

100-HR-3 GROUNDWATER OPERABLE UNIT WELL INSTALLATION SAMPLING AND ANALYSIS PLAN DATA USABILITY ASSESSMENT

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

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Release Approval

Date

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Terms

CHPRC	CH2M HILL Plateau Remediation Company
DQA	data quality assessment
DQI	data quality indicators
DQO	data quality objective
DUA	data usability assessment
DUP	field duplicate sample
EB	equipment (rinsate) blank
EPA	U.S. Environmental Protection Agency
EQL	estimated quantitation limit
FTB	full trip blank
GEA	gamma energy analysis
HEIS	Hanford Environmental Information System
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma/mass spectrometry
LCS	laboratory control sample
MDC	minimum detectable concentration
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
OU	operable unit
PQL	practical quantitation limit (synonymous with EQL)
QA	quality assurance
QC	quality control
RPD	relative percent difference
SAP	sampling and analysis plan
SDG	sample delivery group
SOP	standard operating procedure

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1 Introduction

This data usability assessment (DUA) report evaluates laboratory data for soil and water samples collected during well drilling conducted from 2017 to 2019 under DOE/RL-2013-35, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan* (hereinafter referred to as the 100-HR-3 operable unit [OU] sampling and analysis plan [SAP]), and applicable addenda:

- DOE/RL-2013-35-ADD7, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan, Addendum 7: Wells (199-D5-160, 199-D5-161, 199-D8-102, 699 97 47C, 699-88-41A, 699-93-37A, 699-90-47B, and 699-90-45B)*
- DOE/RL-2013-35-ADD9, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan, Addendum 9: Wells 199-H1-47, 199-H1-48, 199-H1-49, 199-H3-28, 199-H3-29, AND 199-H3-30*
- DOE/RL-2013-35-ADD10, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan, Addendum 10: 199-D1-1, 199-D7-7, 199-H1-12, 199-H3-21, 199-H3-31, 199-H3-32, 199-H7-1, 699-95-48C, and 699-97-47D*
- DOE/RL-2013-35-ADD11, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan, Addendum 11: Wells 199-H3-12, 199-H3-13, 199-H3-22, 199-H1-50, and 699-95-45C*

The data quality indicators (DQI) assessment included in this DUA are used for samples collected under the 100-HR-3 OU SAP (DOE/RL-2013-35) and applicable addenda (7, 9, 10, and 11). This DUA completes the U.S. Environmental Protection Agency (EPA) data quality life cycle (planning, implementation, and assessment).

For this project, a judgmental (focused) sampling design was implemented in the field; therefore, the DQIs precision, accuracy/bias, representativeness, comparability, completeness, and sensitivity for the specific data sets are evaluated according to EPA/240/R-02/004, *Guidance on Environmental Data Verification and Data Validation*. Data verification and data validation are integral to the DQI evaluation process. The CH2M HILL Plateau Remediation Company (CHPRC) will use the results of the DQI evaluation process to interpret the data and determine if the data quality objectives (DQOs) for this activity have been met.

This report documents components of the DUA, including data verification (Chapter 2), data validation (Chapter 3), data quality indicators evaluation (Chapter 4), data quality assessment (Chapter 5), and summary and conclusions (Chapter 6).

1.1 Purpose

The purpose of this DUA is to determine whether the data collected under the 100-HR-3 OU SAP (DOE/RL-2013-35) and associated addenda are the right type and of sufficient quality and quantity to support groundwater monitoring and remediation decisions. The purpose of the 100-HR-3 OU SAP is to identify the well locations, construction, and sampling requirements that meet the OU objectives. Specific quality control (QC) measures are also provided in this SAP. The purpose of the 100-HR-3 Groundwater OU SAP Addenda is to provide site-specific field sampling plans for the proposed wells.

The DUA process is not intended to be a definitive analysis of a project or problem. Rather, the method provides an initial assessment of the reasonableness of the generated data based solely on the associated QC information and not on the technical interpretations of the data values.

The information contained in this report follows guidelines for DUAs established by the Environmental Programs and Strategic Planning organization based on EPA/240/R-02/004.

1.2 Scope

This DUA focuses on the chemical and radiological characterization data collected by sampling saturated soil and groundwater from new wells installed at the 100-HR-3 groundwater OU as required by the 100-HR-3 OU SAP (DOE/RL-2013-35) and applicable addenda. The data are evaluated to determine whether they meet the analytical criteria outlined in the SAP and addenda and are adequate to support decisionmaking. Evaluation of routine groundwater monitoring data is not part of this DUA scope. The data quality assessment (DQA) of physical properties data (such as hydraulic conductivity and total carbonate) and data collected but not required under the addenda are also not within the scope of this report. The review determined whether the data are the right type, quality, and quantity to support the intended use. The DQA completes the data lifecycle (i.e., planning, implementation, and assessment) initiated by the DQO process (EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process*).

This DUA covers data sets for the following 16 wells:

- One well (699-97-47C) installed as identified in DOE/RL-2013-35-ADD7
- Six wells (199-H1-47, 199-H1-48, 199-H1-49, 199-H3-28, 199-H3-29, and 199-H3-30) installed as identified in DOE/RL-2013-35-ADD9
- Four wells (199-H1-12, 199-H3-21, 199-H3-32, and 199-H7-1) installed as identified in DOE/RL-2013-35-ADD10
- Five wells (199-H1-50, 199-H3-12, 199-H3-13, 199-H3-22, and 699-95-45C) installed as identified in DOE/RL-2013-35-ADD11

During well installation, aquifer sediment and groundwater samples were collected for laboratory analysis.

1.3 Project Background

This section describes the sampling design and associated project objectives, including implementation of the sampling design.

1.3.1 Sampling Design

Sixteen new boreholes were drilled under this phase of the 100-HR-3 groundwater operable unit well installation SAP. Soil and water samples were collected at predefined depths during the drilling of each borehole, as described in the applicable addenda. In addition, one post-development water sample was collected for each borehole. Table 1 provides a summary of the number of samples estimated for each borehole.

Table 1. Sample Design Implementation and Completion Evaluation for 100-HR-3 Boreholes

Well Name ^a	Well ID	Addendum	Soil Split-Spoon Samples			Groundwater Samples		
			Number of Intervals Sampled	Number Estimated in Sampling and Analysis Plan ^b	Percent of Estimated Number Completed ^c	Number of Intervals Sampled ^d	Number Estimated in Sampling and Analysis Plan ^{b,d}	Percent of Estimated Number Completed ^c
199-H3-29	C9716	9	7	8	87.5	5	5	100
199-H3-30	C9717	9	4	4	100	3	3	100
199-H3-28	C9715	9	5	5	100	3	3	100
199-H1-49	C9639	9	3	3	100	3	3	100
199-H1-47	C9637	9	2	2	100	2	2	100
199-H1-48	C9648	9	2	2	100	2	2	100
199-H3-21	C9923	10	2	2	100	2	2	100
199-H3-22	C9924	11	7	6	117	2	4	50
199-H3-12	C9987	11	6	6	100	2	4	50
199-H3-13	C9989	11	5	6	83	4	4	100
199-H3-32	C9724	10	4	4	100	4	4	100
699-95-45C	C9933	11	3	3	100	4	4	100
699-97-47C	C9545	7	1	1	100	2	2	100
199-H7-1	C9719	10	4	4	100	3	4	75
199-H1-50	C9931	11	2	2	100	3	3	100
199-H1-12	C9926	10	3	3	100	3	3	100

Note: Complete reference citations are included in Chapter 7.

a. Monitoring and potential extraction wells are listed in the order drilled.

b. Estimates for the numbers of samples at each location are presented in DOE/RL-2013-35-ADD7, DOE/RL-2013-35-ADD9, DOE/RL-2013-35-ADD10, and DOE/RL-2013-35-ADD11.

c. Completed means successfully collected.

d. Includes post-development samples.

