	37	0
1,1-Dichloroethene	TASL	106	1.9	0.9	53	5.7
1,1-Dichloroethene	WSCF	72	6.9	2.8	36	8.3
1,2-Dichloroethane	WSCF	72	1.4	1.4	36	5.6
1,2-Dichloropropane	WSCF	18	5.6	0	9	11.1
1-Butanol	TASL	26	0	0	13	7.7
2-Butanone	GEL	74	67.6	0	37	0
2-Butanone	TASL	108	0	0	54	3.7
2-Hexanone	GEL	26	57.7	0	13	0
4-Methyl-2-pentanone	GEL	74	5.4	0	37	0
4-Methyl-2-pentanone	TASL	108	0	0	54	3.7
Acetone	GEL	74	100	0	37	0
Acetone	TASL	112	0	0	56	7.1

Table F-19. Matrix Spike Out-of-Limit Results

Constituent	Laboratory	Number of MS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of MSD	Percent RPD Out of Limit
Benzene	WSCF	72	1.4	1.4	36	5.6
Bromodichloromethane	WSCF	18	5.6	0	9	11.1
Bromoform	WSCF	18	5.6	5.6	9	22.2
Carbon disulfide	TASL	108	0	0.9	54	3.7
Carbon disulfide	WSCF	72	6.9	2.8	36	8.3
Carbon tetrachloride	GEL	74	12.2	0	37	0
Carbon tetrachloride	TASL	110	0	1.8	55	0
Chlorobenzene	WSCF	72	1.4	0	36	5.6
Chloroprene	GEL	26	0	15.4	13	0
cis-1,2-Dichloroethylene	WSCF	46	2.2	2.2	23	4.3
Dibromochloromethane	WSCF	18	5.6	5.6	9	22.2
Dichlorodifluoromethane	GEL	26	3.8	7.7	13	0
Ethanol	GEL	2	0	0	1	100
Ethanol	WSCF	2	0	50	1	0
Ethyl acetate	GEL	2	0	100	1	0
Ethylbenzene	WSCF	70	1.4	1.4	35	2.9
Isobutyl alcohol	GEL	26	7.7	0	13	0
Methane	TASL	2	0	50	1	0
Methanol	TASL	8	0	0	4	25
Methylene chloride	TASL	112	7.1	2.7	56	3.6
Styrene	WSCF	18	5.6	0	9	22.2
Tetrahydrofuran	TASL	26	0	0	13	7.7
Toluene	WSCF	72	1.4	0	36	5.6
trans-1,2-Dichloroethylene	WSCF	42	4.8	2.4	21	14.3
trans-1,3-Dichloropropene	WSCF	18	5.6	0	9	22.2
Trichloroethene	WSCF	78	1.3	0	39	2.6
<b><i>Semivolatile Organic Compounds: Recovery and RPD Limits = Laboratory Specific (Statistically Derived)</i></b>						
1,2,4-Trichlorobenzene	WSCF	18	0	0	9	11.1
1,4-Dichlorobenzene	TASL	12	0	8.3	6	0
1,4-Dichlorobenzene	WSCF	24	0	0	12	8.3
1,4-Dioxane	GEL	12	0	0	6	16.7

Table F-19. Matrix Spike Out-of-Limit Results

Constituent	Laboratory	Number of MS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of MSD	Percent RPD Out of Limit
1,4-Dioxane	WSCF	24	0	0	12	8.3
2,3,4,6-Tetrachlorophenol	GEL	10	0	0	5	20
2,4,5-Trichlorophenol	GEL	10	0	0	5	20
2,4,5-Trichlorophenol	TASL	16	0	6.2	8	0
2,4,6-Trichlorophenol	GEL	10	0	0	5	20
2,4,6-Trichlorophenol	TASL	16	0	12.5	8	0
2,4-Dichlorophenol	GEL	16	0	0	8	12.5
2,4-Dichlorophenol	TASL	20	0	5	10	0
2,4-Dichlorophenol	WSCF	40	0	0	20	5
2,4-Dimethylphenol	GEL	10	0	0	5	20
2,4-Dimethylphenol	TASL	16	0	6.2	8	0
2,4-Dimethylphenol	WSCF	34	0	0	17	5.9
2,4-Dinitrophenol	GEL	10	0	20	5	40
2,4-Dinitrotoluene	WSCF	18	0	0	9	11.1
2,6-Dichlorophenol	GEL	10	0	0	5	20
2-Chlorophenol	GEL	18	0	0	9	11.1
2-Chlorophenol	WSCF	34	0	0	17	5.9
2-Methylphenol (cresol, o-)	GEL	16	0	0	8	12.5
2-Methylphenol (cresol, o-)	WSCF	40	0	0	20	5
2-Nitroaniline	WSCF	18	0	0	9	11.1
2-Nitrophenol	GEL	16	0	0	8	12.5
2-Nitrophenol	TASL	20	0	5	10	0
2-Nitrophenol	WSCF	40	0	0	20	5
2-Picoline	WSCF	22	0	0	11	9.1
3,3'-Dichlorobenzidine	WSCF	18	0	0	9	11.1
3+4 Methylphenol (cresol, m+p)	GEL	14	0	0	7	14.3
4,4'-DDD (Dichlorodiphenyldichloroethane)	TASL	12	0	33.3	6	0
4,4'-DDE (Dichlorodiphenyldichloroethylene)	TASL	12	0	16.7	6	0
4,4'-DDT (Dichlorodiphenyltrichloroethane)	GEL	6	0	16.7	3	33.3

Table F-19. Matrix Spike Out-of-Limit Results

Constituent	Laboratory	Number of MS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of MSD	Percent RPD Out of Limit
4,4'-DDT (Dichlorodiphenyltrichloroethane)	TASL	12	0	8.3	6	0
4,6-Dinitro-2-methylphenol	GEL	8	0	0	4	25
4-Chloro-3-methylphenol	GEL	18	0	0	9	11.1
4-Chloro-3-methylphenol	WSCF	34	0	0	17	5.9
4-Chloroaniline	WSCF	18	0	0	9	11.1
4-Nitrophenol	GEL	18	11.1	0	9	11.1
4-Nitrophenol	WSCF	34	0	0	17	5.9
Acenaphthene	GEL	18	0	0	9	11.1
Acenaphthene	WSCF	18	0	0	9	11.1
Acenaphthylene	GEL	10	0	0	5	20
Alpha-BHC	TASL	12	0	25	6	0
Alpha-Chlordane	TASL	14	0	7.1	7	0
Anthracene	GEL	10	0	0	5	20
Anthracene	WSCF	18	0	0	9	11.1
Benzo(a)anthracene	GEL	10	0	0	5	20
Benzo(a)pyrene	GEL	10	0	0	5	20
Benzo(a)pyrene	TASL	12	16.7	0	6	16.7
Benzo(a)pyrene	WSCF	18	0	0	9	11.1
Benzo(b)fluoranthene	TASL	12	16.7	0	6	16.7
Benzo(ghi)perylene	GEL	10	0	0	5	20
Benzo(ghi)perylene	TASL	12	16.7	8.3	6	16.7
Benzo(k)fluoranthene	TASL	12	16.7	0	6	16.7
Benzyl alcohol	WSCF	18	0	0	9	11.1
Bis(2-chloro-1-methylethyl)ether	WSCF	18	0	0	9	11.1
Bis(2-Chloroethoxy)methane	TASL	8	0	12.5	4	0
Bis(2-ethylhexyl) phthalate	WSCF	24	0	66.7	12	8.3
Carbazole	WSCF	18	0	0	9	11.1
Chrysene	GEL	10	0	0	5	20
Delta-BHC	TASL	12	0	33.3	6	0
Dibenz[a,h]anthracene	GEL	10	0	0	5	20

