

100-K-47:2 AND 100-K-60:1 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 89303320DEM000030



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Terms

bgs	below ground surface
DQI	data quality indicator
DUA	data usability assessment
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HEIS	Hanford Environmental Information System
LCS	laboratory control sample
MDC	minimum detectable concentration
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
PQL	practical quantitation limit
QA	quality assurance
QC	quality control
RDL	required detection limit
RDR/RAWP	remedial design report/remedial action work plan
RPD	relative percent difference
SAP	sampling and analysis plan
SDG	sample delivery group
UCL	upper confidence limit
WAC	<i>Washington Administrative Code</i>
WI	work instruction

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1 Introduction

This data usability assessment (DUA) evaluates laboratory data for soil samples collected as part of the 100-K-47:2 and 100-K-60:1 waste site verification sampling. The data quality indicator (DQI) assessment included in this DUA is used for samples collected under DOE/RL-96-22, *100 Area Remedial Action Sampling and Analysis Plan* (hereinafter referred to as the 100 Area sampling and analysis plan [SAP]), and DOE/RL-96-17, Rev. 6, *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (hereinafter referred to as the 100 Area remedial design report/remedial action work plan [RDR/RAWP]). A DQI assessment was completed as the project performed the statistical portion of this DUA; however, the SAP did not require a formal data quality assessment to be performed. This DUA completes the U.S. Environmental Protection Agency (EPA) data quality lifecycle (planning, implementation, and assessment).

This report documents the following components of the DUA:

- Chapter 2, Data Verification
- Chapter 3, Data Validation
- Chapter 4, Indicators Evaluation
- Chapter 5, Assessment
- Chapter 6, Summary and Conclusions

1.1 Purpose

The purpose of this DUA is to determine whether data collected for the 100-K-47:2 and 100-K-60:1 waste sites, under the 100 Area SAP (DOE/RL-96-22) and associated RDR/RAWP (DOE/RL-96-17) and work instruction WI No. RA-00438, are the right type and of sufficient quality and quantity to support remediation decisions. The DUA process is not intended to be a definitive analysis of a project or problem. Rather, it provides an initial assessment of the reasonableness of the data that have been generated, based solely on the quality control (QC) information associated with the data, and not upon the technical interpretations of the data values.

The information contained in this report follows guidelines for DUAs based on EPA/240/R-02/004, *Guidance on Environmental Data Verification and Data Validation*, EPA QA/G-8, and SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*.

1.2 Scope

This DUA focuses on the evaluation of data collected for waste sites 100-K-47:2 and 100-K-60:1 by sampling soil as required by the 100 Area SAP (DOE/RL-96-22) and associated WI No. RA-00438 for verification sampling (the data for 100-K-47:1 sampling are not included in this DUA). The data are evaluated to determine whether they meet the analytical criteria including specific QC measures outlined in the 100 Area SAP.

1.3 Project Background

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

The 100-K-47:2 subsite consists of six pipeline segments and includes a 10 cm (4 in.) diameter cement asbestos pipe that ran from 117KE to the KE Collection Box (100-K-71), a 20 cm (8 in.) vitrified clay influent pipe to the 1607-K5 Septic Tank, a 41 cm (16 in.) carbon steel reactor drain that discharged to the 116-K-1 Crib, a 308 cm (12 in.) carbon steel drain line from the KW Collecting Box (100-K-73), a 10 cm

(4 in.) drain line that ran between the 115KW and 105KW Buildings, and a sump drain that ran from the 1706KER Building to the trunk line.

Remediation activities at the 100-K-47:2 waste site began February 2, 2021, and continued through March 8, 2021. Overburden material was removed from overtop of the pipeline and stockpiled for potential use as backfill material. The excavation of the pipeline extended to approximately 8.8 m (29 ft) below ground surface (bgs). The waste materials were directly loaded from the waste site into roll on/roll off containers for disposal at the Environmental Restoration Disposal Facility (ERDF). A small segment of the 100-K-47:2 pipeline was thought to remain north of the 105KE Building, approximately 1.8 m (6 ft) bgs. A test pit and trench were excavated on May 5, 2021, to a depth of 2.7 m (9 ft) bgs; however, no pipeline was encountered. A ground penetrating radar survey that was conducted in the area did not indicate that a pipeline was buried. No samples were collected as there were no pipeline that remained.

The 100-K-60:1, 1904-K Process Sewer includes the underground process sewer from 165KW; it was used to dispose of treated and untreated wastewater generated by the water treatment facilities and powerhouse.

Remediation activities at the 100-K-60:1 waste site began on February 27, 2020, and continued through April 12, 2021. Overburden material was removed from overtop of the pipeline and stockpiled for potential use as backfill material. The excavation of the pipeline extended to approximately 10 m (33 ft) bgs. The waste materials were directly loaded from the waste site into roll on/roll off containers for disposal at ERDF.

1.3.1 Sampling Design

The 100-K-47:2 and 100-K-60:1 pipelines were located greater than 4.6 m (15 ft) bgs; one deep zone decision unit was identified for each waste site, consisting of the bottom of the excavation only.

The extents of the decision units were determined based on the elevation of the soils below the pipelines. In addition, one decision unit was identified for each of the 100-K-47:2 and 100-K-60:1 overburden piles. A statistical sample design was developed to evaluate the 100-K-47:2 and 100-K-60:1 deep zone decision units and includes 12 and 13 samples, respectively. A statistical sample design was also used to evaluate the 100-K-47:2 and 100-K-60:1 overburden decision units, which includes 12 samples each.

The systematic sampling locations for the decision units were determined using Visual Sample Plan (VSP) Version 7.1 software (PNNL, 2018). The samples were analyzed for the contaminants of potential concern (COPC) (Table 3) as specified in WI No. RA-00438. In addition, the 100 Area SAP required the collection of one equipment blank per waste site and a field duplicate on a frequency of 5% of all samples collected or a minimum of one sample per waste site.

1.3.2 Project Objectives

Verification sampling and analysis at the 100-K-47:2 and 100-K-60:1 waste sites was performed to verify attainment of the remedial action objectives in support of interim closure.

1.3.2.1 Implementation of the Sample Design

A review of the sampling design, the field logbooks, and applicable analytical data packages indicates all samples were collected and analyzed in accordance with the sampling design.