ID = identification

1.3.2 Project Objectives

Table 2 presents a summary of the principal study questions for the 100-HR-3 groundwater OU groundwater and soil sampling. Principal study questions and data needs are defined in Section 1.2 of DOE/RL-2013-35.

Table 2. Summary of Principal Study Questions for 100-HR-3 Groundwater OU Groundwater and Soil Sampling

Primary Study Question	Scope of Work	Justification (Data Gap)*
<u>PSQ1a</u> Is the river being protected within the unconfined aquifer?	Drill three extraction boreholes (199-H1-47, 199-H1-48, and 199-H1-49) on the eastern margin of the Cr(VI) plume	Increase hydraulic containment and river shoreline protection on eastern margin of Cr(VI) plume migrating toward the river within unconfined aquifer. The aquifer is thin, requiring need for multiple wells located in this area of higher Cr(VI) concentrations.
<u>PSQ1b</u> Is the river being protected within the confined aquifer?	Drill three extraction boreholes (199-H3-28, 199-H3-29, and 199-H3-30)	Increase hydraulic containment and river shoreline protection of Cr(VI) plume in close proximity to the river within the first water bearing unit of the RUM aquifer. Wells are located for better identification of the plume boundary and possible source of Cr(VI) in the semi-to-confined RUM aquifer. Soil and water sampling during drilling will be extended below first water bearing unit of the RUM to clarify vertical distribution of Cr(VI) deeper in the RUM and possible interaquifer communications.
<u>PSQ2</u> Can mass removal be increased?	Drill one borehole (699-97-47C)	Prevent escape of mass to the north from the Horn and increase extraction capability. High flow rates are not anticipated or needed in this location.
<u>PSQ2</u> Can mass removal be increased?	Drill one borehole (199-H3-21) near the 107-H Retention Basin	This well will be completed in the unconfined aquifer as an extraction well near the former 107-H Retention Basin where elevated concentrations of Cr(VI) and Sr-90 persist. P&T extraction in this location will improve river protection and mass removal of Cr(VI) and Sr-90.
<u>PSQ2</u> Can mass removal be increased?	Drill one borehole (199-H3-22) near the 183-H Solar Evaporation Basins	This well a P&T extraction well to help remediate known groundwater contamination in the first water-bearing unit of the RUM near the 183-H Solar Evaporation Basins.
<u>PSQ3a</u> Is the Cr(VI) plume sufficiently delineated in the unconfined aquifer?	Drill one borehole (199-H1-12) to northeast extent of 100-HR-3	This well will be completed in the unconfined aquifer as a monitoring well to help evaluate the degree of hydraulic containment and river shoreline protection of the Cr(VI) plume at the northeastern extent of 100-HR-3.
<u>PSQ3b</u> Is the Cr(VI) plume sufficiently delineated in the confined aquifer?	Drill one borehole (199-H3-31) in the southeast extent of the 100-H Area	This well will be completed in the uppermost RUM aquifer as a monitoring well to assist in defining the southeastern extent of the Cr(VI) plume in the RUM aquifer in the 100-H Area. It will also help provide additional characterization of this lower aquifer.
<u>PSQ3b</u> Is the Cr(VI) plume sufficiently delineated in the confined aquifer?	Drill one borehole (199-H7-1) in the northern extent of the 100-H Area	This well will be completed in the uppermost RUM aquifer as a monitoring well to assist in defining the northern extent of the Cr(VI) plume in the RUM aquifer in the central Horn area and provide additional characterization of this lower aquifer.

Table 2. Summary of Principal Study Questions for 100-HR-3 Groundwater OU Groundwater and Soil Sampling

Primary Study Question	Scope of Work	Justification (Data Gap)*
<p><u>PSQ3b</u> Is the Cr(VI) plume sufficiently delineated in the confined aquifer?</p>	<p>Drill four boreholes (199-H1-50, 199-H3-12, 199-H3-13, and 699-95-45C)</p>	<p>These wells are installed as monitoring wells and completed in the first water bearing unit of the RUM. Wells have been located and planned to provide critical information on the nature and extent of contamination in the first water-bearing units of the RUM along with characterization of the unconfined aquifer.</p>

Note: Complete reference citations are provided in Chapter 7.

*Technical justification for well 699-97-47 is provided in Table 3 of DOE/RL-2013-35-ADD7. Technical justification for wells 199-H1-47, 199-H1-48, 199-H1-49, 199-H3-28, 199-H3-29 and 199-H3-30 is provided in Table 3 of DOE/RL-2013-35-ADD9. Technical justification for wells 199-H1-12, 199-H3-21, 199-H3-32 and 199-H7-1 is provided in Table 2 of DOE/RL-2013-35-ADD10. Technical justification for wells 199-H1-50, 199-H3-12, 199-H3-13, 199-H3-22, and 699-95-45C is provided in Chapter 2 of DOE/RL-2013-35-ADD10.

- OU = operable unit
- P&T = pump and treat
- PSQ = principal study question
- RUM = Ringold Formation upper mud

1.3.2.1 Implementation of the Sample Design

Table 1 provides a summary of the wells, associated addendums, the planned number of samples, and the actual number of samples taken for the 100-HR-3 boreholes. A review of the addenda, field sampling reports, and applicable analytical data packages indicate all samples were collected and analyzed in accordance with the sampling design with the following exceptions:

- For well 199-H3-29, one soil sample for hexavalent chromium at a depth of 190 ft and one water sample for hexavalent chromium at a depth of 130 ft were not taken (Note: One extra water sample for hexavalent chromium was taken at 59 ft). No reason was found in the field sampling reports for the missing samples; however, insufficient sample volume is the likely explanation.
- For well 199-H3-22, one soil sample at depth 30–32.5 ft was not taken due to a lack of soil (Note: Two extra samples were taken, one at depth 48–53 ft and one at depth 81 ft). Additionally, two water samples were not taken: one at 45 ft (no water present) and one at 105 ft (insufficient water to pump).
- For well 199-H3-12, two water samples at depths of 45 ft and 65 ft were not taken (no water present).
- For 199-H3-13, one soil sample was not taken at 125–127 ft (depth not reached).
- For 199-H7-1, no water sample was taken at 95 ft (planned at 95 but taken at 75).

1.4 Quality Assurance and Quality Control Requirements

This section describes the analytical and laboratory quality assurance (QA) and QC requirements identified in 100-HR-3 OU SAP (DOE/RL-2013-35).

1.4.1 Laboratory Information

Test America Richland, ALS Environmental, and GEL Laboratories, LLC performed sample analyses.

1.4.2 Analytical Methods

Samples were analyzed using methods listed in Table 3. Both multi- and single-component method-based analyses were used. Multi-component method-based analyses are those typically based on EPA methods, as applicable, that yield concentration data for multiple analytes in a single analysis. The analytes may include both target and non-target analytes. Single-component method-based analyses are those typically based on EPA methods as applicable, that yield concentration data for a single-target analyte in a single analysis. Sample results were reported in the Hanford Environmental Information System (HEIS) database.

Table 3. Analytical Methods

Parameter	Analytical Method(s)
Soil	
Chromium	EPA 6020
Hexavalent chromium	EPA 7196
Nitrate	EPA 300 or 9056
Gross beta	GPC
Technetium-99	LSC
Water	
Calcium	EPA 6010
Chromium	EPA6020
Magnesium	EPA6010
Manganese	EPA 6020
Potassium	EPA 6010
Sodium	EPA 6010
Uranium	EPA 6020
Hexavalent chromium	EPA 7196
Bicarbonate	SM-2320
Carbonate	SM-2320
Chloride	EPA 300 or 9056
Fluoride	EPA 300 or 9056
Nitrate	EPA 300 or 9056
Phosphate	EPA 300 or 9056
Sulfate	EPA 300 or 9056
Gross alpha/beta	GPC
Strontium-90	GPC
Technetium-99	LSC

Table 3. Analytical Methods

Parameter	Analytical Method(s)
Tritium	LSC

Notes: For EPA Method 300, see EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*.