Table F-19. Matrix Spike Out-of-Limit Results

Constituent	Laboratory	Number of MS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of MSD	Percent RPD Out of Limit
Dibenz[a,h]anthracene	TASL	12	16.7	16.7	6	16.7
Dibenzofuran	WSCF	18	0	0	9	11.1
Dimethoate	WSCF	18	11.1	0	9	11.1
Di-n-butylphthalate	WSCF	18	0	11.1	9	11.1
Di-n-octylphthalate	WSCF	18	0	5.6	9	11.1
Endosulfan II	GEL	6	0	16.7	3	0
Endrin	GEL	6	0	16.7	3	0
Endrin	TASL	12	0	8.3	6	0
Fluoranthene	GEL	10	0	0	5	20
Fluorene	GEL	10	0	0	5	20
Fluorene	WSCF	18	0	0	9	11.1
Hexachlorobenzene	WSCF	18	0	0	9	11.1
Hexachloroethane	WSCF	18	0	0	9	11.1
Hexachlorophene	WSCF	18	0	0	9	11.1
Indeno(1,2,3-cd)pyrene	GEL	10	0	0	5	20
Indeno(1,2,3-cd)pyrene	TASL	12	16.7	16.7	6	16.7
Methoxychlor	GEL	6	0	33.3	3	0
Naphthalene	GEL	16	0	0	8	12.5
Naphthalene	TASL	16	0	6.2	8	0
Naphthalene	WSCF	24	0	0	12	8.3
n-Nitrosodimethylamine	WSCF	18	0	0	9	11.1
n-Nitrosodi-n-dipropylamine	WSCF	18	0	0	9	11.1
Pentachlorophenol	GEL	26	0	0	13	7.7
Pentachlorophenol	TASL	18	0	11.1	9	0
Pentachlorophenol	WSCF	40	0	0	20	5
Phenanthrene	GEL	10	0	0	5	20
Phenol	GEL	26	0	0	13	15.4
Phenol	WSCF	40	0	0	20	5
Pyrene	WSCF	18	0	0	9	11.1
Tributyl phosphate	WSCF	22	9.1	0	11	9.1

**Table F-19. Matrix Spike Out-of-Limit Results**

Constituent	Laboratory	Number of MS <sup>a</sup>	Percent Out of Limit Low	Percent Out of Limit High	Number of MSD	Percent RPD Out of Limit
<i>Radiochemical Analytes: Recovery Limits = 60% - 140%, RPD Limit = 20%<sup>b</sup></i>						
Gross alpha	GEL	66	0	0	33	3
Gross beta	GEL	66	0	1.5	33	0
Technetium-99	TARL	66	0	3	0	0
Tritium	WSCF	34	2.9	0	0	0

a. Includes both matrix spike and matrix spike duplicates.

b. Laboratory-specific limits were used if provided. Otherwise the stated limits were used to evaluate MS/MSDs.+

GEL = GEL Laboratory

MS/MSD = matrix spike / matrix spike duplicate

RPD = relative percent difference

TARL = TestAmerica Richland

TASL = TestAmerica St. Louis

WSCF = Waste Sampling and Characterization Facility

### F9.3.1 Matrix Spikes by Laboratory

By laboratory, GEL reported an overall success rate for MS recoveries at 97.2%. Percentage-wise, 5.9% (16 results) of the GEL MS/MSD recoveries for general chemistry parameters were outside of QC limits, all being low recoveries; 12.3% (123 results) of the MS/MSD recoveries for anions were outside of QC parameters, almost all (112) being high recoveries; 0.5% (39 results) of the MS/MSD recoveries for metals were outside of QC parameters, nearly evenly split between high and low recoveries; 6.9% (164 results) of the MS/MSD recoveries for VOCs were outside of QC parameters, with nearly all (156) low recoveries; 0.9% (9 results) of the MS/MSD recoveries for SVOCs being outside of QC parameters, 7 high and 2 low recoveries; and 0.5% (1 result) of the MS/MSD recoveries for radionuclides were out of QC parameters with the single result being a high recovery. GEL had the highest number of analytes (20) that had MSD RPDs that exceeded the 20% RPD criterion. These ranged from 20 to 100%.

TARL reported an overall success rate for MS recoveries at 98.4%. Percentage-wise, 4.4% (7 results) of the TARL MS/MSD recoveries for anions were outside of QC limits with 4 high and 3 low recoveries; 0.7% (4 results) of the MS/MSD recoveries for metals were outside of QC parameters, 3 high recoveries and 1 low; and 3.0% (2 results) of the MS/MSD recoveries for radionuclides were outside of QC parameters, both high recoveries. No MS/MSD recovery results for general chemistry parameters, VOCs or SVOCs were recorded for TARL. No analytes had MSD RPDs that exceeded the 20% RPD criterion for TARL.

TASL reported an overall success rate for MS recoveries at 97.7%. Percentage-wise, 3.8% (9 results) of the TASL MS/MSD recoveries for general chemistry parameters were outside of QC limits, with 6 low and 3 high recoveries; 16.5% (164 results) of the MS/MSD recoveries for anions were outside of QC parameters, with 80 being low and 64 high recoveries; 0.6% (37 results) of the MS/MSD recoveries for metals were outside of QC parameters, nearly evenly split between high and low recoveries; 0.8%

(19 results) of the MS/MSD recoveries for VOCs were outside of QC parameters, with 11 low and 8 high recoveries; 4.5% (44 results) of the MS/MSD recoveries for SVOCs being outside of QC parameters, 32 high and 12 low recoveries; and none of the MS/MSD recoveries for radionuclides were out of QC parameters. One analyte also had an MSD RPD that exceeded the 20% RPD criterion: methanol.

WSCF reported an overall success rate for MS recoveries at 97.4%. Percentage-wise, 0.7% (2 results) of the TASL MS/MSD recoveries for general chemistry parameters were outside of QC limits, both with low recoveries; 4.3% (42 results) of the MS/MSD recoveries for anions were outside of QC parameters, with 29 being low and 13 high recoveries; 1.3% (37 results) of the MS/MSD recoveries for metals were outside of QC parameters, 33 being low and 4 being high recoveries; 5.0% (51 results) of the MS/MSD recoveries for VOCs were outside of QC parameters, with 31 low and 20 high recoveries; 2.6% (23 results) of the MS/MSD recoveries for SVOCs being outside of QC parameters, 19 high and 4 low recoveries; and one (low) of the MS/MSD recoveries for radionuclides were out of QC parameters. Four analytes also had MSD RPDs that exceeded the 20% RPD criterion: bromoform, dibromochloromethane, styrene, and trans-1,3-dichloropropene.

### F9.3.2 Matrix Spikes by Analyte Class

By analyte class, the highest MS out-of-limit recovery rates were: anions at 4.8%, VOCs at 3.2%, and SVOCs at 1.8%. The general chemical parameters had a 1.1% out-of-limit recovery rate; all but one TASL MS result for total organic halides are discussed previously in the WSCF MS section. Radiochemical parameters had an out-of-limit rate of only 0.4%. The rates of MSDs that exceeded RPD limits were: radiochemical parameters at 22.2% (this represents only two of nine total reported MSDs for radiochemical parameters), SVOCs at 2.1%, VOCs at 1.8%, and general chemical parameters at 1.5%. Ammonia/anions and metals had rates of out-of-limit MSD RPDs at less than 1%.

For the general chemical parameters, 2,686 MSs met the evaluation criteria with 124 MS recoveries less than the lower recovery limits and 192 results greater than the upper recovery limits. GEL, TASL, TARL, and WSCF reported all the anion MS results. The out-of-limit MS results were distributed over 10 analytes. For the anion MSDs, 514 MSD results were evaluated; of these, none exceeded the 20% RPD criterion. The MSD results were reported by TASL and WSCF.

For the anions, 762 MSs met the evaluation criteria with 24 MS recoveries less than the lower recovery limits and 3 results greater than the upper recovery limits. GEL, TASL, and WSCF reported all the general chemistry parameter MS results. The out-of-limit MS results were distributed over six analytes. For the general chemistry parameter MSDs, 190 MSD results were evaluated; of these, none exceeded the 20% RPD criterion. The MSD results were reported by GEL, TASL, and WSCF.

For the metals, 17,946 MSs met the evaluation criteria with 76 MS recoveries less than the lower recovery limits and 41 results greater than the upper recovery limits. GEL, TASL, TARL, and WSCF reported all the anion MS results. The out-of-limit MS results were distributed over 20 metals. For the metals MSDs, 8,865 MSD results were evaluated; of these, none exceeded the 20% RPD criterion. The MSD results were reported by GEL, TARL, TASL, and WSCF.

For the VOCs, 5,662 MSs met the evaluation criteria with 198 MS recoveries less than the lower recovery limits and 36 results greater than the upper recovery limits. GEL, TASL, and WSCF reported all the VOC MS results. The out-of-limit MS results were distributed over 36 polar and non-polar VOC analytes. For the VOC MSDs, 2,948 MSD results were evaluated; of these, 6 exceeded the 20% RPD criterion. The MSD failures were reported by GEL, TASL and WSCF and were distributed over five polar and non-polar compounds. The out-of-limit RPD values ranged from 22.2% to 100%.