Waste site verification sample locations, associated sample delivery group (SDG), and Hanford Environmental Information System (HEIS) sample identification numbers are identified in Table 1 for 100-K-47:2 and in Table 2 for 100-K-60:1. All samples were analyzed for metals, mercury, hexavalent chromium, anions, pH, isotopic plutonium, isotopic uranium, total beta strontium, carbon-14, tritium, cesium-137, cobalt-60, and europium-152, -154, and -155 as required in WI No. RA-00438 for verification sampling.

Table 1. 100-K-47:2 Waste Site Verification Samples

Location ID	SDG Numbers	HEIS ID
47_2-VS-1	GEL554371	B424H3
47_2-VS-2	GEL554371	B424H5
47_2-VS-3	GEL554371	B424H7
47_2-VS-4	GEL554371	B424H9
47_2-VS-5	GEL554371	B424J2
47_2-VS-6	GEL554371	B424J4
47_2-VS-7	GEL554371	B424J6
47_2-VS-8	GEL554371	B424J8
47_2-VS-9	GEL554371	B424K0
47_2-VS-10	GEL554371	B424K2
47_2-VS-11	GEL554371	B424K4
47_2-VS-12	GEL554371	B424K7
47_2- VS-4 DUP	GEL554371	B424J0
47_2-OB-VS-1	GEL554485	B42H95
47_2-OB-VS-2	GEL554485	B42H97
47_2-OB-VS-3	GEL554485	B42H99
47_2-OB-VS-4	GEL554485	B42HB1
47_2-OB-VS-5	GEL554485	B42HB5
47_2-OB-VS-6	GEL554485	B42HB7
47_2-OB-VS-7	GEL554485	B42HB9
47_2-OB-VS-8	GEL554485	B42HC1
47_2-OB-VS-9	GEL554485	B42HC3
47_2-OB-VS-10	GEL554485	B42HC5
47_2-OB-VS-11	GEL554485	B42HC7
47_2-OB-VS-12	GEL554485	B42HD1
47_2-OB-VS-4 DUP	GEL554485	B42HB3
Equipment Blank	GEL554485	B42HC9

DUP = field duplicate samples

ID = identification

HEIS = Hanford Environmental Information System

SDG = sample delivery group

Table 2. 100-K-60:1 Waste Site Verification Samples

Location ID	SDG Numbers	HEIS ID
K-60:1-VS-1	GEL554698	B42477
K-60:1-VS-2	GEL554698	B42479
K-60:1-VS-3	GEL554698	B42481
K-60:1-VS-4	GEL554698	B42483
K-60:1-VS-5	GEL554698	B42486
K-60:1-VS-6	GEL554698	B42488
K-60:1-VS-7	GEL554698	B42490
K-60:1-VS-8	GEL554698	B42492
K-60:1-VS-9	GEL554698	B42494
K-60:1-VS-10	GEL554698	B42496
K-60:1-VS-11	GEL554698	B42498
K-60:1-VS-12	GEL554698	B424B1
K-60:1-VS-13	GEL554698	B424B3
K-60:1- VS-4 DUP	GEL554698	B42484
K-60:1-OB-VS-1	GEL554698	B42HD3
K-60:1-OB-VS-2	GEL554698	B42HD5
K-60:1-OB-VS-3	GEL554698	B42HD7
K-60:1-OB-VS-4	GEL554698	B42HD9
K-60:1-OB-VS-5	GEL554698	B42HF3
K-60:1-OB-VS-6	GEL554705	B42HF5
K-60:1-OB-VS-7	GEL554705	B42HF7
K-60:1-OB-VS-8	GEL554705	B42HF9
K-60:1-OB-VS-9	GEL554705	B42HH1
K-60:1-OB-VS-10	GEL554705	B42HH3
K-60:1-OB-VS-11	GEL554705	B42HH5
K-60:1-OB-VS-12	GEL554705	B42HH9
K-60:1-OB-VS-4 DUP	GEL554698	B42HF 1
Equipment Blank	GEL554705	B42HH7

DUP = field duplicate samples
 ID = identification
 HEIS = Hanford Environmental Information System
 SDG = sample delivery group

1.4 Data Quality Assurance and Quality Control Requirements

This section describes the analytical and laboratory quality assurance (QA) and QC requirements identified in the 100 Area SAP (DOE/RL-96-22).

1.4.1 Laboratory Information

Analysis of all samples was performed by GEL Laboratories, LLC.

Chapters 2, 3, 4, and 5 discuss the analytical data provided by the laboratory.

1.4.2 Analytical Methods

Samples were analyzed using the methods listed in Table 3. Both multi-component and single-component method-based analyses were used. Multi-component method-based analyses are those analyses typically based on EPA methods, as applicable, which yield concentration data for multiple analytes in a single analysis. The analytes may include both target analytes and nontarget analytes. Single-component method-based analyses are those analyses typically based upon EPA methods, as applicable, which yield concentration data for a single target analyte in a single analysis. Sample results were entered into the HEIS database.

Table 3. Soil COPCs and Analytical Methods

Parameter	Analytical Method
Cs-137	Gamma energy analysis
Co-60	Gamma energy analysis
Eu-152	Gamma energy analysis
Eu-154	Gamma energy analysis
Eu-155	Gamma energy analysis
Sr-90	Gas flow proportional counter
Pu-238	Alpha energy analysis
Pu-239/240	Alpha energy analysis
U-233/234	Alpha energy analysis
U-235	Alpha energy analysis
U-238	Alpha energy analysis
C-14	Liquid scintillation counting
Tritium	Liquid scintillation counting
Antimony	EPA 6010
Arsenic	EPA 6020
Barium	EPA 6020
Beryllium	EPA 6020
Boron	EPA 6020

Table 3. Soil COPCs and Analytical Methods

Parameter	Analytical Method
Cadmium	EPA 6020
Chromium	EPA 6020
Cobalt	EPA 6020
Copper	EPA 6020
Lead	EPA 6020
Manganese	EPA 6020
Molybdenum	EPA 6020
Nickel	EPA 6020
Selenium	EPA 6020
Silver	EPA 6010
Vanadium	EPA 6010
Zinc	EPA 6020
Mercury	EPA 7471
Cr(VI)	EPA 7196
Chloride	EPA 9056
Fluoride	EPA 9056
Nitrate	EPA 9056
Nitrite	EPA 9056
Sulfate	EPA 9056
pH	EPA 9045

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

EPA = U.S. Environmental Protection Agency

1.4.3 Analytical Requirements

Analytical performance requirements for soil samples are defined in the 100 Area SAP (DOE/RL-96-22). Table 4 summarizes the analytical performance requirements for laboratory analysis of soil samples.