For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*.

EPA = U.S. Environmental Protection Agency

GPC = gas flow proportional counter

LSC = liquid scintillation counter

SM = standard method

1.4.3 Analytical Requirements

Analytical performance requirements for soil and groundwater samples are defined in the 100-HR-3 OU SAP (DOE/RL-2013-35). Tables 4 and 5 summarize the analytical performance requirements for laboratory analysis of soil and groundwater samples, respectively.

Table 4. Analytical Performance Requirements for Soil Samples

CAS	Analyte	EQL ^a	Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Laboratory Measurements (Radiological)					
12587-47-2	Gross beta	--	GPC	--	--
14133-76-7	Technetium-99	1.5 pCi/g	LSC	≤30 ^c	70–130 ^d
Performance Requirements for Laboratory Measurements (Non-Radiological)					
7440-47-3	Chromium	1 mg/kg	EPA 6020	≤30 ^e	70–130 ^f
7440-61-1	Uranium	1.5 mg/kg	EPA 6020	≤30 ^e	70–130 ^f
18540-29-9	Hexavalent chromium	0.5 mg/kg	EPA 7196	≤30 ^e	70–130 ^f
NO3-N	Nitrate (as N)	5 mg/kg	EPA 300.0	≤30 ^e	70–130 ^f

a. MDC for radiological measurements

b. Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement I*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*.

c. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

d. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for GEA, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method.

e. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

f. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed.

-- = no data or not applicable

CAS = Chemical Abstracts Service

EPA = U.S. Environmental Protection Agency

EQL = estimated quantitation limit

GEA = gamma energy analysis

GPC = gas proportional counting

LSC = liquid scintillation counter

Table 5. Analytical Performance Requirements for Water Samples

CAS	Analyte	EQL ^a	Analytical Method ^a	Precision Requirement (%) ^b	Accuracy Requirement (%) ^c
Performance Requirements for Laboratory Measurements (Radiological)					
12587-46-1	Gross alpha	3 pCi/L	GPC	≤30 ^c	70-130 ^d
12587-47-2	Gross beta	4 pCi/L	GPC	≤30 ^c	70-130 ^d
10098-97-2	Strontium-90 ^e	2 pCi/L	GPC	≤30 ^c	70-130 ^d
14133-76-7	Technetium-99	15 pCi/L	LSC	≤30 ^c	70-130 ^d
10028-17-8	Tritium	400 pCi/L	LSC	≤30 ^c	70-130 ^d
Performance Requirements for Laboratory Measurements (Non-Radiological)					
7440-70-2	Calcium	1,000µg/L	EPA 6010	≤20 ^c	80-120 ^d
7440-47-3	Chromium	10 µg/L	EPA 6020	≤20 ^c	80-120 ^d
7439-95-4	Magnesium	750 µg/L	EPA 6010	≤20 ^c	80-120 ^d
7439-96-5	Manganese	5 µg/L	EPA 6020	≤20 ^c	80-120 ^d
7440-09-7	Potassium	4,000 µg/L	EPA 6010	≤20 ^c	80-120 ^d
7440-23-5	Sodium	500 µg/L	EPA 6010	≤20 ^c	80-120 ^d
7440-61-1	Uranium	15 µg/L	EPA 6020	≤20 ^c	80-120 ^d
18540-29-9	Hexavalent chromium	10 µg/L	EPA 7196	≤20 ^c	80-120 ^d
CO3ALKALINITY	Carbonate	--	SM-2320	--	--
71-52-3	Bicarbonate	--	SM-2320	--	--
1 6887-00-6	Chloride	400 µg/L	EPA 300.0	≤20 ^c	80-120 ^d
16984-48-8	Fluoride	500 µg/L	EPA 300.0	≤20 ^c	80-120 ^d
NO3-N	Nitrate (as N)	100 µg/L	EPA 300.0	≤20 ^c	80-120 ^d
1 4808-79-8	Sulfate	550 µg/L	EPA 300.0	≤20 ^c	80-120 ^d
14265-44-2	Phosphate	--	EPA 300.0	--	--

a. MDC for radiological measurements

b. Equivalent methods may be substituted. For the three-digit EPA method, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For the four digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*. Tentatively identified compounds will be reported for Method 8260 (SW-846).

c. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

d. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for GEA, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method.

e. Strontium-90 will be assessed as total radioactive strontium.

-- = not applicable or no data available

CAS = Chemical Abstracts Service

EPA = U.S. Environmental Protection Agency

EQL = estimated quantitation limit

GEA = gamma energy analysis

GPC = gas flow proportional counter

LSC = liquid scintillation counter

SM = standard method

1.4.4 Laboratory Quality Assurance and Quality Control Requirements

The QA/QC requirements govern nearly all aspects of analytical laboratory operation, including instrument procurement, maintenance, calibration, and operation. Laboratory requirements for internal QC checks are performed as appropriate for the analytical method at a rate of one per sample delivery

group (SDG) or 1 in 20 (5%), whichever is more frequent. Laboratory internal QC checks include the following:

- Laboratory Contamination.** As appropriate to the method, each analytical batch contains a laboratory method blank (material of composition similar to that of the samples with known or minimal contamination of the analytes of interest) carried through the complete analytical process. The method blank is used to evaluate false positive results in samples caused by contamination during handling at the laboratory.
- Analytical Accuracy.** A laboratory control sample (LCS) is typically run with every analytical batch. The percent recovery of the LCS is used to evaluate analytical accuracy. In addition, for most analyses, a known quantity of representative analytes of interest (matrix spike [MS]) is added to a separate aliquot of a sample from the analytical batch. The known amount added is compared to the actual measured amount to calculate the percent recovery. The recovery percentage of the added MS is used to evaluate analytical accuracy. For analyses not amenable to MS techniques (such as gamma energy analysis [GEA]) or where analytical recovery is evaluated from recovery of the tracers or carriers, the accuracy of the laboratory preparation and analysis evaluation defaults to the LCS.
- Analytical Precision.** Separate aliquots removed from the sample containers (duplicate samples) are analyzed for each constituent as appropriate to the analytical method. The duplicate sample results are compared to the original sample results, which are evaluated as relative percent differences (RPDs) and are used to assess analytical precision. Alternately, a matrix spike duplicate (MSD) may be used for assessing precision. For a MSD, a separate aliquot is removed from the same sample container and spiked in the same manner as the MS. The results, not recoveries, from the MS/MSD are used to calculate a RPD and to assess precision.

Laboratories are also subject to periodic audits of laboratory performance, systems, and overall program. Audits check that the laboratories are performing to laboratory contract requirements. No audits were performed specific to the data analyses performed as part of this project.

1.4.4.1 Qualification Flags

During the generation of environmental analytical data, any of several qualification flags may be assigned to an individual result. The HEIS database carries qualification flags applied by three sources: the laboratory, third-party data validator, or a data user or reviewer. The tables of data within this report show all of these applied qualification flags. Potential flags and their meaning are provided in Table 6.

Table 6. Qualification Flags

Flag	Definition
Laboratory-Applied Flags	
>	WETCHEM – Result greater than quantifiable range or greater than upper limit of the analysis range.
*	INORGANICS – Duplicate analysis not within control limits.
+	INORGANICS – Correlation coefficient for MSA is <0.995.
A	ORGANICS – Valid for TICs only The TIC is a suspected aldol-condensation product.
B	INORGANICS and WETCHEM – The analyte was detected at a value <PQL but ≥MDL. ORGANICS – The analyte was detected in both the associated QC blank and in the sample, and the blank concentration exceeded the customer’s contractual requirements. RADIONUCLIDES – The associated QC sample blank has a result ≥2x the MDA; after corrections, result is ≥MDA for this sample.