For the SVOCs, 2,564 MSs met the evaluation criteria with 18 MS recoveries less than the lower recovery limits and 58 recoveries greater than the upper recovery limits. GEL, TASL, and WSCF reported all the SVOC MS results. The MS failures were distributed over 17 polar and non-polar SVOC analytes. For the SVOC MSDs, 1,320 MSD results were evaluated; of these, 76 exceeded the 20% RPD criterion. The MSD failures were reported by GEL, TASL, and WSCF and were distributed over 17 polar and non-polar compounds. The out-of-limit RPD values ranged from 20% to 40% (2,4-dinitrophenol).

For the radionuclides, 345 MSs met the evaluation criteria with one MS recovery less than the lower recovery limits and three recoveries greater than the upper recovery limits. GEL, TARL, TASL, and WSCF reported all the radionuclide MS results. For the radionuclide MSDs, 66 MSD results were evaluated; of these none exceeded the 20% RPD criterion.

## F9.4 Laboratory Sample Duplicates

Laboratory sample duplicates give a measure of the repeatability of an analytical result. Only those sample results with values five times greater than the MDL or the MDA, or one times the estimated quantitation limit were evaluated. The RPDs for sample duplicates that met the evaluation criteria were compared to either the laboratory-specific statistically derived RPD maximum or to a maximum of 20% if no laboratory-specific RPD was available. When laboratory sample duplicate RPDs are outside QC limits, laboratories may apply a laboratory qualifier of X and an accompanying explanatory note.

Of the 5,235 reported laboratory sample duplicates, 2,230 (42.6%) met the evaluation criterion; of these, 103 RPDs exceeded the precision criteria for an overall acceptance rate of 95.4%. Table F-20 summarizes the out-of-limit results for laboratory sample duplicates.

**Table F-20. Laboratory Sample Duplicate Out-of-Limit Results**

Constituent	Laboratory	Number of Laboratory Duplicates	Number Laboratory Duplicates Evaluated*	Percent RPD Out of Limit	Range of RPD Out
<i>General Chemical Parameters: RPD Limit = 20%</i>					
Alkalinity	GEL	87	80	1.2	67.4
Total organic halides	TASL	22	7	28.6	24 - 29
<i>Ammonia and Anions: RPD Limit = 20%</i>					
Ammonium ion	GEL	21	7	42.9	61.2 - 196
Chloride	TARL	31	31	35.5	30.8 - 74.8
Chloride	TASL	123	111	0.9	22
Cyanide	GEL	29	14	14.3	25.9 - 29.1
Fluoride	GEL	171	92	1.1	33.9
Fluoride	TARL	31	31	16.1	21.7 - 42.4
Fluoride	TASL	118	93	1.1	25
Nitrate	TARL	31	29	34.5	68.1 - 138.1

Table F-20. Laboratory Sample Duplicate Out-of-Limit Results

Constituent	Laboratory	Number of Laboratory Duplicates	Number Laboratory Duplicates Evaluated*	Percent RPD Out of Limit	Range of RPD Out
Sulfate	TARL	31	30	36.7	67.8 - 138.5
<i>Metals: RPD Limit = 20%</i>					
Hexavalent chromium	TARL	330	234	9.4	21.6 - 345.5
Uranium	TARL	51	49	6.1	23.3 - 34.8
<i>Volatile Organic Compounds: RPD Limit = 20%</i>					
<i>Semivolatile Organic Compounds: RPD Limit = 20%</i>					
<i>Radiochemical Parameters: RPD Limit = 20%</i>					
Cesium-137	GEL	39	1	100	28.5
Cobalt-60	TARL	46	1	100	33.9
Gross alpha	GEL	33	3	66.7	22.8 - 30.1
Gross alpha	WSCF	53	4	50	20.4 - 63.5
Gross beta	GEL	34	21	14.3	21 - 32
Gross beta	TARL	67	34	8.8	21 - 28
Gross beta	WSCF	60	27	3.7	30.4
Iodine-129	GEL	12	1	100	20.3
Iodine-129	TARL	59	14	21.4	25 - 57.9
Neptunium-237	TARL	5	1	100	33.3
Plutonium-238	TARL	17	1	100	26.1
Strontium-90	GEL	37	17	17.6	23.5 - 27
Uranium-233/234	TARL	9	8	12.5	69.9
Uranium-234	GEL	10	5	20	36.5
Uranium-235	TARL	9	2	50	55.2
Uranium-235	WSCF	13	7	42.9	25.1 - 55.7
Uranium-238	GEL	10	6	16.7	42
Uranium-238	TARL	9	7	14.3	22.6

\* Meets the evaluation criterion that the sample-duplicate pair has at least one result greater than or equal to five times the method detection limit or the minimum detectable activity.

RPD = relative percent difference

TASL = TestAmerica St. Louis

GEL = GEL Laboratory

WSCF = Waste Sampling and Characterization Facility

**Table F-20. Laboratory Sample Duplicate Out-of-Limit Results**

Constituent	Laboratory	Number of Laboratory Duplicates	Number Laboratory Duplicates Evaluated*	Percent RPD Out of Limit	Range of RPD Out
-------------	------------	---------------------------------	---	--------------------------	------------------

TARL = TestAmerica Richland

By laboratory, TARL had the lowest laboratory sample duplicate success: of its 472 sample duplicates that met the evaluation criterion, 398 met the 20% limit for an 84.3% success rate. The three most significant sample duplicate failures were for chloride (35.5%), nitrate (34.5%), and sulfate (36.7%).

GEL reported 247 laboratory sample duplicate results that met the evaluation criterion with 228 (92.3%) that met RPD criteria. The most significant failures were for cyanide, gross beta, and strontium-90. .

TASL reported 211 laboratory sample duplicate results that met the evaluation criterion with 207 (98.1%) that met the 20% RPD criterion. The RPD failures were for total organic halides, chloride, and fluoride.

WSCF reported 38 sample duplicate results that met the evaluation criterion with 32 (84.2%) that met the 20% RPD criterion. The RPD failures were for gross alpha, gross beta, and uranium-235.

By analyte class, the radiochemical parameters had the largest percent of laboratory sample duplicate failures: of the 160 duplicates that met the evaluation criterion, 30 (18.8%) failed the RPD criteria.

## F9.5 Surrogates and Surrogate Duplicates

Surrogates and surrogate duplicates are used to monitor percent recovery and precision during the analysis of samples for total petroleum hydrocarbons (TPHs), VOCs, and SVOCs. Surrogates are typically deuterated, fluorinated, or brominated organic compounds with chemical properties similar to those of the analytes of interest in a sample but are not normally found in groundwater samples. Known amounts of the surrogates are added to the sample prior to sample preparation and analysis to monitor the recovery of the organic compounds during the analytical process.

For the current reporting period, GEL, TASL, and WSCF reported surrogate data for TPHs, VOCs, and SVOCs. As Table F-1 indicates, percent recoveries for surrogates are compared to statistically derived laboratory-specific process control limits. The precision limit for surrogate duplicate RPDs was 20% unless the laboratory provided a statistically derived precision limit. The laboratories may apply a laboratory qualifier of X and an accompanying explanatory note in the data report or case narrative when laboratory surrogate/surrogate duplicate percent recoveries or RPDs are outside QC limits.

Tables F-15 and F-16 indicate that 99% of the percent recoveries for the 10,317 reported surrogates and 98.5% of the RPDs for the 339 reported surrogate duplicates met the QC criteria for CY2014. These success rates, along with those for the other measures of laboratory accuracy and precision, continue to provide assurance that the laboratories are producing data with sufficient accuracy and precision to meet the needs of the groundwater monitoring program. The CY2014 surrogate success rates are similar to the CY2013 success rates of 98.8% for surrogate percent recoveries and 95.1% for surrogate RPDs and the CY2012 success rates of 98.4% for surrogate percent recoveries and 98.1% for surrogate RPDs. Table F-21 lists the out-of-limit surrogate results for the current reporting period.