Table 4. Analytical Performance Requirements for Soil Samples

CAS Number	Analyte	RDL ^a	Analytical Method ^b	Precision Requirement (% RPD) ^c	Accuracy Requirement (% Recovery) ^d
Performance Requirements for Laboratory Measurements (Radiological)					
10045-97-3	Cs-137	0.05	Gamma energy analysis	30	70–130
10198-40-0	Co-60	0.05	Gamma energy analysis	30	70–130
14683-23-9	Eu-152	0.1	Gamma energy analysis	30	70–130
15585-10-1	Eu-154	0.1	Gamma energy analysis	30	70–130
14391-16-3	Eu-155	0.1	Gamma energy analysis	30	70–130
10098-97-2	Sr-90	1	Gas flow proportional counter	30	70–130
13981-16-3	Pu-238	1	Alpha energy analysis	30	70–130
PU-239/240	Pu-239/240	1	Alpha energy analysis	30	70–130
U-233/234	U-233/234	1	Alpha energy analysis	30	70–130
U-235/236	U-235	1	Alpha energy analysis	30	70–130
U-238	U-238	1	Alpha energy analysis	30	70–130
14762-75-5	C-14	1	Liquid scintillation counting	30	70–130
10028-17-8	Tritium	10	Liquid scintillation counting	30	70–130
Performance Requirements for Laboratory Measurements (Inorganics – Metals, Anions)					
7440-36-0	Antimony	0.6	EPA 6010	30	70–130
7440-38-2	Arsenic	10	EPA 6020	30	70–130
7440-39-3	Barium	2	EPA 6020	30	70–130
7440-41-7	Beryllium	0.5 ^e	EPA 6020	30	70–130
7440-42-8	Boron	2 ^e	EPA 6020	30	70–130
7440-43-9	Cadmium	0.5 ^e	EPA 6020	30	70–130
7440-47-3	Chromium	1	EPA 6020	30	70–130
7440-48-4	Cobalt	2 ^e	EPA 6020	30	70–130
7440-50-8	Copper	1 ^e	EPA 6020	30	70–130
7439-92-1	Lead	5	EPA 6020	30	70–130
7439-96-5	Manganese	5 ^e	EPA 6020	30	70–130
7439-98-7	Molybdenum	2 ^e	EPA 6020	30	70–130
7440-02-0	Nickel	4 ^e	EPA 6020	30	70–130
7782-49-2	Selenium	1	EPA 6020	30	70–130
7440-22-4	Silver	0.2	EPA 6010	30	70–130
7440-62-2	Vanadium	2.5 ^e	EPA 6020	30	70–130

Table 4. Analytical Performance Requirements for Soil Samples

CAS Number	Analyte	RDL ^a	Analytical Method ^b	Precision Requirement (% RPD) ^c	Accuracy Requirement (% Recovery) ^d
7440-66-6	Zinc	1	EPA 6020	30	70–130
7439-97-6	Mercury	0.2	EPA 7471	30	70–130
18540-29-9	Cr(VI)	0.5	EPA 7196	30	70–130
16887-00-6	Chloride	2 ^e	EPA 9056	30	70–130
16984-48-8	Fluoride	5 ^e	EPA 9056	30	70–130
NO3-N	Nitrate	0.75 ^e	EPA 9056	30	70–130
NO2-N	Nitrite	0.75 ^e	EPA 9056	30	70–130
14808-79-8	Sulfate	5	EPA 9056	30	70–130
pH	pH	N/A	EPA 9045	30	70–130

a. Units are in pCi/g or mg/kg, unless otherwise specified.

b. Equivalent methods may be substituted. See SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*.

c. The precision criteria shown are for batch laboratory replicate sample RPDs.

d. 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.

e. RDLs are consistent with RDLs in Table 2-1 of DOE/RL-96-17, Rev. 6, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*.

CAS = Chemical Abstracts Service

EPA = U.S. Environmental Protection Agency

N/A = not applicable

RDL = required detection limit

RPD = relative percent difference

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

- **Laboratory Contamination.** Each analytical batch contains a laboratory method blank (material of composition similar to that of the samples with known/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.** 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 and corrected for the recovery of tracers or carriers, the accuracy of the laboratory preparation and analysis is evaluated via QC reference samples (such as a laboratory control sample).

- **Analytical Precision.** Separate aliquots removed from the sample containers (duplicate samples) are analyzed for each analytical batch for radionuclides and inorganics. 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 of metals and organic parameters. 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 the RPD and to assess precision.
- **Laboratory Control Samples or QC Reference Samples (Analytical Accuracy).** A laboratory control sample (LCS) may be prepared from an independent standard or from the same standard used for instrument calibration at a concentration within the calibration range. The LCS is taken through all the preparation and analysis steps used in the method. The LCS or QC reference sample measures the accuracy of the analytical process. Depending on how it is introduced into the analysis, the LCS is sometimes referred to as a blank spike sample.

Laboratories are also subject to periodic audits of laboratory performance, systems, and overall program. No audits were conducted specific to the 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, the third-party data validator, or a data user/reviewer. Potential flags and their meanings are provided in Table 5.

Table 5. Qualification Flags

Flag	Definition of 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 <RDL but \geq IDL/MDL (as appropriate). 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 $\geq 2\times$ the MDA and, after corrections, result is \geq MDA for this sample.
C	INORGANICS and WETCHEM: The analyte was detected in both the sample and the associated QC method blank, and the blank concentration exceeded the customer's contractual requirements. ORGANICS (PESTICIDE only): The identification of a pesticide confirmed by GC/MS
D	All: Analyte was reported at a secondary DF, 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.