Table 6. Qualification Flags

Flag	Definition
C	INORGANICS and WETCHEM – The analyte was detected in both the sample and the associated QC method blank, and the blank concentration is >5% of the sample result. ORGANICS (PESTICIDE only) – The identification of a pesticide confirmed by GC/MS
D	All – Analyte was reported at a secondary dilution factor, typically DF>1 (i.e., the primary preparation required dilution to either bring the analyte within the calibration range or to minimize interference). Required for organics/wetchem if the sample was diluted.
E	INORGANICS – Reported value is estimated because of interference. See comment on cover page, hardcopy case narrative, or specific inorganic hardcopy data sheet.
J	ORGANICS – Estimated value constituent detected at <PQL and ≥MDL and estimated concentration of TICs.
M	INORGANICS – Duplicate precision criteria not met.
N	All (except GC/MS based analysis) – Spike and/or spike duplicate sample recovery is outside control limits. ORGANICS (GC/MS only) – Presumptive evidence of compound based on mass spectral library search.
o	All: The laboratory control sample recovery is outside control limits.
P	ORGANICS (PCB only) - Aroclor target analyte with >25% difference between column analyses.
Q	ORGANICS (dioxins & PCB-congeners only) – Estimated maximum concentration. Used if one of the qualitative identification criteria is not met (e.g., chlorine isotopic ratios outside theoretical range).
S	INORGANICS – Reported value determined by the MSA.
T	ORGANICS (GC/MS only) – Spike and/or spike duplicate sample recovery is outside control limits.
U	All – The constituent was analyzed for and was not detected. The data should be considered usable for decisionmaking purposes.
W	INORGANICS– Post-digestion spike recovery for GFAA out of control limit. Sample absorbance <50% of spike absorbance.
X	All – The result-specific translation of this qualifier code is provided in the data report and/or case narrative. Additional result-specific translation information may also be found in the result comment field in HEIS for this record.
Y	Same as X if more than one flag is required.
Z	Same as X and Y if more than two flags are required.
Third Party-Validation Applied Flags	
UJ	The constituent was analyzed for and was not detected. Because of a quality control deficiency identified during data validation, the value reported may not accurately reflect the RL. The data should be considered usable for decisionmaking purposes.
J	Indicates the constituent was analyzed for and detected. The associated value is estimated because of a quality control deficiency identified during data validation. The data should be considered usable for decisionmaking purposes.
J+	Indicates the constituent was analyzed for and detected. The result is an estimated quantity, but the result may be biased high. The data should be considered usable for decisionmaking purposes.
J-	Indicates the constituent was analyzed for and detected. The associated value is estimated with a suspected negative bias due to quality control deficiency identified during data validation. The data should be considered usable for decisionmaking purposes.
NJ	The analysis indicates the presence of an analyte that has been tentatively identified and the associated numerical value represents its approximate concentration.
C	The target pesticide or Aroclor analyte identification has been confirmed by GC/MS.

Table 6. Qualification Flags

Flag	Definition
X	The target pesticide or Aroclor analyte identification was not confirmed when GC/MS analysis was performed. The data should be considered unusable for decisionmaking purposes.
UR	Indicates the constituent was analyzed for and not detected. However, due to an identified quality control deficiency, the data should be considered unusable for decision-making purposes.
R	Rejected value: The value may not reflect true concentrations. The ability to establish detection/non-detection may be questionable. Validation activities identified major quality control deficiency/ies or sample matrix interferences. The data should be considered unusable for most purposes. Any use of this data should be undertaken with great care. The data should not be used for certain regulatory decisionmaking purposes.
Data User-Applied Flags	
A	Indicates an issue with the chain of custody that could affect data usability.
F	Result is undergoing further review. (This review qualifier is assigned when a RDR is first processed.)
G	Record has been reviewed and determined to be correct, or the record has been corrected with laboratory confirmation or other supporting information.
H	Laboratory holding time exceeded before the sample was analyzed.
P	Potential problem. Collection/analysis circumstances make the result questionable.
Q	Associated quality control sample is out of limits.
R	Do not use. Further review indicates the result is not valid. (This review qualifier is used only when there is documented evidence 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 may be found in the result comment field (in the HEIS result table) for this record and/or in the sample comment field in the HEIS sample table.

Note: Wetchem is a group of analytical methods that are associated with "wet" chemical reactions.

DF = dilution factor	MSA = method of standard additions
GC/MS = gas chromatograph/mass spectrometer	PQL = practical quantitation limit
GFAA = graphite-furnace atomic absorption	QC = quality control
HEIS = Hanford Environmental Information System	RDR = request for data review
MDA = minimum detectable activity	RL = reporting limit
MDL = method detection limit	TIC = tentatively identified compound

1.4.5 Field Quality Control Sampling Requirements

The 100-HR-3 OU SAP (DOE/RL-2013-35) required collection of full trip blank (FTB) samples, equipment rinsate blank (EB) samples, and field duplicate samples (DUP). Table 7 summarizes the required frequency for each field QC sample type.

Table 7. Project Field Quality Control Checks

QC Sample Type	Purpose	Frequency
Full trip blank	Assess contamination from containers or transportation	1 per 20 samples, <i>per media sampled</i> .
Equipment rinsate blank	Verify adequacy of sampling equipment decontamination	As needed. ^a If disposable equipment is used or equipment is dedicated to a particular well, then an equipment rinsate blank is not required. Otherwise, 1 per 20 samples, <i>per media sampled</i> .

Table 7. Project Field Quality Control Checks

QC Sample Type	Purpose	Frequency
Field duplicates	Estimate precision, including sampling and analytical variability	One per batch, ^b 20 samples maximum, for groundwater monitoring activities. A minimum of one field duplicate will be collected at each borehole <i>per media sampled</i> .

a. Whenever a new type of non-dedicated equipment is used, an equipment rinsate blank will be collected every time sampling occurs until it can be shown that less frequent collection of equipment rinsate blanks is adequate to monitor the decontamination procedure for the non-dedicated equipment.

b. Batching across projects is allowed for similar matrices (e.g., Hanford Site groundwater).

QC = quality control

1.4.5.1 Field Blank Requirements

Full trip blanks are used to monitor for potential sample contamination from the sampling container, preservation reagents, or storage conditions. Trip blanks are prepared and sealed prior to traveling to the sampling site, transported to the sampling site (not opened in the field), and then shipped as part of the sample set to the laboratory. Full trip blanks may be used for all or a subset of the analyses as defined by project-specific standard operating procedures (SOPs), SAP, or other work control document. When used for volatile organic compounds analysis only, the QC samples are frequently identified as a daily trip blank.

Equipment blanks (EBs), also known as equipment rinsate blanks, are used to monitor the effectiveness of the decontamination process for reusable sampling equipment. EBs are not usually required for dedicated sampling equipment, disposable sampling equipment, or vendor-provided sampling equipment (e.g., used during a borehole drilling event). They are samples of high purity deionized water or silica sand contacted with the sampling surfaces of equipment used to collect samples prior to using that equipment for field sampling. EBs are collected at the frequency specified in the project-specific SOPs, SAP, or other work control documents. An EB shall be collected from each type of reusable sampling equipment to ensure that the decontamination procedures are effective for the specific equipment types. EBs shall be analyzed for the same analytes as samples collected using that equipment or as specified in the project-specific SOPs, SAP, or other work control documents.

For the field blank samples (e.g., full trip blank, equipment rinsate blank), results greater than two times the method detection limit (MDL) are identified as suspected contamination. For radiological data, blank results are flagged as suspected contamination if they are greater than two times the total minimum detectable concentration (MDC).