Table F-21. Surrogate Out-of-Limit Results

Surrogate	Lab	Method	Number of Surrogates	Percent Out of Limit Low	Percent Out of Limit High	Number of Surrogate Duplicates	Percent RPD Out of Limit*
<b>General Chemical Parameters: Recovery Limits = Laboratory Specific (Statistically Derived)</b>							
o-Terphenyl	GEL	WTPH_DIESEL	172	2.3	-	0	-
<b>Volatile Organic Compounds: Recovery Limits = Laboratory Specific (Statistically Derived)</b>							
1,2-Dichloroethane-d4	TASL	8260_VOA_GCMS	767	-	0.7	0	-
1,2-Dichloroethane-d4	WSCF	8260_VOA_GCMS	501	-	3.2	39	5.1
4-Fluorobromobenzene	TASL	8260_VOA_GCMS	767	-	0.3	0	-
4-Fluorobromobenzene	WSCF	8260_VOA_GCMS	501	-	2.6	39	2.6
Dibromofluoromethane	TASL	8260_VOA_GCMS	767	-	0.3	0	-
Toluene-d8	WSCF	8260_VOA_GCMS	501	-	2.0	39	5.1
<b>Semivolatile Organic Compounds: Recovery Limits = Laboratory Specific (Statistically Derived)</b>							
2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	GEL	8081_PEST_GC	23	-	4.3	0	-
2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	TASL	8081_PEST_GC	52	3.8	3.8	0	-
2,4,5,6-Tetrachloro-m-xylene	TASL	8081_PEST_GC	52	-	1.9	0	-
2,4,6-Tribromophenol	TASL	8270_SVOA_GCMS	131	-	8.4	0	-
2,4,6-Tribromophenol	WSCF	8270_SVOA_GCMS	242	5.0	-	33	-
2-Fluorobiphenyl	TASL	8270_SVOA_GCMS	144	-	0.7	0	-
2-Fluorobiphenyl	WSCF	8270_SVOA_GCMS	191	0.5	-	24	-
2-Fluorophenol	WSCF	8270_SVOA_GCMS	191	2.1	-	24	-

**Table F-21. Surrogate Out-of-Limit Results**

Surrogate	Lab	Method	Number of Surrogates	Percent Out of Limit Low	Percent Out of Limit High	Number of Surrogate Duplicates	Percent RPD Out of Limit*
2-Methylnaphthalene-d10	WSCF	8270_SVOA_GCMS	191	0.5	-	24	-
Nitrobenzene-d5	TASL	8270_SVOA_GCMS	144	-	0.7	0	-
Nitrobenzene-d5	WSCF	8270_SVOA_GCMS	191	0.5	0	24	0
Phenol-d5	WSCF	8270_SVOA_GCMS	191	0.5	0	24	0
p-terphenyl-d14	TASL	8270_SVOA_GCMS	144	7.6	0.7	0	0

\* Sample duplicate RPD limit of 20% was used to evaluate surrogate duplicates.

GEL = GEL Laboratory

RPD = relative percent difference

TASL = TestAmerica St. Louis Laboratory

WSCF = Waste Sampling and Characterization Facility

Overall, 10,317 surrogates and 339 surrogate duplicates were analyzed. Only 1% of surrogates were out of limit, and 1.5% of surrogate duplicates were out of limit. Surrogates and surrogate duplicates results were reported from GEL, TASL, and WSCF. None were reported from TARL.

By laboratory, WSCF had the lowest surrogate percent recovery rate at 98.2%; GEL, TASL, and TARL reported no surrogate duplicate results. WSCF also had the only five out of limit RPDs, all for VOCs.

By analyte class, general chemical parameters (o-terpenyl), GEL had 4 out of low limit surrogates; VOCs had 9 (1,2-Dichloroethane-d4, 4-Fluorobromobenzene, and dibromofluoromethane) out of high limit surrogates for TASL and 39 (1,2-Dichloroethane-d4, 4-Fluorobromobenzene, and Toluene-d8) out of high limit for WSCF; SVOCs had 1 (2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl) out of high limit surrogates for GEL and 17 (Table F-21) out of high limit for TASL.

## F10 Laboratory Performance

During CY2014, laboratory performance was tracked using two methods: the groundwater quarterly blind standards program and laboratory performance evaluation programs. The results of the blind standards program are discussed in Section F-10.1 and the laboratory performance evaluation programs are discussed in Section F-10.2.

### F10.1 Quarterly Blind Standard Evaluations

The groundwater monitoring program issues blind standards to the supporting laboratories to provide a measure of intra- and inter-laboratory precision and accuracy. These standards help groundwater staff troubleshoot analytical problems identified through data reviews and QC evaluations. The blind standards also may be used to confirm the adequacy of corrective actions to resolve analytical problems. Blind standards are required to be submitted to the participating laboratories on a quarterly basis ([DOE/RL-91-50](#) and CHPRC-00189); this requirement was not met during CY2014; CY2014 third quarter blinds were not submitted, and the fourth quarter blind standards were not submitted to the laboratories until after January 1, 2015. The quality requirements and control limits for the groundwater monitoring blind standards are given in [DOE/RL-91-50](#) and CHPRC-00189 and are listed in Table F-22. A success rate is calculated for the results returned by each supporting laboratory:

$$\text{Success Rate} = \frac{\text{number of results meeting QC recovery criteria}}{\text{total number of results reported}} \times 100 \quad \text{(Equation F-4)}$$

The acceptance criterion for the success rate is 80% (CHPRC-00189).

**Table F-22. Groundwater Blind Standard Recovery and Precision Requirements<sup>a,b</sup>**

Analyte Class	Recovery Limits (% Recovery)	Precision Limit <sup>c</sup> (% RSD)
General Chemical Parameters	75 - 125	≤ 25
Ammonia and Anions	75 - 125	≤ 25
Metals	80 - 120	≤ 20
Volatile Organic Compounds	75 - 125	≤ 25
Semivolatile Organic Compounds <sup>d</sup>	N/R	N/R
Radiological Parameters	70 - 130	≤ 20

a. Sources: [DOE/RL-91-50](#), *Hanford Site Environmental Monitoring Plan*, and CHPRC-00189, *CH2M HILL Plateau Remediation Company Environmental Quality Assurance Program Plan*.

b. Blind standards are required to be submitted to participating laboratories on a quarterly basis; the identity of the analytes and their concentrations vary from quarter to quarter.

c. If the results are less than five times the required detection limit, then the criterion is that the difference of the results of the replicates is less than the required detection limit.

d. The blind standards program does not require semivolatile organic compound standards.

N/R = not required

RSD = relative standard deviation

During CY2014, the groundwater monitoring program sent blind standards to GEL, TARL, TASL, and WSCF. In summary, the evaluation of the double-blind standards for 2014 indicates that, with some exceptions, the participating laboratories generally met the 80% success rate requirement for the groundwater monitoring program. Performance was somewhat uneven over the reporting period with GEL and TASL turning in one quarter with a success rate less than 80%. Of the blind results for all laboratories for 2014, 75% of the blind sample determinations were acceptable. This percentage is similar to the historical success rates of 88.5% for 2012, 83.6% for 2011, and 86.6% for 2010. Table F-23 presents the available success rates for each laboratory by quarter during CY2014.

**Table F-23. Blind Standards Laboratory Success Rates for CY2014**

Laboratory	Success Rate (%) by Quarter <sup>a</sup>			
	Q1	Q2	Q3	Q4
GEL	88.2	76.9	N/A	N/A
TARL	84.8	88.9	N/A	N/A
TASL	97.5	73.2	N/A	N/A
WSCF	86.1	N/A	N/A	N/A

a. Success Rate = 100 x number of results within QC recovery criteria / total number of results submitted. The minimum acceptable success rate is 80% (CHPRC-00189, CH2M HILL Plateau Remediation Company Environmental Quality Assurance Program Plan). Success rates less than the 80% criterion are denoted by shaded cells.

GEL = GEL Laboratory

N/A = not applicable

TARL = TestAmerica Richland Laboratory

TASL = TestAmerica St. Louis Laboratory

WSCF = Waste Sampling and Characterization Facility

Blind standards were generally prepared in triplicate and submitted to the laboratories to check the accuracy and precision of analyses. For most constituents, the blind standards were prepared in a groundwater matrix from an appropriate background well to simulate actual groundwater samples. Multi-metal blind standards for analysis by ICP techniques were prepared in deionized water using commercially prepared metals standards. The blind standards were submitted to the laboratories as regular groundwater samples.

After analysis, the laboratories' results were compared with the spiked concentrations to generate percent recoveries and the %RSDs were determined for the results. The percent recoveries and %RSDs were compared to the control limits to determine whether the data met the QC criteria<sup>3</sup>. Out-of-limit results were reviewed for errors. In situations where several results for the same method were unacceptable, an RDR may be generated to reanalyze the blind samples (if within holding times) or for recheck of the results. Any remaining out-of-limit results were discussed with the laboratory, potential problems were investigated, and corrective actions were requested when appropriate. Table F-24 summarizes the blind

<sup>3</sup> If the blind standard concentration is less than five times the required detection limit for the analyte, the secondary precision criterion is used: the difference between the maximum and minimum value reported must be less than the required detection limit (DOE/RL-91-50).

standards that exceeded the recovery or precision criteria during 2014; results that are outside the recovery or precision limits are in shaded cells.