Table 5. Qualification Flags

Flag	Definition of Laboratory-Applied Flags
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 <RDL or PQL and \geq MDL; 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.
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 the 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 decision-making 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	
U	The constituent was analyzed for but was not detected above the MDL. The data should be considered usable for decision-making purposes.
UJ	The constituent was analyzed for and was not detected. Because of a QC deficiency identified during data validation, the value reported may not accurately reflect the RL. The data should be considered usable for decision-making purposes.
J	Indicates the constituent was analyzed and detected. The associated value is estimated because of a QC deficiency identified during data validation. The data should be considered usable for decision-making purposes.
J+	Indicates the constituent was analyzed and detected. The result is an estimated quantity, but the result may be biased high. The data should be considered usable for decision-making purposes.
J-	Indicates the constituent was analyzed and detected. The associated value is estimated with a suspected negative bias due to QC deficiency identified during data validation. The data should be considered usable for decision-making 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 5. Qualification Flags

Flag	Definition of Laboratory-Applied Flags
X	The target pesticide or Aroclor analyte identification was not confirmed when GC/MS analysis was performed. The data should be considered unusable for decision-making purposes.
UR	Indicates the constituent was analyzed and not detected. However, due to an identified QC 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/nondetection may be questionable. Validation activities identified major QC deficiencies 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 decision-making 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 QC 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 the result as 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 chromatography/mass spectrometry	PQL	= practical quantitation limit
GFAA	= graphite-furnace atomic absorption	QC	= quality control
HEIS	= Hanford Environmental Information System	RDL	= required detection limit
IDL	= instrument detection limit	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 Area SAP (DOE/RL-96-22) required collection of equipment rinsate blank samples and field duplicate samples (DUP). Table 6 summarizes the required frequency for each field QC sample type.

Table 6. Field Project Quality Control Checks

Quality Control Sample Type	Purpose	Frequency
Equipment rinsate blank	Verify adequacy of sampling equipment decontamination	One sample per waste site
Field duplicates	Estimate precision, including sampling and analytical variability	5% of all samples or a minimum of one sample per waste site

1.4.5.1 Field Blank Requirements

Equipment blank samples are collected for nondedicated sampling devices to assess the adequacy of the decontamination process. Equipment blanks consist of silica sand poured over the decontaminated sampling equipment and placed in containers, as identified on the project sampling authorization form. If disposable (i.e., single use) equipment is used, equipment blanks are not required.

1.4.5.2 Field Duplicate Requirements

Field duplicate samples are used to evaluate sample consistency and the precision of field sampling methods. 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 valid comparisons between the samples can be made (e.g., at least some of the constituents will be greater than the detection limit).

Evaluation of the results can provide an indication of sample homogeneity or of intra-laboratory variability. Only those field duplicate result pairs with at least one result greater than the practical quantitation limit (PQL) or greater than or equal to five times the minimum detectable concentration (MDC) are evaluated. Field duplicate sample results must agree within 30% as measured by the RPD to be acceptable. Large RPDs can be an indication of laboratory performance problems or sample inhomogeneity and should be investigated.

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 7 provides a summary of the laboratory QC acceptance criteria used.

Table 7. Laboratory QC Acceptance Criteria

Quality Control Element	Acceptance Criteria
Laboratory duplicate samples	Laboratory duplicate samples with one or both of the measured concentrations \geq PQL/5 \times MDC and the RPD is \leq 30% for solid matrices to be considered acceptable.
Laboratory blank samples	Laboratory blank samples must be less than the MDL or $<$ 5% sample concentration.

Table 7. Laboratory QC Acceptance Criteria

Quality Control Element	Acceptance Criteria
Laboratory control samples	LCS percent recovery must be between the upper and lower control limits listed in the 100 Area SAP (DOE/RL-96-22).
MS/MSD (where applicable)	Laboratory spike percent recovery must be between 70% to 130% control limits. In addition, where the sample result is $\leq 4\times$ the spiking concentration, the MS/MSD RPD must have an RPD less than or equal to 30% for solid matrices. Spike values are not applicable when the sample result is $>4\times$ the spiking concentration.

Reference: DOE/RL-96-22, *100 Area Remedial Action Sampling and Analysis Plan*.

LCS = laboratory control sample

MSD = matrix spike duplicate

MDC = minimum detectable concentration

PQL = practical quantitation limit

MDL = method detection limit

RPD = relative percent difference

MS = matrix spike

SAP = sampling and analysis plan

2 Data Verification

Data verification is the process of evaluating the completeness, correctness, conformance, and compliance of a specific dataset against the method, procedural, or contractual requirements. It includes confirmation that the specified sampling and analytical requirements have been completed (i.e., verification that the number, type, and location of all samples for 100-K-47:2 and 100-K-60:1 as identified in WI No. RA-00438 verification sampling 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.

Data verification is performed in accordance with company procedures, which require verification of a minimum of 25% of all final analytical data packages. This verification procedure requirement is all-inclusive and based on a random selection of the total final analytical data packages and not based on individual projects. For the WI No. RA-00438 verification sampling project within the scope of this DUA, one SDG was verified for a 25% verification rate.

The following sections evaluate and describe the sampling design versus field implementation. All discrepancies between the sampling and analysis requirements outlined in the 100 Area SAP (DOE/RL-96-22) 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 blank and field duplicate are discussed below. Results discussed below were evaluated to field QC acceptance criteria requirements specified for soil samples as identified in the 100 Area SAP (DOE/RL-96-22).

2.2.1 Field Blanks

Field equipment blank samples are collected and 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.

Two equipment blanks were run in conjunction with the verification sampling. All results were non-detects except for the following: Antimony (two results), barium (two results), chromium (two results), copper (two results), manganese (two results), nickel (one result), chloride (two results), sulfate (two results) and europium-152 (one result). Four constituents (antimony, chromium, chloride, and sulfate) had associated sample results with equipment blank concentrations greater than 5% of the sample concentration. This indicates a possible high bias in the sample results. All equipment blank results were lower than the 100 Area SAP (DOE/RL-96-22) required detection limit (RDL). The europium-152 result was flagged (X) by the laboratory and the result comments indicate this result is considered a false positive due to low abundance. There is one sample result associated with this equipment blank that was also flagged as a false positive by the lab, all other results were nondetects. Also, Ottawa sand was used as the equipment blank, and it is common to have trace levels of metals, chloride, and sulfate detected in this matrix. Therefore, the potential bias for these constituents is not conclusive. The equipment blank frequency requirement was met.