1.4.5.2 Field Duplicate Requirements

Field duplicate samples are used to evaluate sample homogeneity of the sample matrix, the precision of field sampling methods and the precision of the analysis processes. Field duplicates are independent samples collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers, and analyzed as independent samples at a single laboratory.

The duplicate should be collected generally from an area expected to have some contamination so that valid comparisons between the samples can be made (e.g., at least some of the constituents will be greater than detection limit).

Only those field duplicate result pairs with at least one result greater than five times the MDL or MDC are evaluated. Field duplicate sample results for samples must agree within 20% (water) or 30% (soil) as measured by the RPD to be acceptable. Large RPDs can be an indication of laboratory performance problems and should be investigated.

A **field split** is a representative sample from a sampling event sent to a third-party laboratory (i.e., reference laboratory). Evaluation of the results can provide an indication of inter-laboratory variability.

1.4.6 Laboratory Quality Control Requirements

In addition to the evaluation performed on field QC data (as described in Section 1.4.5), a broad review of the laboratory QC results was also conducted. Laboratory QC results are stored electronically in HEIS and were evaluated using various database queries against the acceptance criteria. Table 8 provides a summary of the laboratory QC acceptance criteria used.

Table 8. Laboratory QC Acceptance Criteria

QC Element	Acceptance Criteria
Laboratory duplicate samples	Laboratory duplicate samples with one or both of the measured concentrations \geq PQL (or 5x the MDC for radiochemistry) and the RPD is \leq 20% for water and \leq 30% for solid matrices to be considered acceptable.
Laboratory blank samples	If analyte concentration in the laboratory blank is \geq MDL/MDA but \leq PQL, no qualification is necessary when the concentration in the associated samples is \geq 20x the laboratory blank concentration.
LCSs	LCS percent recovery must be between the upper and lower control limits listed in the 100-HR-3 OU SAP (DOE/RL-2013-35) and summarized in Tables 4 and 5.
Matrix spikes/matrix spike duplicates (where applicable)	Where the sample result is \leq 4x the spiking concentration, laboratory spikes are evaluated by comparing the percent recovery with the upper and lower accuracy control limits given in Tables 4 and 5. In addition, where the sample result is \leq 4x the spiking concentration, the MS/MSD RPD must have an RPD \leq 20% for water and \leq 30% for solid matrices. Spike values not applicable when sample result is $>$ 4x the spiking concentration.

Source: DOE/RL-2013-35, 100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan.

LCS = laboratory control sample	OU = operable unit
MDA = minimum detectable activity	PQL = practical quantitation limit
MDC = minimum detectable concentration	QC = quality control
MDL = method detection limit	RPD = relative percent difference
MS = matrix spike	SAP = sampling and analysis plan
MSD = matrix spike duplicate	

2 Data Verification

Data verification is the process of evaluating the completeness, correctness, conformance, and compliance of a specific data set against the method, procedural, or contractual requirements. The process includes confirmation that the specified sampling and analytical requirements have been completed (i.e., verification that the number, type, and location of all samples identified in the 100-HR-3 OU SAP [DOE/RL-2013-35] and addenda have been collected and that all required measurements and analyses were performed). This evaluation is documented in the completeness section (Section 4.1.5), which evaluates the sampling design versus field implementation. In addition, verification is performed for field QC and laboratory QC samples and is documented in the field QC and laboratory QC sections (Sections 2.2 and 2.3, respectively).

2.1 Data Verification Results

Data verification requires the evaluation of collected documentation to verify that key information for subsequent validation and data indicator evaluations are present.

In accordance with CHPRC procedures, data verification is performed, which requires verification of a minimum of 25% of all final analytical data packages. Final analytical data package verification was performed on randomly selected data deliverables. This random selection is not project specific (i.e., the actual percent of data deliverables verified for the 100-HR-3 OU may be more or less than 25%). For the data set addressed in this DUA, 46.5% of the data packages were verified.

The following sections provide an evaluation and description of the sampling design versus field implementation. All discrepancies between the sampling and analysis requirements outlined in the 100-HR-3 OU SAP (DOE/RL-2013-35) (and applicable addenda) and what was actually performed are identified. Data verification is performed for field QC and laboratory QC samples.

2.2 Field Quality Control

The results of the field blanks, field duplicates, and field splits are discussed below.

2.2.1 Field Blanks

Field EB samples are analyzed to determine if positive results may be attributed to contaminants introduced as a result of sampling equipment. Any analyte measured above the laboratory detection limits is evaluated for potential impacts to associated sample results.

One EB was run in conjunction with the 100-HR-3 OU soil interval sampling for total and hexavalent chromium. The hexavalent chromium result was non-detect, and the total chromium, while a detection, was below two times the MDL and also below the method practical quantitation limit (PQL). The detection does not meet the SAP requirements for a suspected contamination. In addition, Ottawa sand was used as the EB. Detectable levels of trace metals are commonly observed in Hanford FTBs using this material.

Twenty-seven FTB samples were collected in conjunction with the 390 samples (125 soil and 265 water) in this data set. Six of the FTB samples were soil (7 were needed to meet 1 in 20) and 21 FTB samples were water (14 were needed to meet the 1 in 20 requirement). For the six soil FTBs, 10 results were evaluated. Three results were non-detects (one each for nitrate, technetium-99, and hexavalent chromium) and seven were detections: two hexavalent chromium, three chromium, one uranium, and one gross beta). The two hexavalent chromium, one of the chromium, and the gross beta detections fall below SAP criteria for a possible contamination. The other two chromium and the uranium detections were associated with a dilution at the laboratory and indicate a possible lab error rather than contamination and sample results associated with these blanks should be considered usable. For the 21 water FTBs, 65 results were evaluated. All results were non-detects.

2.2.2 Field Duplicates

Field duplicate samples were required to be collected at a frequency of not less than 1 per 20 field samples for water samples from new wells. Nine groundwater field duplicate samples and one groundwater field split were collected, which meets the field QC frequency criteria. The field duplicates and field split samples were analyzed for the same target analytes as the primary field samples. Duplicate pair results were evaluated if at least one of the two results was greater than five times the MDL or MDC. A total of 115 duplicate pair results were evaluated. All RPD results were within ± 20 RPD when the results met the evaluation criteria.

A minimum of one DUP was required to be collected at each new well, *per media sampled*. Ten sediment field duplicates and one sediment split were collected from well borings. The field duplicates and field split samples were analyzed for the same target analytes as the primary field samples. A total of 17 duplicate pair results were evaluated. All but one met the 30% RPD criteria when the results met the evaluation criteria. The gross beta result, with a RPD of 40% from a soil sample collected at well 199-H3-12 did not meet criteria. Only one result actually met the evaluation criteria and indicates this was a discrete counting issue rather than a sampling issue. Duplicate sediment samples were not collected from wells 199-H1-12, 199-H7-1, 199-H1-50, 199-H3-13, and 199-H3-22. SAP duplicate collection criteria for soils was not met for these wells. During the sample planning process, duplicates are assigned based on site wide activities in order to meet the routine requirement of 1 duplicate per 20 samples. The requirement in this SAP to perform one duplicate and one FTB per borehole was inadvertently omitted.

2.3 Laboratory Quality Control

Laboratory contamination, precision and accuracy are discussed below.

2.3.1 Laboratory Contamination

CHPRC laboratory contracts require that laboratory method blanks be analyzed with each batch of up to 20 samples.

A total of 369 laboratory blank results were reported for the water samples. Of those blank results, nine blank results reported detected concentrations above the MDL but below the PQL, and two results were above the PQL. Eight of the blanks with results less than the PQL has associated samples results over 20 times the blank value. One uranium blank had results associated sample results less than 20 times the blank value, and the two associated samples (from well 199-H3-30) were flagged accordingly. Both blank results that were above the PQL (sodium and potassium) had sample results over 20 times the blank concentration. All of the laboratory blank results for the water samples, except for the one uranium described above, satisfied evaluation criteria. The one blank failure was also noted during third party validation and the associated sample results flagged J+ indicating usable data but with a possible high bias.