The most notable observations for the CY2014 blind standards were:

- *Total organic carbon*: During the first quarter of the reporting period, TASL and GEL returned TOC recoveries that trended high with one result from each lab that exceeded the upper recovery limit; the acceptable recovery range is 75% to 125%. For the second quarter of CY2014, the TOC recoveries were within the acceptance range.
- *Total organic halides*: Two types of standards were used to generate TOX blind samples each quarter: one based on the relatively non-volatile compound 2,4,5-trichlorophenol and one based on the same standards as those used for the VOC blind standard containing carbon tetrachloride, chloroform, tetrachloroethene, and trichloroethene. For the trichlorophenol-based standard, most of the recoveries reported by GEL, TASL, and WSCF were within the 75% and 125% recovery limits. In contrast, the VOA-based TOX standards showed generally low recoveries with all three laboratories reporting some TOX recoveries less than the lower recovery limit of 75%. Out-of-limit low recoveries ranged from 57.5% to 74.3%. The predominantly low recoveries may reflect TOX recoveries for actual groundwater samples because the TOX content of many Hanford-Site groundwater samples is likely due to volatile organic compounds.
- *Anions*: For the second quarter, both GEL and TASL reported recoveries of fluoride between 16% and 17%. Because the fluoride results were so nearly identical between the two laboratories, a make-up error in the standard is strongly suspected, and these results are not considered to be out of limits.
- *Metals*: All four participating laboratories returned results for metals blind standards during CY2014. GEL, TASL, and WSCF reported metals determined by inductively coupled plasma – atomic emission spectroscopy (ICP-AES) and inductively coupled plasma – mass spectrometry (ICP-MS). TARK and WSCF reported hexavalent chromium by colorimetry, and GEL and TARK reported total uranium by kinetic phosphorescence analysis (KPA). The recovery acceptance limits for the metals are 80% to 120%. Barium, iron, mercury, and strontium exhibited low out-of-limit recoveries that ranged from 45.5% to 77.3%. Aluminum, uranium, and zinc, exhibited high out-of-limit recoveries that ranged from 122% to 134%.

Table F-24. CY2014 Blind Standard Out-of-Limit Results

Constituent	Laboratory	Spike Value	RDL	MDL / MDA	Units	Recovery Limits (%)	Recovery 1 (%)	Recovery 2 (%)	Recovery 3 (%)	Recovery 4 (%)	Precision Limit (%)	Precision (%RSD)	Precision Criterion Exceeded?
<b>CY2014 1<sup>st</sup> Quarter</b>													
TOC	GEL	1,010	1000	330	ug/L	75 - 125	128.7	111.9	112.9	122.8	25	6.8	N*
TOC	TASL	1,010	1000	270	ug/L	75 - 125	128.7	118.8	108.9	99.0	25	11.2	N*
TOX (phenol)	GEL	505	10	3.33	ug/L	75 - 125	82.4	87.3	88.5	72.9	25	8.6	N
TOX (VOA)	GEL	510	10	3.33	ug/L	75 - 125	72.2	71.8	73.5	—	25	1.3	N
TOX (VOA)	TASL	510	10	1.8	ug/L	75 - 125	78.0	74.3	75.9	—	25	2.5	N
TOX (VOA)	WSCF	510	10	25	ug/L	75 - 125	69.6	72.0	65.5	—	25	4.7	N
Aluminum	GEL	196	20	15	ug/L	80 - 120	93.5	97.5	133.8	—	20	20.5	Y
Barium	WSCF	196	5	0.40	ug/L	80 - 120	98.1	103.2	55.2	—	20	30.9	Y
Iron	GEL	196	50	30	ug/L	80 - 120	45.5	76.6	51.6	—	20	28.5	Y*
Strontium	WSCF	196	10	0.4	ug/L	80 - 120	94.0	99.1	53.1	—	20	30.7	Y
Uranium	GEL	49.5	1	2.05	ug/L	80 - 120	116.6	110.9	122.2	—	20	4.9	N
Zinc	WSCF	24.5	10	4	ug/L	80 - 120	108.2	123.7	133.5	—	20	10.5	N*
Tetrachloroethene	WSCF	5.00	5	1	ug/L	75 - 125	66.0	76.0	76.0	—	25	8.0	N*
Trichloroethene	WSCF	97.4	5	0.5	ug/L	75 - 125	67.8	82.1	78.0	—	25	9.7	N
Gross alpha	GEL	302	3	2.95	pCi/L	70 - 130	141.2	116.7	111.0	—	20	13.0	N
Gross alpha	TARL	302	3	3.88	pCi/L	70 - 130	97.8	62.0	59.7	—	20	29.2	Y
Gross alpha	WSCF	302	3	6	pCi/L	70 - 130	43.1	49.7	63.0	—	20	19.5	N
Gross beta	WSCF	31.6	4	6.2	pCi/L	70 - 130	117.2	110.8	136.2	—	20	10.9	N
Plutonium-239	GEL	1.47	1	0.653	pCi/L	70 - 130	122.4	94.6	208.2	—	20	41.8	Y*
Plutonium-239	TARL	1.47	1	0.241	pCi/L	70 - 130	62.2	68.7	60.4	—	20	6.4	N*
Plutonium-239	WSCF	1.47	1	0.066	pCi/L	70 - 130	74.8	95.2	61.9	—	20	21.9	N*
<b>CY2014 2<sup>nd</sup> Quarter</b>													
TOX (VOA)	GEL	247	10	3.33	µg/L	75 - 125	59.5	57.5	57.5	—	25	2.0	N
TOX (VOA)	TASL	247	10	1.8	µg/L	75 - 125	71.3	70.4	72.9	—	25	1.7	N
Cyanide	GEL	206	5	3.34	µg/L	75 - 125	130.1	120.4	126.2	—	25	3.9	N
Mercury	GEL	5.03	0.5	0.067	µg/L	80 - 120	77.3	69.8	80.5	—	20	7.3	N
Carbon tetrachloride	GEL	543	5	1.5	µg/L	75 - 125	67.4	71.1	67.2	—	25	3.2	N

Table F-24. CY2014 Blind Standard Out-of-Limit Results

Constituent	Laboratory	Spike Value	RDL	MDL / MDA	Units	Recovery Limits (%)	Recovery 1 (%)	Recovery 2 (%)	Recovery 3 (%)	Recovery 4 (%)	Precision Limit (%)	Precision (%RSD)	Precision Criterion Exceeded?
Carbon tetrachloride	TASL	543	5	1.30	µg/L	75 - 125	49.7	49.7	49.7	—	25	0.0	N
Chloroform	GEL	221	5	1.5	µg/L	75 - 125	70.6	70.6	69.2	—	25	1.1	N
Chloroform	TASL	221	5	1	µg/L	75 - 125	45.2	45.2	45.2	—	25	0.0	N
Tetrachloroethene	GEL	9.67	5	0.3	µg/L	75 - 125	68.0	58.9	62.0	—	25	7.4	N*
Tetrachloroethene	TASL	9.67	5	0.18	µg/L	75 - 125	48.6	50.7	51.7	—	25	3.1	N*
Trichloroethene	GEL	202	5	1.5	µg/L	75 - 125	64.4	43.5	48.3	—	25	21.0	N
Trichloroethene	TASL	202	5	2.5	µg/L	75 - 125	43.6	44.1	43.1	—	25	1.1	N
Carbon-14	TASL	985	200	10.8	pCi/L	70 - 130	100.4	102.6	28.3	—	20	54.8	Y*
Gross alpha	TARL	50.1	3	4.79	pCi/L	70 - 130	59.1	54.5	58.1	—	20	4.2	N
Iodine-129	GEL	1.50	1	0.545	pCi/L	70 - 130	46.1	130.7	94.0	—	20	47.4	Y*
Iodine-129	TARL	1.50	1	0.37	pCi/L	70 - 130	132.0	113.3	107.3	—	20	10.8	N*

\* The blind standard concentration was less than five times the required detection limit for this analyte. Hence, the secondary precision criterion was used: the difference between the maximum and minimum value reported must be less than the required detection limit.