2.2.2 Field Duplicates

Evaluation of the sample/field duplicate pairs can only be performed accurately 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 greater than or equal to 5 times the MDC were evaluated.

Four duplicate samples (B424J0, B42HB3, B42484, and B42HF1) were collected for this dataset resulting in a total of 156 constituent pairs. Of the 156 pairs, 64 had at least one of the samples detected above the PQL, qualifying them for RPD evaluation. All of the evaluated RPDs met the 30% RPD acceptance criteria except for 18 results. The RPDs for these results are summarized in Table 8. None of the results associated with the RPD exceedances were above the cleanup levels listed in the 100 Area SAP (DOE/RL-96-22) or the 100 Area RDR/RAWP (DOE/RL-96-17). The RPD exceedances along with laboratory duplicates and spike results indicate probable sample inhomogeneity which is not unusual in soil samples. The sampling frequency requirement for field duplicate samples was met.

Table 8. Field Duplicate RPD Exceedances

Constituent	100-K-47:2 RPD	100-K-47:2 OB RPD	100-K-60:1 RPD	100-K-60:1 OB RPD
Antimony	--	34%	32%	31.90%
Arsenic	45.90%	39.90%	--	--
Chromium	--	62.70%	--	--
Chloride	55%	--	--	--
Lead	40%	45.50%	--	--
Manganese	--	31.30%	--	--
Molybdenum	--	54.20%	--	--
Nickel	--	37%	--	--

Table 8. Field Duplicate RPD Exceedances

Constituent	100-K-47:2 RPD	100-K-47:2 OB RPD	100-K-60:1 RPD	100-K-60:1 OB RPD
Nitrate	--	60%	--	52.90%
Silver	49%	--	--	--
Sulfate	--	53%	83.80%	66%

RPD = relative percent difference

2.3 Laboratory Quality Control

Laboratory QC is discussed in the following sections.

2.3.1 Laboratory Contamination

Hanford Site contractors' laboratory contracts require that laboratory method blanks be analyzed with each batch of up to 20 samples.

A total of 153 laboratory blank results were reported for the soil samples. Of the 153, 9 blank results reported detected concentrations above the method detection limit (MDL) but below the PQL as follows: three results for antimony and one result each for barium, beryllium, cadmium, copper, silver, and vanadium.

All of the laboratory blank results satisfied evaluation criteria with the following exceptions. The blank results associated with the antimony (42 samples), beryllium (13 samples), copper (1 sample), and silver (2 samples) were greater than 5% of the sample results. The laboratory applied a "C" qualifier to the affected results, indicating a possible high bias. Data validation resulted in a J+ validation qualifier added to all samples with the "C" qualifier. This indicates that the data are considered usable but may be biased high. All the affected sample results were below the 100 Area SAP (DOE/RL-96-22) and 100-K RDR/RAWP soil cleanup levels so the potential high bias does not affect conclusions drawn from the data.

2.3.2 Laboratory Precision

Laboratory precision was determined by evaluating the RPD between duplicate sample pair results or between spike and spike duplicate pairs where applicable. Evaluation of the duplicate pairs can only be performed accurately 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 greater than or equal to 5 times the MDC were evaluated.

For the laboratory duplicates, a total of 90 duplicate pairs and 51 spike duplicate pairs were reported. Of those results, 17 duplicate pairs and all spike duplicate pairs had sufficiently high results to allow evaluation of the RPD criteria. Of the 17 pairs evaluated, 2 sample/duplicate pairs had RPD values exceeding the 100 Area SAP (DOE/RL-96-22) criteria. One sample/duplicate pair, associated with all 13 samples in SDG GEL554371 (100-K-47:2), exceeded the RPD control limits for chloride (72.8%) and nitrate (56.2%). In addition, one sample/duplicate pair, associated with all 20 samples in SDG GEL554698 (100-K-60:1 and 100-K-60:1 OB), exceeded the RPD control limits for mercury (53.3%). All associated results were flagged "J" because of third-party validation and are summarized in the validation summary. Based on associated laboratory QC, the elevated RPDs appear to be due to the

heterogeneous matrix of the sample rather than poor instrument/method precision. All sample results associated with the RPD excursions were below the respective cleanup levels.

2.3.3 Laboratory Accuracy

Two types of QC were used to assess accuracy for this DUA: the LCS and MS. The LCS is used to assess the accuracy of the laboratory preparation and analysis processes. The MS samples (and MSD recoveries) are used to assess the accuracy of the published method on the sample matrix and evaluate matrix effects that may bias the data. In cases where the sample concentration is greater than four times the spiking concentration, spike recoveries are not evaluated.

2.3.3.1 Laboratory Control Samples

A total of 143 LCS results were reported for the soil samples. All LCS recoveries satisfied the QC acceptance criteria.

2.3.3.2 Matrix Spike Recovery

A total of 101 MS and 51 MSD results were reported for the soil samples. There were six spike recoveries and three spike duplicate recoveries outside of the acceptance criteria as follows:

- Arsenic - MS at 69.3%
- Cobalt - MS at 147%
- Copper - MS at 48% and an MSD at 157% (from separate analytical batches)
- Chromium - MS at 58.7%
- Lead - MS/MSD pair at 50.6% and 61.6%, respectively
- Nickel - two MS results at 68.4% and 60.7%

The laboratory ran an additional post-digestion spike for each of these constituents. The post-digestion spike recoveries associated with all of the out-of-limits MS results were within the control limits. This indicates the failures are likely due to sample inhomogeneity. The poor duplicate RPD performance for multiple constituents further indicates there were homogeneity issues with the soil samples. All samples associated with spike failures were flagged “N” by the laboratory and further flagged “J,” “J-,” or “J+,” as appropriate, during third-party validation.