A total of 128 laboratory blank results were reported for soil samples. Of the 128 blank results, one blank result (for gross beta) reported detected concentrations above the MDC. The result of the associated sample from well 199-H3-22 was also a detection above the MDC. Because of the blank contamination, the laboratory applied a "B" qualifier to the result, indicating a possible high bias.

2.3.2 Laboratory Precision

Laboratory precision was determined by the difference between duplicate sample pair results or between MS/MSD sample results. Evaluation of the duplicate pairs can be performed accurately only when there is sufficient constituent present to be quantified. Therefore, only RPDs where at least one of the samples in the pair was detected above the PQL (or over five times the MDC for radiochemical constituents) were evaluated.

For the water samples, a total of 268 duplicate and 165 MS/MSD pairs were evaluated. All of the duplicate pairs meeting the evaluation criteria had acceptable RPDs. All MS/MSD pairs met evaluation criteria and all had acceptable RPDs.

For the soil samples, a total of eight MS/MSD pairs were evaluated and all MS/MSD pair RPDs were acceptable. In addition, a total of 74 duplicate pairs were evaluated. Three sample/duplicate pairs, two for chromium and one for uranium, exceeded the 30% RPD control limits. Two of the duplicate RPD exceedances (one chromium and one uranium) were associated with four samples from well 199-H3-13. The RPD issue for these samples was also identified in third-party validation and the associated results

were flagged with a “J” validation qualifier. The other duplicate RPD exceedance (chromium) was associated with one sample from well 199-H1-12. There were no validation qualifiers applied to this sample.

2.3.3 Laboratory Accuracy

Three types of QC are used to assess accuracy. The LCS is used to assess the accuracy of the laboratory preparation and analysis processes. The MS samples are used to assess the accuracy of the published method on the sample matrix and evaluate matrix effects that may bias the data. Tracer and carrier recoveries can also be used to evaluate method accuracy. Sample and QC results are corrected for tracer and carrier recovery; however, the acceptable percent recovery ranges are quite large.

2.3.3.1 Laboratory Control Samples

A total of 378 LCS results were reported for water samples and a total of 92 LCS results were reported for soil samples. All LCS recoveries satisfied the evaluation criteria.

2.3.3.2 Matrix Spike Recovery

Matrix spike and matrix spike duplicate recoveries are also used as a measure of analytical accuracy. In cases where the sample concentration is greater than four times the spiking concentration, spike recoveries are not evaluated.

There were a total of 531 matrix spike sample results reported for the water samples and 12 spike recoveries that did not meet SAP accuracy criteria. A summary of spike failures and impacted samples follows:

- One calcium spike associated with sample B3NHF0 (199-H1-12)
- One chloride spike associated with sample B3N6H1 (199-H1-50)
- One chromium spike associated with samples B3MPD7 (199-H3-12), B3MPD8 (199-H3-12), B3MPR9 (199-H3-13), and B3MPT0 (199-H3-13)
- Two magnesium spikes associated with samples B3N4V4 (199-H7-1) and B3N6H4 (199-H1-50)
- One nitrate spike associated with samples B3BK73 and B3BK81 (199-H3-29)
- Two sodium spikes associated with samples B3N4V4 and B3N503 (199-H7-1)
- Three sulfate spikes associated with samples B3MPD6 (199-H3-12), B3MPR8 (199-H3-13), B3N6H1 (199-H1-50), B3BK73 (199-H3-29), and B3BK81 (199-H3-29)
- One hexavalent chromium associated with samples B3BJC4 and B3BJB6 (199-H1-49)

With the exception of the hexavalent chromium, all other spike recoveries were not significant enough to affect data usability. The hexavalent chromium spike recovery was identified in third-party validation as being very low and resulted in the non-detect sample value being rejected with a “UR” flag.

There were a total of 84 matrix spike results reported for the soil samples. There were eight spike recoveries that did not meet SAP accuracy criteria. A summary of the spike failures and impacted samples follows:

- Six chromium spikes associated with samples B3MP30 (199-H3-22), B3MP35 (199-H3-22), B3MP36 (199-H3-22), B3MPL7 (199-H3-13), B3MPM3(199-H3-13), B3MPM7 (199-H3-13), B3MT41 (199-H3-32), B3N6F2 (199-H1-50), B3NHC0 (199-H1-12), and B3NP8 (699-95-45C)

- Two hexavalent chromium spikes associated with samples B3BK30, B3BK05, B3BK07, B3BK10, and B3BK13 (199-H3-29), B3MP82 (199-H3-12), and B3MP88 (199-H3-12)

In the case of the chromium spike failures, there were passing post digestion spikes also run. These data indicate the chromium spike failures were either due to soil inhomogeneity or a matrix interference. None of the failing soil spike recoveries was significant enough to impact data usability.

2.3.3.3 Tracer/Carrier Recovery

Tracers (Tc-99) and carriers (strontium-90) were analyzed in association with the applicable samples and lab QC. The SAP does not specifically address tracer and carrier acceptance criteria, so the lab-established method performance criteria were used for evaluation. A total of 211 results were evaluated. All tracer and carrier recoveries satisfied the analytical method performance requirements.

3 Data Validation

Data validation is an analyte- and sample-specific process that extends the evaluation of data beyond method or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set, typically data in single analytical batches. Data validation is an independent assessment to ensure that the reliability of data is known by the user. Analytical data validation provides a level of assurance, based on technical evaluation that an analyte is either present or absent. Validation includes verification of required deliverables (e.g., the minimum detection limits), evaluation of analytical results based on method blanks, and the effect of quality deficiencies on the analytical sample data. Third-party validation was performed on a minimum of 5% of the project data and is described in this chapter.

3.1 Data Validation

Analytical Quality Associates, Inc. performed data validation.. All validation qualifiers resulting from data validation were entered into HEIS.

3.2 Data Validation Results

The 100-HR-3 OU SAP (DOE/RL-2013-35) specifies that at least 5% (by matrix and analyte group) of all chemical and radiochemical data must undergo validation. Level C data validation includes the evaluation and qualification of sample results based on the following:

- Matrix spike, laboratory control sample, laboratory duplicate, and chemical recovery criteria (as appropriate to the method)
- Examined field blanks, field duplicates, and field splits (if information is provided)

Table 9 summarizes the samples and constituents that were independently validated for the 100-HR-3 OU drilling campaign. As shown in Table 9, the 5% 100-HR-3 OU SAP (DOE/RL-2013-35) requirement was satisfied for all matrices and constituents.

Table 9. Validated Sample Summary

Analyte	Total Number of Samples Analyzed	Total Number of Samples Validated	Percent Validated
Soil Samples			
Chromium	47	7	14.9
Uranium	13	7	53.8

Table 9. Validated Sample Summary

Analyte	Total Number of Samples Analyzed	Total Number of Samples Validated	Percent Validated
Hexavalent chromium	69	7	10.1
Nitrate	13	7	53.8
Gross beta	13	6	46.2
Technetium-99	13	7	53.8
Water Samples			
Calcium	39	4	10.3
Chromium	87	10	11.5
Magnesium	38	4	10.5
Manganese	23	2	8.7
Potassium	38	4	16.7
Sodium	24	2	8.3
Uranium	39	4	10.3
Hexavalent chromium	92	6	6.5
Bicarbonate	35	4	11.4
Carbonate	34	4	11.8
Chloride	24	2	8.3
Fluoride	27	2	7.4
Nitrate	38	2	5.3
Sulfate	33	2	6.1
Gross alpha	11	2	18.2
Gross beta	21	2	9.5
Strontium-90	20	4	20
Technetium-99	35	4	11.4
Tritium	10	3	30

Percent complete for all soil categories was 100% with only three minor deficiencies (discussed below) identified. Percent complete for all water categories except hexavalent chromium was 100% with only two minor deficiencies (discussed below) identified.