GEL = GEL Laboratory

MDA = minimum detectable activity

MDL = method detection limit

RDL = required detection limit

RSD = relative standard deviation

TARL = TestAmerica Richland Laboratory

TASL = TestAmerica St. Louis Laboratory

TOC = total organic carbon

TOX = total organic halide

VOA = volatile organic analysis

WSCF = Waste Sampling and Characterization Facility

- *Volatile Organic Compounds*: GEL, TASL, and WSCF reported results for VOC blind standards during CY2014. The recovery acceptance limits for the VOCs are 75% to 125%. The VOC blind standards contained carbon tetrachloride, chloroform, tetrachloroethene, and trichloroethene at concentrations that ranged from 5 to 500 µg/L. Most of the reported recoveries trended low with a number of recoveries less than the lower recovery limit of 75%; this continues the historical trend of low recoveries for the VOC blind standards. Low recoveries for these analytes are attributed in part to losses of the VOCs from those blind standards during standards make-up and sample handling.
- *Radiochemical parameters*: All four participating laboratories returned results for radiochemical blind standards during CY2014. The recovery acceptance limits for radiochemical parameters are 70% to 130%. The following bullets discuss the highlights of those results.
  - *Gross alpha*: GEL, TARL, and WSCF returned gross alpha results for this reporting period. TARL and WSCF reported gross alpha results each during CY2014; the recoveries for these results all trended less than 100% with a total of 15 recoveries less than the lower recovery limit of 70% for this analysis. A corrective action is in place to investigate and resolve the low recovery issue at the two laboratories; this corrective action should be completed during CY2015. For the two quarters that GEL analyzed gross alpha blind standards, the laboratory reported recoveries well within the 70% to 130% recovery limits.
  - *Iodine-129*: GEL and TARL reported results for iodine-129 blind standards during CY2014. For the first quarter, both labs returned recoveries well within the acceptance limits of 70% to 130%. The spike value for the first quarter was 9.8 pCi/mL which is approximately ten times the MDAs for the two laboratories. For the second quarter, two GEL recoveries were outside the acceptance limits with one low and one high recovery. TARL reported one iodine-129 recovery just outside the upper acceptance limits. The second quarter spike value was 1.5 pCi/L which is only about three times the laboratories' MDAs. Consequently, it is no great surprise that more failures and greater variability were observed for the second quarter iodine-129 results.
  - *Plutonium-239*: GEL, TARL, and WSCF returned plutonium-239 blind standard results for CY2014. For the first quarter, the plutonium spike value was 1.47 pCi/L and each of the three labs had at least one value fall outside the acceptance range. For the second quarter, the spike value was 10.2 pCi/L, and the two reporting labs, GEL and TARL, were well within the recovery acceptance range.

## F10.2 National Performance Evaluation Studies

During 2014, Environmental Resources Associates (ERA) and DOE conducted national studies to evaluate laboratory performance for chemical and radiological constituents. GEL, TARL, TASL, and WSCF participated in the EPA-sanctioned water pollution/supply (WP/WS) performance evaluation studies conducted by ERA. GEL, TARL, and TASL, also participated in ERA's InterLaB RadChem Proficiency Testing Program (RAD) and in DOE's Mixed Analyte Performance Evaluation Program (MAPEP). Because of its closure in early 2014, WSCF's participation in the performance evaluation programs was limited. The results of those studies related to groundwater monitoring at the Hanford Site are described in this section.

### F10.2.1 Water Pollution/Supply Performance Evaluation Studies

The purpose of WP/WS performance evaluation studies is to evaluate the performance of laboratories in analyzing selected organic and inorganic compounds in water matrices. An accredited agency, e.g. ERA,

distributes standard water samples to participating laboratories. These samples contain specific organic and inorganic analytes at concentrations unknown to the participating laboratories. After analysis, the laboratories submit results to the accredited agency, which uses regression equations to determine acceptance and warning limits for the study participants. The results of these studies are expressed as a percentage of the results that the accredited agency found acceptable and independently verify the level of laboratory performance. If there is an unacceptable result, the laboratories may order an ERA QuiK<sup>4</sup>Response sample to verify successful corrective action. QuiK<sup>TM</sup>Response samples are similar to water pollution/water supply samples, and results are reported in a comparable fashion.

For the one water pollution performance evaluation study (ERA WP-228) in which WSCF participated during the reporting period, the percentage of results within the acceptance limits was 99% of 109 total results reported (Table F-25). One constituent, TOX<sub>s</sub>, had an unacceptable result.

**Table F-25. Summary of WSCF Performance Evaluation Studies**

Study Number	Date	Correct Results / Total Results
<b>WatR<sup>b</sup> Pollution/WatR<sup>b</sup> Supply Performance Evaluation Studies, Environmental Resource Associates</b>		
WP-228	January 2014	108/109 <sup>a</sup>
<b>InterLaB RadCheM Proficiency Testing Program, Environmental Resource Associates</b>		
RAD-96	January 2014	5/5

a. Unacceptable result was for total organic halide.

b. WatR is a trademark of Environmental Resource Associates, Golden Colorado.

For the three WP/WS performance evaluation studies in which TASL participated during 2014 (ERA WP-114, WP-238 and WP-714), the percentage of results within the acceptance limits was 97% of 752 total results reported (Table F-26). As noted in Table F-26, 18 different constituents had unacceptable results, seven (ammonia, BOD and 5 VOA constituents) of which were repeated across two studies. However, because TARL does not report BOD and rarely reports ammonia for groundwater samples, these two failures are not germane to groundwater monitoring data quality. Acceptable results were achieved in the subsequent Rapid Response samples for all constituents that originally failed. As noted, the number of constituents reported by TASL in the water pollution studies was considerably greater than those constituents reported by WSCF; therefore, the percentages from the two laboratories are not directly comparable.

For the four water pollution performance evaluation studies (ERA WP-228, WP-234, WP-236 and WP-237) in which TARL participated during the reporting period, the percentage of results within the acceptance limits was 98% of 63 total results reported (Table F-26). Antimony had an unacceptable result; however, because TARL does not report this constituent for groundwater samples, the failure is not germane to groundwater monitoring data quality. Again, the number of constituents evaluated was very limited; therefore, the percentage of results is not comparable to that of the other laboratories.

<sup>4</sup> QuiKResponse is a trademark of Environmental Resource Associates, Golden, Colorado.

Table F-26. Summary of TestAmerica Performance Evaluation Studies

Study Number	Date	Correct Results / Total Results	
		TASL	TARL
<b>WatR<sup>a</sup> Pollution/WatR<sup>a</sup> Supply Performance Evaluation Studies, Environmental Resource Associates</b>			
WP-114	January 2014	342/357 <sup>b</sup>	—
WP-228	January 2014	—	22/23 <sup>c</sup>
WP-234	July 2014	—	25/25
WP-236	September 2014	—	6/6
WP-237	October 2014	—	9/9
WP238	November 2014	71/71	—
WP-714	July 2014	313/324 <sup>d</sup>	—
13921 Rapid Response	September 2014	69/72 <sup>e</sup>	—
<b>DOE Mixed Analyte Performance Evaluation Program, Radiological and Environmental Sciences Laboratory</b>			
MAPEP-14-MaW30	February 2014	31/36 <sup>f</sup>	18/19 <sup>g</sup>
MAPEP-14-GrW30	February 2014	2/2	2/2
MAPEP-14-XaW30	February 2014	1/1	1/1
MAPEP-14-OrW30	February 2014	80/80	—
MAPEP-14-MaW31	November 2014	32/35 <sup>h</sup>	15/15
MAPEP-14-GrW31	November 2014	2/2	2/2
MAPEP-14-XaW31	November 2014	1/1	1/1
MAPEP-14-OrW31	November 2014	80/80	—
<b>InterLaB RadCheM Proficiency Testing Program, Environmental Resource Associates</b>			
RAD-93	April 2013	12/12	14/17 <sup>j</sup>
RAD-97	April 2014	12/13 <sup>i</sup>	18/19 <sup>j</sup>
RAD-99	October 2014	—	13/19 <sup>k</sup>
MRAD-20	March 2013	15/15	—
ERA QR 060614M	July 2014	—	1/1

a. WatR is a trademark of Environmental Resource Associates, Golden Colorado.

b. Unacceptable results were for thallium, BOD, ammonia, pH, carbon tetrachloride, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, ethylbenzene, toluene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, m+p xylene, and xylenes (total).

c. Unacceptable result was for antimony.

**Table F-26. Summary of TestAmerica Performance Evaluation Studies**

Study Number	Date	Correct Results / Total Results	
		TASL	TARL

d. Unacceptable results were for BOD, TSS, ammonia, total phosphorus, 1,2-dichlorobenzene, 1,3-dichlorobenzene, ethylbenzene, naphthalene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and benzo(b)fluoranthene.

e. Unacceptable result was for total phosphorus.

f. Unacceptable results were for beryllium, mercury, nickel, thallium and iron-55.

g. Unacceptable result was for potassium-40.

h. Unacceptable results were for antimony, lead, and Pu-239/240.

i. Unacceptable result was for gross beta.

j. Unacceptable result was for radium-226.

k. Unacceptable results were for barium-133, cesium-134, cesium-137, cobalt-60, zinc-65 and iodine-131.