2.3.3.3 Tracer/Carrier Recovery

Tracers for Alpha Energy Analysis (AEA) and carriers (strontium-90) were analyzed in association with the soil and laboratory QC samples. The 100 Area SAP (DOE/RL-96-22) does not specifically address tracer and carrier acceptance criteria, so the laboratory statement of work (SOW) contractual performance criteria were used for evaluation. A total of 110 tracer results and 55 carrier results were evaluated. All tracer and carrier recoveries satisfied the contractual performance requirements with the following exceptions:

- The uranium-232 tracer recovery for samples B42479 and B42HB1 both came in at 106%. The sample results for B42479 were nondetects and no validation flags were applied.
- The uranium-238 result for B42HB1 was a detection and a validation flag of “J-” was applied to the result.
- The plutonium-242 tracer recovery for sample B42HB7 came in at 22.3%; both the plutonium-238 and plutonium-239/240 were nondetects and were flagged UJ during validation.

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 dataset, typically data in single analytical batches. Data validation is an independent assessment to ensure the reliability of data are 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 might include verification of required deliverables (e.g., the minimum detection limits); verification of instrument calibrations; and evaluation of analytical results based on method blanks (MBs), recovery of various internal standards, correctness of uncertainty calculations, the identification and quantification of analytes, and the effect of quality deficiencies on the analytical sample data. Third-party validation was performed on 100% of total project results associated with the 100-K-47:2 and 100-K-60:1 verification sampling and is described in this section.

3.1 Data Validation Reports

Data validation was performed by Analytical Quality Associates, Inc., of Albuquerque, New Mexico. All validation qualifiers resulting from data validation were entered into HEIS.

3.2 Data Validation Results

The 100 Area SAP (DOE/RL-96-22) specifies that at least 5% of data packages must undergo validation. Level C data validation includes the evaluation and qualification of sample results based on the following:

- MS, LCS, laboratory duplicate, and chemical and surrogate recovery criteria (as appropriate to the method)
- Field blanks, field duplicates, and field splits (if information is provided)

Table 9 summarizes the quantity of samples and laboratory methods that were validated for the 100-K-47:2 and 100-K-60:1 verification sampling. There are four data packages that report all 100-K-47:2 and 100-K-60:1 verification sampling analysis data. The 100 Area SAP (DOE/RL-96-22) requirement of having at least 5% of data packages validated was satisfied.

Table 9. Validated Soil Sample Summary

Analyte Category	Total Number of Samples Analyzed	Total Number of Samples Validated	Percent Validated
Alpha energy analysis	55	55	100
Gas flow proportional counter	55	55	100
Gamma energy analysis	55	55	100
Liquid scintillation counting	55	55	100
ICP/AES (EPA 6010)	55	55	100
ICP/MS (EPA 6020)	55	55	100
CVAA (EPA 7471)	55	55	100
Cr(VI) (EPA 7196)	55	55	100
Anions (EPA 9056)	55	55	100

Table 9. Validated Soil Sample Summary

Analyte Category	Total Number of Samples Analyzed	Total Number of Samples Validated	Percent Validated
pH (EPA 9045)	55	55	100

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

AES	=	atomic emission spectroscopy	ICP	=	inductively coupled plasma
CVAA	=	cold vapor atomic absorption	MS	=	mass spectrometry
EPA	=	U.S. Environmental Protection Agency			

A total of 49 samples, 2 equipment blanks, and 4 field duplicates were validated. All categories had 100% complete with some minor deficiencies (discussed below) and no major deficiencies identified.

3.2.1 Major Deficiencies

A major deficiency results in qualification of sample data as unusable for decision-making purposes; however, no major deficiencies were found for the 100-K-47:2 and 100-K-60:1 verification sampling.

3.2.2 Minor Deficiencies

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

Multiple minor deficiencies that lead to validation flags being applied to the results were identified for the dataset. These deficiencies are listed below:

- Out of limit plutonium-242 and uranium-232 tracer recoveries (low and high)
- Laboratory blank contamination for antimony, beryllium, cadmium, copper, and silver
- A negative laboratory blank value for vanadium
- High MS recoveries for cobalt, copper, and lead
- Low MS recoveries for arsenic, chromium, copper, lead, and nickel
- Poor duplicate precision for chloride, nitrate, and mercury
- pH analysis performed outside of holding time

The minor deficiencies listed above led to validation flags being applied to the data as follows:

- A J+ flag, indicating a possible high bias, was applied to antimony (42 samples), beryllium (13 samples), cadmium (13 samples), copper (1 sample), and silver (2 samples).
- A J- flag, indicating a possible low bias, was applied to uranium-238 (1 sample), nickel (13 samples), and pH (55 samples).
- A J flag was applied to arsenic (7 samples), chromium (21 samples), cobalt (13 samples), copper (22 samples), lead (20 samples), nickel (21 samples), mercury (18 samples), chloride (13 samples), and nitrate (11 samples).
- A UJ flag was applied to plutonium-238 and -239/240 (1 sample), arsenic (1 sample), lead (1 sample), nickel (1 sample), mercury (2 samples), and nitrate (2 samples).

All the data are considered usable for decision-making purposes, and all flags applied due to spike failures or poor duplicate precision are likely related to inhomogeneity in the soil samples.

3.2.3 Qualification Flags Applied to the Dataset

Table 10 provides details on the qualification flags applied to the dataset and the related minor deficiency observed during the data validation process.

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

Method/Analyte(s)	Qualifier*	Affected Samples	Reason
Radiochemistry			
U-238	J-	B42HB1	High tracer recovery
Pu-238 Pu-239/240	UJ	B42HB7	Low tracer recovery
Inorganics (EPA 6020– ICP/MS Metals)			
Beryllium, cadmium	J+	B424H3, B424H5, B424H7, B424H9, B424J0, B424J2, B424J4, B424J6, B424J8, B424K0, B424K2, B424K4, B424K7	Laboratory blank contamination
Vanadium	UJ	B42HC9	Negative laboratory blank value
Copper	J+	B42HH7	Laboratory blank contamination
Lead	J	B424H3, B424H5, B424H7, B424H9, 424J0, B424J2, B424J4, B424J6, B424J8, B424K0, B424K2, B424K4, B424K7	High matrix spike recovery
Chromium	J	B424H3, B424H5, B424H7, B424H9, B424J0, B424J2, B424J4, B424J6, B424J8, B424K0, B424K2, B424K4, B424K7	Low matrix spike recovery
Nickel	J-	B424H3, B424H5, B424H7, B424H9, B424J0, B424J2, B424J4, B424J6, B424J8, B424K0, B424K2, B424K4, B424K7	Low matrix spike recovery
Copper, nickel	J	B42H95, B42H97, B42H99, B42HB1, B42HB3, B42HB5, B42HB7, B42HB9, B42HC1, B42HC3, B42HC5, B42HC7, B42HC9, B42HD1	Low matrix spike recoveries
Cobalt	J	B42H95, B42H97, B42H99, B42HB1, B42HB3, B42HB5, B42HB7, B42HB9, B42HC1, B42HC3, B42HC5, B42HC7, B42HD1	High matrix spike recovery
Arsenic, chromium, lead, nickel	J	B42HF5, B42HF7, B42HF9, B42HH1, B42HH3, B42HH5, B42HH9	Low matrix spike recoveries
Arsenic, lead, nickel	UJ	B42HH7	Low matrix spike recoveries