3.2.1 Major Deficiencies

For hexavalent chromium there was a very low matrix spike recovery leading to the rejection of two water sample results, which gave a percent complete of the validated data set of 66.7% for hexavalent chromium.

3.2.2 Minor Deficiencies

A minor deficiency results in qualification of sample data as an estimate; however, the data are considered usable for decisionmaking purposes.

In the water samples, a minor deficiency (due to contamination in the blank) led to the uranium results for two samples being qualified as estimates and flagged “J+.” In addition, a minor deficiency (analysis outside the hold time but within twice the hold time) led to the hexavalent chromium results for four samples being qualified as estimates and flagged “J-.”

In the soil samples a minor deficiency (due to low matrix spike recovery and poor duplicate precision) led to the chromium results for four samples being qualified as estimates and flagged “J.” In addition, a minor deficiency (due to poor duplicate precision) led to the uranium results for four samples being qualified as estimates and flagged “J.”

3.2.3 Qualification Flags Applied to the Data Set

Tables 10 and 11 list the qualification flags applied to the data set as a result of the data validation process.

Table 10. Summary of Data Validation Qualification Flags for Soil Samples

Method/Analyte(s)	Qualifier*	Affected Samples	Reason
Radiochemistry			
Radiochemical	None	N/A	N/A
Inorganics (EPA 6020-ICP/MS Metals)			
Cr	J	BIMPL7, B3MPM3,B3MPM7, B3MPN3	Low matrix spike recovery and poor duplicate precision
U	J	BIMPL7, B3MPM3,B3MPM7, B3MPN3	Poor duplicate precision
Inorganics (EPA 6010-ICP-AES Metals)			
ICP-AES	None	N/A	N/A
Inorganics (EPA 9056A Anions)			
N/A	None	N/A	N/A
Inorganics (EPA 7196A– Hexavalent Chromium)			
Cr VI	None	N/A	N/A

Note: For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*.

*Qualifiers are defined in Section 1.4.4.1.

EPA = U.S. Environmental Protection Agency

ICP-AES = inductively coupled plasma-atomic emission spectroscopy

ICP/MS = inductively coupled plasma/mass spectrometry

N/A = not applicable

Table 11. Summary of Data Validation Qualification Flags for Water Samples

Method/Analyte(s)	Qualifier*	Affected Samples	Reason
Radiochemistry			
Radiochemical	None	N/A	N/A
Inorganics (EPA 6020-ICP/MS Metals)			
U	J+	B3BKT3, B3BKV2	Laboratory blank contamination
Inorganics (EPA 6010-IC-/AES Metals)			
ICP-AES	None	N/A	N/A

Table 11. Summary of Data Validation Qualification Flags for Water Samples

Method/Analyte(s)	Qualifier*	Affected Samples	Reason
Inorganics (SM 2320 Alkalinity)			
N/A	None	N/A	N/A
Inorganics (EPA 9056 Anions)			
N/A	None	N/A	N/A
Inorganics (EPA 7196A– Hexavalent Chromium)			
Cr(VI)	J-	B3N6D6, B3N6D7, B3NHC9, B3NHD4	Analysis beyond but within twice the holding time
Cr(VI)	UR	B3BJC4, B3BJB6	Very low matrix spike recovery

Note: For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*.

*Qualifiers are defined in Section 1.4.4.1.

EPA	=	U.S. Environmental Protection Agency
ICP-AES	=	inductively coupled plasma-atomic emission spectroscopy
ICP/MS	=	inductively couples plasma/mass spectrometry
N/A	=	not applicable
SM	=	standard method

3.2.3.1 Holding Times and Sample Preservation

Holding times are defined as the period of time from sample collection to sample analysis or extraction, and the period of time from sample extraction to sample analysis. Holding times are calculated from the date of sample collection as recorded on the chain-of-custody form to determine the validity of the results.

Soils. The holding time requirements for the constituents in soils are as follows. No specific preservation requirements exist for metals analysis in soil.

- The holding time requirements for inductively coupled plasma (ICP) and ICP/mass spectrometry (ICP/MS) metals are analysis within 180 days of sample collection.
- Hexavalent chromium requires extraction within 30 days of sample collection and analysis within 7 days of extraction.
- Anions require extraction within 28 days of sample collection and analysis within 48 hours of sample extraction
- The holding time requirements for radiochemistry methods are analysis within 180 days of sample collection.

All soil samples were properly preserved and analyzed within the prescribed holding times.

Water. The holding times and preservation requirements for the constituents in water are as follows:

- The holding time requirements for ICP and ICP/MS metals are analysis within 180 days of sample collection. Sample preservation requires nitric acid addition to pH <2.
- The holding time requirements for all anions except nitrate and phosphate are analysis within 28 days of sample collection. The holding time requirements for nitrate and phosphate are analysis within 48 hours of sample collection.

- Hexavalent chromium requires analysis within 24 hours of sample collection.
- Alkalinity requires analysis within 14 days of sample collection.
- The holding time requirements for radiochemistry methods are analysis within 180 days of sample collection. Sample preservation for all constituents except tritium requires nitric acid addition to pH <2.

All water hold times and preservation requirements were met, with the exception of hexavalent chromium. Two hexavalent chromium samples were analyzed outside twice the hold time, and six hexavalent chromium samples were analyzed outside of hold time but within two times hold time. While two hexavalent chromium sample results were flagged rejected “R” as a result of hold time exceedance, hexavalent chromium in Hanford Site groundwater has been observed to be stable over several months, and sample results are expected to be representative of actual concentrations at the time of sampling.

4 Data Quality Indicator Evaluation

The DQI evaluation process is used to assess data usability for non-statistical (judgmental) sampling designs. Data verification and data validation reports were reviewed to determine the usability of the data set as a whole and the quality of individual results as appropriate in terms of the following DQIs:

- **Precision** – Describes the repeatability of field duplicate data and laboratory QC duplicates (e.g., RPDs of laboratory sample duplicates, laboratory control sample duplicates, and matrix spike/matrix spike duplicates).
- **Accuracy/Bias** – Discusses evidence of field contamination and laboratory QC (e.g., percent recoveries of laboratory control samples and matrix spikes).
- **Representativeness** – Discusses the extent to which the sampling design was accomplished, the representativeness of the samples, and the design as a whole. Identify any specific measurements not representative of the target condition, explain why they are non-representative, and discuss the impact to the data set.
- **Comparability** – If multiple laboratories were used or if this data set is intended to be combined with others, discuss the nature of differences that may limit the comparability. For example, note that samples were analyzed using recognized standard methods. If multiple laboratories analyzed field QC split samples, discuss how closely the results agreed between the two laboratories.
- **Completeness** – Discusses the accomplishment of all SAP-required data generating activities. Include a comparison of samples actually collected versus those identified in the original sampling design. Include required field QC blanks, duplicates, and splits in the comparison. Also, compare the analyses performed to the analyses identified in the SAP. Comment on the impact to data set usability of any planned samples that were not taken or analyses not performed.
- **Sensitivity** – Discusses any laboratory data that do not meet the SAP-required reporting limits and other decision thresholds as described in the project DQOs.

4.1 Data Quality Indicator Evaluation Results

The DQI evaluation step involves assessing whether the samples collected and the resulting analytical data meet project quality objectives in terms of the DQIs described above. The data verification acceptance rates discussed below are based on the evaluation of QC performance compared to the SAP requirements for the entire data set. Validation acceptance rates are based on the data determined to be legitimate (i.e., not rejected) in the validated data set.