For the seven WP/WS performance evaluation studies in which GEL participated during 2014 (ERA WP-222, WP-231, WP-237 and WS-210, WS-213, WS-216, and WS-217), the percentage of results within the acceptance limits was 99% of 1005 total results reported (Table F-27). Eleven different constituents had unacceptable results. Ortho-Phosphate was missed in three separate studies and was also missed in the MAPEP study, however it passed in the remaining studies and was also passed in two different make up programs. All other constituents with unacceptable results passed in subsequent QuiKResponse or QT program sample analyses.

**Table F-27. Summary of GEL Performance Evaluation Studies**

Study Number	Date	Correct Results / Total Results
<b>WatR<sup>a</sup> Pollution/WatR<sup>a</sup> Supply Performance Evaluation Studies, Environmental Resource Associates</b>		
WP-228	January 2014	28/29 <sup>b</sup>
WP-231	April 2014	340/342 <sup>c</sup>
WP-237	October 2014	331/334 <sup>d</sup>
WS-210	January 2014	144/148 <sup>e</sup>
WS-213	April 2014	5/5
WS-216	July 2014	142/145 <sup>f</sup>
WS-217	August 2014	2/2
011014L – Quick Response	February 2014	1/1
040114H – Quick Response	May 2014	5/5
062514K – Quick Response	June 2014	1/1
082614F – Quick Response	September 2014	9/9
QT-0000010	September 2014	2/2
QT-0000011	August 2014	51/52 <sup>g</sup>

**Table F-27. Summary of GEL Performance Evaluation Studies**

Study Number	Date	Correct Results / Total Results
QT-0000012	August 2014	4/4
<b>DOE Mixed Analyte Performance Evaluation Program, Radiological and Environmental Sciences Laboratory</b>		
MAPEP-14-MaW30	June 2014	25/26 <sup>h</sup>
MAPEP-14-OrW30	June 2014	80/80
MAPEP-14-GrW30	June 2014	2/2
MAPEP-14-XaW30	June 2014	1/1
<b>InterLaB RadChem Proficiency Testing Program, Environmental Resource Associates</b>		
RAD-96	January 2014	25/25
RAD-98	July 2014	23/25 <sup>i</sup>
MRAD-20	March 2014	25/26 <sup>j</sup>

- a. WatR is a trademark of Environmental Resource Associates, Golden Colorado.
- b. Unacceptable result was for amenable cyanide.
- c. Unacceptable results were for total phosphorus and ortho-phosphate.
- d. Unacceptable results were for 1,2-dichloropropane, low level residual chlorine and calcium hardness.
- e. Unacceptable results were for aluminum, beryllium, phosphate and freon-113.
- f. Unacceptable results were for ortho-phosphate, hexavalent chromium and total dissolved solids.
- g. Unacceptable result was for extractable organic halides.
- h. Unacceptable result was for ortho-phosphate.
- i. Unacceptable result was for strontium-89
- j. Unacceptable result was for americium-241.

DOE = U.S. Department of Energy

### F10.2.2 InterLaB RadChem Proficiency Testing Program Studies

The purpose of the RAD Proficiency Testing Program (also conducted by ERA) is to evaluate the performance of laboratories in the analysis of selected radionuclides. This program provides blind standards that contain specific amounts of one or more radionuclides in a water matrix to participating laboratories. After sample analysis, the results are forwarded to ERA for comparison with the known values and with results from other laboratories. ERA bases its control limits on the EPA's *National Standards for Water Proficiency Testing Studies, Criteria Document* (EPA NERL-Ci-0045).

During the reporting period, WSCF participated in one study, RAD-96 (Table F-25), with an acceptance percentage of 100% of 5 results.

TARL participated in two studies, RAD-97 and RAD-99 (Table F-26), with an acceptance percentage of 82% of 38 results with seven unacceptable. Six of the unacceptable results are the result of one gamma analysis. The lab has investigated the issue and implemented corrective actions. They have also passed subsequent gamma evaluations.

TASL participated in two studies, RAD-97 and MRAD-20 (Table-26), and analyzed a total of 28 constituents with an acceptance percentage of 96% with 1 unacceptable result for gross beta. However, TASL does not report this constituent for groundwater samples, so failure is not germane to groundwater monitoring data quality.

GEL participated in three studies (RAD-96, RAD-98 and MRAD-20) and analyzed a total of 76 constituents with an acceptance percentage of 96% with 3 unacceptable results (Table F-27).

### **F10.2.3 DOE Mixed Analyte Performance Evaluation Program**

DOE's MAPEP examines laboratory performance in the analysis of soil and water samples containing metals, SVOCs, and radionuclides. This report considers only results from the water samples. The program is conducted at the Radiological and Environmental Sciences Laboratory in Idaho Falls, Idaho. DOE evaluates the accuracy of the MAPEP results for radiological, inorganic, and organic analytes by determining if the results fall within 30% of the reference value. Two studies were available for all labs during the reporting period: MAPEP-14-30 and MAPEP-14-31. TARL, and TASL, participated in both studies, and GEL participated in MAPEP-14-30. WSCF did not report any MAPEP results.

TASL analyzed inorganics, semi-volatile organics, and radionuclides including gross alpha/beta for the MAPEP studies (Table F-26). Of 237 analytes, eight had unacceptable results yielding a 97% acceptable result rate. The missed analytes were beryllium, mercury, nickel, thallium, iron-55 antimony, lead, and Pu-239/240 (both studies). All of these unacceptable results were isolated events (not repeated in both studies or in the previous year).

TARL reported results for radionuclides, including gross alpha/beta, for the two MAPEP studies (Table F-26). Of 40 constituents, one had unacceptable results, yielding a 98% acceptable result rate. The missed analyte was the naturally occurring Potassium-40 and was not missed in the subsequent study.

For the one reported MAPEP study, GEL analyzed inorganics, semi-volatile organics, and radionuclides, including gross alpha/beta (Table F-27). Of 119 analytes, GEL had a 100% acceptable result rate.

## **F11 Data Usability Conclusions**

In general, this quality assessment for CY2014 groundwater monitoring data shows that the great majority of the data are useable for the purposes of groundwater monitoring. This assessment also noted some limitations in the data set. These limitations are summarized in the following subsections.

### **F11.1 Data Completeness**

As detailed in Section F-5 and in Tables F-2 and F-5, 99.8% of groundwater samples planned for CY2014 was collected, the requirements for the number of field QC samples were met or exceeded, and 96.7% of the analytical results met the completeness criteria. Based on the review performed in this DQA, nearly all required samples, field QC, and analytical results were collected in accordance with the groundwater monitoring requirements of [DOE/RL-91-50](#) and CHPRC-00189.

### **F11.2 Sample Preservation and Holding Time**

As noted in Section F-7, improper sample preservation was a very minor issue with only 0.2% of all laboratory samples affected by sample preservation issues; only 8 analyses were cancelled as a result of this issue. Missed holding times had a somewhat greater impact on the groundwater monitoring data set with 0.5% of the analytical results associated with missed holding times. Most of the results with missed holding times were still generated within two times the holding time and hence were deemed useable by the groundwater monitoring program.

### **F11.3 Field Quality Control**

Field QC samples were collected and analyzed in accordance with the groundwater monitoring requirements of [DOE/RL-91-50](#) and CHPRC-00189. Field QC issues generated minimal impact to data usability. Section F-8 discusses groundwater monitoring field QC samples in detail.

For the FBs, the number and types of FBs collected met groundwater monitoring collection requirements, and 97.8% of the FB results were found to meet groundwater monitoring criteria. Of the 325 FB results that exceeded the criteria, 109 were for metals and 132 for VOCs. Many of the out-of-limit metal results were likely due to sample swaps of the FB with a groundwater sample either in the field or at the laboratory. Most of the out-of-limit VOC results were traced to probable contamination of the deionized water source used to generate the blank (methylene chloride) or to laboratory contamination during sample preparation and analysis (acetone).

For the field sample duplicates, 30.7% of the reported duplicate laboratory results met the evaluation criterion, and of these duplicate results, 95.0% were acceptable, indicating reasonable precision for field sampling operations laboratory analysis.

For the field sample TOC and TOX quadruplicates, 10.5% of the reported quadruplicate laboratory results met the evaluation criterion, and of these quadruplicate results, 83.7% met the reproducibility criterion. This represents fair reproducibility although some deficiencies in the laboratory sample preparation and analysis of these analytes may still exist. Groundwater monitoring personnel will continue to evaluate groundwater TOC and TOX data to determine what course of corrective action to take on this issue.