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

Method/Analyte(s)	Qualifier*	Affected Samples	Reason
Chromium	J	B42HH7	Low matrix spike recovery
Copper	J	B42HF5, B42HF7, B42HF9, B42HH1, B42HH3, B42HH5, B42HH7, B42HH9	High matrix spike recoveries
Inorganics (EPA 6010– ICP/AES Metals)			
Antimony	J+	B42H95, B42H97, B42H99, B42HB1, B42HB3, B42HB5, B42HB7, B42HB9, B42HC1, B42HC3, B42HC5, B42HC7, B42HC9, B42HD1, B42477, B42479, B42481, B42483, B42484, B42486, B42488, B42490, B42492, B42494, B42496, B42498, B424B1, B424B3, B42HD3, B42HD5, B42HD7, B42HD9, B42HF1, B42HF3, B42HF5, B42HF7, B42HF9, B42HH1, B42HH3, B42HH5, B42HH7, B42HH9	Laboratory blank contamination
Silver	J+	B42HC1, B42HD1	Laboratory blank contamination
Inorganics (EPA 7471 CVAA)			
Mercury	J	B42477, B42479, B42481, B42483, B42484, B42486, B42488, B42490, B42492, B42494, B42496, B42498, B424B1, B424B3, B42HD3, B42HD5, B42HD7, B42HF3	Poor duplicate precision
Mercury	UJ	B42HD9, B42HF1	Poor duplicate precision
Inorganics (EPA 7196A Hexavalent Chromium)			
Cr(VI)	None	N/A	N/A
Anions (EPA 9056)			
Nitrate, chloride	J	B424H3, B424H7, B424J0, B424J2, B424J4, B424J6, B424J8, B424K0, B424K2, B424K4, B424K7	Poor duplicate precision
Chloride	J	B424H5, B424H9	Poor duplicate precision
Nitrate	UJ	B424H5, B424H9	Poor duplicate precision

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

Method/Analyte(s)	Qualifier*	Affected Samples	Reason
pH (EPA 9045)			
pH	J-	B424H3, B424H5, B424H7, B424H9, B424J0, B424J2, B424J4, B424J6, B424J8, B424K0, B424K2, B424K4, B424K7, B42H95, B42H97, B42H99, B42HB1, B42HB3, B42HB5, B42HB7, B42HB9, B42HC1, B42HC3, B42HC5, B42HC7, B42HC9, B42HD1, B42477, B42479, B42481, B42483, B42484, B42486, B42488, B42490, B42492, B42494, B42496, B42498, B424B1, B424B3, B42HD3, B42HD5, B42HD7, B42HD9, B42HF1, B42HF3, B42HF5, B42HF7, B42HF9, B42HH1, B42HH3, B42HH5, B42HH7, B42HH9	Extraction beyond the holding time

Note: For 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.

AES	=	atomic emission spectroscopy	ICP	=	inductively coupled plasma
CVAA	=	cold vapor atomic absorption	MS	=	mass spectrometry
EPA	=	U.S. Environmental Protection Agency	N/A	=	not applicable

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.

Inorganics. The holding time requirements for inorganic analyses performed in soils are as follows. No specific preservation requirements exist for these analyses in soil.

- The holding time requirements for inductively coupled plasma and inductively coupled plasma/mass spectrometry metals are analysis within 180 days of sample collection.
- Mercury requires analysis within 28 days of sample collection.
- Hexavalent chromium requires analysis within 30 days of sample collection.
- Anions require extraction within 28 days of sample collection and analysis within 48 hours of extraction.
- The holding time requirement for pH analysis is as soon as possible after sample collection.

All analyses were performed within the prescribed holding times except for pH. The laboratory performed pH analysis on all samples within 15 days after sample collection. All samples with pH results had the data user-applied flag “H” and had the “J-” flag applied during data validation.

Radionuclides. The maximum holding time for radiochemical analysis is 180 days in soil. No specific preservation requirements exist for radiochemical soil analysis.

All samples were analyzed within the prescribed holding time.

3.2.3.2 Review of Laboratory QC Information

Laboratory data package case narratives were reviewed to identify potential QC issues that would affect the usability of these data. Overall, no issues were identified that would have led to the rejection of any reported results. Some minor data quality issues have been discussed in this section.

4 Data Quality Indicator Evaluation

Data verification and data validation reports were reviewed to determine the usability of the dataset 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, LCS duplicates, and MS/MSDs).
- **Accuracy/Bias** – discusses evidence of field contamination and laboratory QC (e.g., percent recoveries of LCSs, MSs, and surrogates).
- **Representativeness** – discusses the extent to which the sampling design was accomplished, the representativeness of the samples and the design as a whole. This discussion includes any specific measurements not representative of the target condition and the impacts to the dataset.
- **Comparability** – discusses the nature of differences that may limit comparability.
- **Completeness** – discusses the accomplishment of all SAP-required data generating activities. The discussion includes a comparison of samples actually collected versus those identified in the original sampling design, required field QC blanks, duplicates, and splits, and analyses performed compared to the analyses identified in the SAP.
- **Sensitivity** – discusses any laboratory data that do not meet the SAP-required reporting limits and other decision thresholds as described in the project data quality objectives.