4.1.1 Precision

Laboratory precision is determined by the difference between duplicate sample pair results or between MS/MSD sample results. Data verification results showed an overall precision QC acceptance rate of 96.3% in the soil samples and 100% in the water samples. No results are deemed unusable based on the verification review of precision.

Data validation for soils resulted in the qualification of chromium (four samples) and uranium (four samples) results based on poor duplicate precision. Data validation for water resulted in no qualifications based on precision. Data validation results show an overall QC acceptance rate of 100% for precision.

4.1.2 Accuracy/Bias

Laboratory accuracy is assessed by using three types of QC: LCS, MS/MSD, and tracer/carrier recoveries. These QC types are used to determine the accuracy of the laboratory preparation and analysis process and to evaluate matrix effects that may bias the data.

Data verification results for the soil samples showed an overall accuracy QC acceptance rate of 90.5% based on matrix spike recovery; however, post-spike results for all failed spikes passed, indicating this was a matrix or homogeneity issue in the soil. All LCS, tracer, and carrier recoveries satisfied the QC criteria. No results are deemed unusable based on the verification review of accuracy.

Data verification results for the water samples showed an overall accuracy QC acceptance rate of 97.7% based on matrix spike recovery. All LCS, tracer, and carrier recoveries satisfied the QC criteria. Two hexavalent chromium samples were rejected due to very low spike recoveries, giving an overall hexavalent chrome acceptance rate of 97.8% in the water samples.

Data validation resulted in the qualification of four chromium soil samples. Data validation results show an overall QC acceptance rate of 100% for accuracy in the soils.

Data validation for the water samples resulted in the rejection of two hexavalent chromium samples for a completeness percentage of 66.67% in the validated hexavalent chrome data. However, this percentage changes to 97.8% when all hexavalent chromium samples are considered. For the remainder of the constituents, the QC acceptance rate is 100% for accuracy in the water samples.

Ten hexavalent chromium results were flagged as suspect (Y) as part of the routine data review process. Six of those ten were flagged due to a known bias that can occur when iron and manganese are released to groundwater during drilling, which causes reducing conditions and artificially lowers hexavalent chromium concentrations.

Other than the known bias that can occur with hexavalent chromium measured in samples taken during drilling, there were no systemic biases overall identified for this data set.

4.1.3 Representativeness

Other than the very low spike recovery resulting in two rejected hexavalent chromium samples, the other quality control issues noted are relatively minor. Associated data for all samples except the two rejected values are considered valid for decisionmaking purposes. Overall, data quality indicators show the data sets to be representative of their respective sample locations with no systemic bias noted.

4.1.4 Comparability

To generate comparable data, sampling was accomplished using the same procedures used uniformly over the Hanford Site for field sampling. To generate comparable results, laboratory analyses were performed using industry-recognized standard procedures (Table 3).

During the sample analysis period for this data set, the labs performing the analysis had no systemic analytical issues identified. All labs maintained Washington state accreditation, indicating they passed two performance evaluation samples each year.

4.1.5 Completeness

All samples estimated for collection and all required data generating activities outlined in the applicable addenda of the 100-HR-3 OU SAP (DOE/RL-2013-35) were completed, with the following exceptions:

- Well 199-H3-22: One soil sample and two water samples were not taken.
- Well 199-H3-12: Two water samples were not taken.
- Well 199-H3-13: One soil sample was not taken.
- Well 199-H7-1: No water sample was taken at 95 ft.

In every case but one, samples were not taken because sample material was not available at the required depth or the depth was not reached. For well 199-H7-1, the water sample at 95 ft was not planned.

As outlined in the addenda, all required constituents were reported, with the following exceptions:

- There are no results for one soil sample analyzed for hexavalent chromium and the post-development phosphate result from well 699-97-47C.
- No strontium-90 results for the water samples were collected from well 199-H7-1.

4.1.5.1 Field Blanks

For water samples, analysis of 21 FTBs was performed. The 21 FTBs exceed the SAP required 14 FTBs, which was based on analyzing 1 FTB for every 20 samples.

For soil samples, analysis of one soil EB and six soil FTBs were performed. The one soil EB met the SAP requirement, which was based on analyzing one EB every time reusable sampling equipment was used. The six soil FTBs did not meet the SAP required seven soil FTBs, which was based on analyzing one FTB for every 20 samples. One FTB was inadvertently omitted during sample planning.

The overall performance of the field blanks is discussed in Section 2.2.1. No significant issues were noted.

4.1.5.2 Field Duplicates

For water samples, nine duplicates and one field split were performed. The nine duplicates meet the 1 in 20 frequency requirement for water field duplicates.

For soil samples, 10 field duplicates and 1 split were run. The SAP requires a field duplicate to be run for each borehole; however, this requirement is not routine and was inadvertently missed during sample planning for 5 of the 15 wells drilled. Duplicate sediment samples were not collected from wells 199-H1-12, 199-H7-1, 199-H1-50, 199-H3-13, and 199-H3-22. The overall performance of the field duplicates is discussed in Section 2.2.2. No significant issues were noted.

4.1.6 Sensitivity

For the metals and general chemistry analysis, the estimated quantitation limit (EQL) review was done by confirming that all "B" flagged (detected but below the lab PQL) results were below the 100-HR-3 OU SAP (DOE/RL-2013-35) EQL requirements listed in Tables 4 and 5. For the radiochemistry results, the MDC of samples with non-detected values were compared to the MDC values in the SAPs. All metals

and general chemistry values met the required EQL values dictated in the 100-HR-3 OU SAP. All radiochemistry non-detects met the required MDC, with the exception of the following:

- All non-detect Tc-99 values in both soil and water
- Two non-detect values for tritium in water

The Tc-99 MDC requirement in water is 15 pCi/L; the lab achieved values varying between two and three times the required value. The Tc-99 MDC requirement in soil is 1.5 pCi/kg; the lab achieved values approximately two times the required value. For tritium in water, the required MDC value is 400 pCi/L; the lab achieved approximately 50 pCi/L. For radiochemistry, the lab reports actual measured values; therefore, the reported non-detect values are not censured to the MDC value. While the laboratories did not meet the SAP requirements for these two constituents, they did meet the contractual requirements outlined in the statement of work. There were no action levels dictated by the 100-HR-3 OU SAP (DOE/RL-2013-35).

5 Data Quality Assessment

The 100-HR-3 OU SAP (DOE/RL-2013-35) and associated addenda are based on a judgmental sampling design, which does not require a statistical evaluation of the results.

6 Conclusions

Based on the results of this DUA, the sample set is sufficiently complete as there is a low overall degree of qualified data points. Given the high degree of acceptable data, the analytical results are considered useable for their intended purposes as indicated in Chapter 4. Samples were collected and analyzed as specified in the 100-HR-3 OU SAP (DOE/RL-2013-35) and the associated addenda. Sample results accurately indicate the presence or absence of target analyte contamination at sample locations.

Laboratory and matrix accuracy and precision were in control overall and no systematic or general discrepancies were obvious. Sample results appear to be representative of site conditions at the time of collection. Results obtained are comparable to industry standards in that collection and analytical techniques followed approved, documented procedures (except as noted in this report and reflected in qualified data points). All results are reported in industry standard units.

Detection limits, precision, accuracy, and data completeness were evaluated to determine whether any analytical data should be rejected as a result of QA/QC deficiencies. The conclusions of this DUA are that the data that have been collected are of the right type, quality, and quantity for direct regulatory use.

While there was no specific data verification requirement called out in the SAP for the data set addressed in this DUA, 46.5% of the data packages were verified with no significant issues noted. Lastly, the 5% 100-HR-3 OU SAP (DOE/RL-2013-35) requirement for data validation was satisfied. Data validation was performed on 10.1% to 53.8% of soil samples, and 5.3% to 30.0% of water samples, depending on analyte group.

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