Of the CY2014 split sample results, 27.5% met the evaluation criterion and 90.8% of those results met the precision criterion. This success rate for split sample results is in keeping with historical trends for split samples and indicates reasonable analytical agreement between laboratories. The metals analyses constituted 60% of the split failures and may have resulted from samples swapped either in the field or in

the laboratory, heterogeneous distribution of metal-containing particulates between the split samples, and/or possible dilution errors at the time of analysis.

#### **F11.4 Laboratory Quality Control**

Overall, the frequency at which laboratory QC samples were analyzed met the requirements of [DOE/RL-91-50](#) and CHPRC-00189. About 98% of laboratory QC sample results met requirements. This indicates reasonable control of sample preparation and analytical methods at the laboratories with respect to cleanliness, precision, and accuracy. Section F-9 discusses the laboratory QC associated with groundwater monitoring samples in detail.

Of the laboratory MBs, 97.2% met the QC requirements. This indicates adequate cleanliness during laboratory sample preparation and analysis. Numerically, most of these failures were for the ICP metals with 533 of 11,682 blank results (4.9%) exceeding QC criteria. By percent, the general chemistry parameters experienced the highest out-of-limit rate with 123 of 889 MBs (13.8%) exceeding QC criteria. Most of these MB failures were associated with alkalinity.

As a measure of analytical accuracy, 99.3% of the results for LCS, 97.5% of the MSs, and 99.0% of the surrogates met QC requirements. This indicates that the analytical methods are yielding adequate accuracy for the groundwater monitoring program.

With respect to analytical precision, 98.7% of the LCSDs and 98.9% of the MSDs met QC precision requirements, while 95.4% of sample duplicates and 98.5% of surrogate duplicates met QC precision requirements. These precision results indicate that the analytical methods are producing groundwater monitoring data that meet groundwater monitoring precision requirements.

#### **F11.5 Laboratory Performance**

The blind standards program and the performance evaluation studies provided an additional check on laboratory performance.

For the blind standards program, two laboratories, TARL and TASL, each had one quarter during CY2014 in which the laboratory did not meet the 80% success rate criterion defined in CHPRC-00189. Other issues observed as a result of the blind standards program are:

- *Total organic halides:* GEL, TASL, and WSCF reported the VOA-based TOX standards with generally low recoveries with all three laboratories reporting some TOX recoveries less than the lower recovery limit of 75%. Out-of-limit low recoveries ranged from 57.5% to 74.3%.
- *Volatile Organic Compounds:* GEL, TASL, and WSCF reported recoveries that trended low with a number of recoveries less than the lower recovery limit of 75%; this continues the historical trend of low recoveries for the VOC blind standards.
- *Gross alpha:* TARL and WSCF reported gross alpha results that trended low with 15 recoveries less than the lower recovery limit; GEL reported gross alpha recoveries well within the recovery limits. A corrective action is in place to investigate and resolve the low recovery issue and should be completed during CY2015.

These issues will continue to be monitored during and corrective actions sought as warranted.

The results of the performance evaluation studies indicate that the participating laboratories are, overall, providing analytical results within acceptable accuracy limits for analytes of interest to groundwater monitoring.

## **F11.6 Conclusions**

Based on this DQA, sample results appear to accurately represent target analyte concentrations in Hanford Site groundwater, and the analytical data are sufficient in quantity and quality to be usable for the groundwater monitoring program. The percent useable data for the CY2014 groundwater monitoring data set is 96.7%; this easily exceeds the [DOE/RL 91-50](#) groundwater monitoring requirement of 85% data usability. Furthermore, 98.1% of the laboratory QC samples met QC requirements. This high rate of acceptable laboratory QC results indicates that laboratory accuracy, precision, and contamination control during sample preparation and analysis support the use of the data set for the groundwater monitoring program. Field QC samples were collected and laboratory QC samples were analyzed at the frequencies required in [DOE/RL 91-50](#) and CHPRC-00189.

This page intentionally left blank

## F12 References

- 40 CFR 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants," *Code of Federal Regulations*. Available at: <http://www.gpo.gov/fdsys/pkg/CFR-2012-title40-vol24/xml/CFR-2012-title40-vol24-part136.xml>.
- 40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis," *Code of Federal Regulations*. Available at: <http://www.gpo.gov/fdsys/pkg/CFR-2008-title40-vol25/pdf/CFR-2008-title40-vol25-sec265-93.pdf>.
- APHA/AWWA/WEF, 2012, *Standard Methods For the Examination of Water and Wastewater*, 22<sup>nd</sup> Edition, American Public Health Association, American Water Works Association, and Water Environment Federation, Washington, D.C.
- CHPRC-00189, 2014, *CH2M HILL Plateau Remediation Company Environmental Quality Assurance Program Plan*, Rev. 12, CH2M HILL Plateau Remediation Company, Richland, Washington.
- DOE/RL-91-50, 2013, *Hanford Site Environmental Monitoring Plan*, Rev. 6A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: <http://www.hanford.gov/files.cfm/DOE-RL-91-50-6A.pdf>.
- ECY 97-602, 1997, *Analytical Methods for Petroleum Hydrocarbons*, Toxics Cleanup Program and The Ecology Environmental Laboratory, Washington State Department of Ecology, Olympia, Washington. Available at: <https://fortress.wa.gov/ecy/publications/publications/97602.pdf>.
- EPA-600/R-94/111, 1994, *Methods for the Determination of Metals in Environmental Samples, Supplement I*, Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: <http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=300036HL.txt>.
- EPA-600/4-79/020, 1983, *Methods for Chemical Analysis of Water and Wastes*, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: <http://nepis.epa.gov/Exe/ZyNET.exe/30000Q10.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1976+Thru+1980&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRes trict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C76thru80%5CTxt%5C00000001%5C30000Q10.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL>.
- EPA/600/R-93/100, 1993, *Methods for the Determination of Inorganic Substances in Environmental Samples*, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: <http://monitoringprotocols.pbworks.com/f/EPA600-R-63-100.pdf>.

- EPA-821-R-98-002, 1999, *Method 1664, Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry*, Office of Water, U.S. Environmental Protection Agency, Washington, D.C. Available at:  
[http://water.epa.gov/scitech/methods/cwa/oil/upload/2007\\_07\\_10\\_methods\\_method\\_oil\\_1664.pdf](http://water.epa.gov/scitech/methods/cwa/oil/upload/2007_07_10_methods_method_oil_1664.pdf).
- EPA Method 300.0, 1993, *Determination of Inorganic Anions by Ion Chromatography*, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at:  
[http://water.epa.gov/scitech/methods/cwa/bioindicators/upload/2007\\_07\\_10\\_methods\\_method\\_300\\_0.pdf](http://water.epa.gov/scitech/methods/cwa/bioindicators/upload/2007_07_10_methods_method_300_0.pdf)
- EPA Method 9056, 1994, *Determination of Inorganic Anions by Ion Chromatography*, U.S. Environmental Protection Agency, Washington D.C. Available at:  
<http://www.caslab.com/EPA-Methods/PDF/EPA-Method-9056.pdf>
- EPA NERL-Ci-0045, 1998, *National Standards for Water Proficiency Testing Studies, Criteria Document*, U.S. Environmental Protection Agency, Washington, D.C.
- O'Dell, James W., 1993, *Method 410.4 The Determination of Chemical Oxygen Demand by Semi-Automated Colorimetry*, Rev. 2.0, Inorganic Chemistry Branch, Chemistry Research Division, Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at:  
[http://water.epa.gov/scitech/methods/cwa/bioindicators/upload/2007\\_07\\_10\\_methods\\_method\\_410\\_4.pdf](http://water.epa.gov/scitech/methods/cwa/bioindicators/upload/2007_07_10_methods_method_410_4.pdf).
- Peden, Mark E., 1986, *Methods for Collection and Analysis of Precipitation*, ISWS Contract Report 381, Illinois State Water Survey, Analytical Chemistry Unit, Champaign, Illinois. Available at:  
<http://www.isws.illinois.edu/pubdoc/CR/ISWSCR-381.pdf>.
- Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at:  
<http://www.epa.gov/epawaste/inforesources/online/index.htm>.
- SGW-52194, 2012, *Volatile Organic Compound Contamination in Groundwater Samples and Field Blanks*, Rev. 0, J.G. Douglas, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: <http://pdw.hanford.gov/arpir/pdf.cfm?accession=0091690>.
- SW-846, 2007, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at:  
<http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm>.