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 dataset. Validation acceptance rates are based on the data determined to be valid (i.e., not rejected) in the validated dataset.

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 97.9%. Data validation resulted in the qualification of chloride and nitrate results for 13 samples and mercury for 20 samples based on poor duplicate precision. Data validation results show an overall data acceptance rate of 100% for precision.

4.1.2 Accuracy/Bias

Laboratory accuracy is assessed by using two types of QC: the LCS and the MS recoveries, which 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 showed an overall accuracy QC acceptance rate of 94.1% based on MS recovery. Two tracer recoveries were outside of the validation criteria, giving an overall acceptance rate of 98.1%. All LCS and carrier recoveries satisfied the QC criteria. Data validation resulted in the qualification of multiple samples/constituents based on MS recovery (see Table 10). Data validation results show an overall data acceptance rate of 100% for accuracy.

Detections for three of the four laboratory blanks run for antimony indicates a possible high bias for those results. All antimony results were below project cleanup levels, however, so this bias does not impact data usability. No other systemic bias was noted during the review.

4.1.3 Representativeness

Based on other associated laboratory QC, both the duplicate precision issues and the spike recovery issues observed under the precision and accuracy/bias reviews are likely related to inhomogeneity in the soil samples. These issues are relatively minor, and the data qualifications allow for the results to be used in the decision-making process. Overall, the DQIs show the dataset to be representative of the sample locations. Other than the possible antimony bias noted in the accuracy/bias discussion above, no systemic biases were noted.

4.1.4 Comparability

To generate comparable samples, 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 and analytical methods summarized in Table 4.

4.1.5 Completeness

For the 100-K-47:2 and 100-K-60:1 verification sampling under WI No. RA-00438, a total of 55 samples (49 samples, 4 duplicates, and 2 equipment blanks) were submitted for laboratory analysis yielding 2,145 analytical laboratory results. All results are considered usable, resulting in 100% completeness.

4.1.5.1 Field Blanks

As required in the 100 Area SAP (DOE/RL-96-22), one equipment blank was collected from each waste site.

4.1.5.2 Field Duplicates

As required in the 100 Area SAP (DOE/RL-96-22), four field duplicates were collected during verification sampling, meeting the 1 duplicate per 20 samples requirement.

4.1.6 Sensitivity

All reported sample MDLs and minimum detectable activity (MDAs) with associated nondetected sample results were compared to the 100 Area SAP (DOE/RL-96-22) required detection limits listed in Table 4. The MDLs and MDAs that exceeded the required detection limits along with potential impacts on the data for decision-making purposes are described below.

For radiological analysis results, all 55 carbon-14 and tritium results were nondetects with all associated MDC values above the 100-Area SAP RDLs.

For carbon-14, the RDL is 2 pCi/g with the reported MDC's ranging from 2.38 to 3.71. The highest reported nondetect was 1.6 pCi/g, which is below the carbon-14 remedial action goal of 8.69. These results do not impact data usability.

Tritium has an RDL of 10 pCi/g with the associated reported MDC values ranging between 21.3 and 29.29. All MDC values were also above the cleanup level of 12.6 pCi/g. The highest reported nondetect was 11.7, which is below the groundwater protection cleanup level; therefore, the results do not significantly impact data usability. It should be noted that all MDCs reported met the current SOW contractual limit of 30 pCi/g for soil samples.

Strontium-90 has an RDL of 1 pCi/g. There were 53 nondetected results with the reported MDCs ranging from 1.04 to 1.87. The highest reported nondetect was 1.42 pCi/g, which is significantly below the 100 Area SAP groundwater protection cleanup level of 27.6 pCi/g. These results do not impact data usability.

Europium-154 has an RDL of 0.1 pCi/g. There were 10 nondetected results with the reported MDCs ranging from 1.04 to 1.87. The highest reported nondetect was 0.629 pCi/g which is below the 100 Area SAP cleanup level of 3 pCi/g. These results do not impact data usability.

There were 3 results for uranium-233/234, 10 results for uranium-235/236, and 2 results for uranium-238 with MDC values above the RDL of 1, 0.5, and 1 pCi/g, respectively. All values for these samples were non-detects with the actual reported nondetect values below the cleanup levels for each constituent. These results do not impact data usability.

For metals, four antimony results had MDL values above the RDL of 0.6 mg/kg with a maximum MDL value of 3.41 mg/kg. MDLs are directly influenced by dilutions. These samples were diluted by a factor of 10, which would increase the MDL by 10 times. The value of 3.41 mg/kg is below the cleanup level of 5 mg/kg; thus, these results do not impact data usability.

5 Data Quality Assessment

Sampling performed for the 100 Area SAP (DOE/RL-96-22) and WI No. RA-00438 verification sampling are based on statistical sampling designs requiring a statistical evaluation of the results. The statistical tests used and the subsequent results are complete and are presented in ECF-100KR2-21-0134, *100-K-47:2 and 100-K-60:1 Waste Site Cleanup Verification 95% UCL Calculations*, and DOE/RL-2021-55, *Remaining Sites Verification Package for the 100-K-47:2 and 100-K-60:1 Waste Sites*.

The project performed 95% upper confidence limit (UCL) statistical evaluations for all constituents. WAC 173-340, "Model Toxics Control Act—Cleanup," statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL be calculated on the appropriate distribution using Washington State Department of Ecology (Ecology) software. For datasets of 10 or greater (such as for these sites), distributional testing was done using Ecology's MTCASat software that incorporates guidance contained in EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide*, EPA QA/G-9. The radionuclide data used a nonparametric distribution and the nonradionuclide data used a normal distribution and lognormal distribution depending on the constituent. A few constituents did not meet the lognormal or normal distribution requirements and were rejected as discussed below.

100-K-47:2. The lognormal and normal distributions were rejected for copper, manganese, selenium, vanadium, chloride, and fluoride; the Z-statistic was used for statistical evaluations of these compounds.

Selenium and silver did not pass the *Washington Administrative Code* (WAC) three-part test that determined if the 95% UCL was above cleanup limits, greater than 10% of results were above cleanup limits, and/or if any sample result was greater than two times the cleanup limit. The project will perform a detailed assessment for these compounds. All other constituents were acceptable and meet project needs.

100-K-47:2 OB. The lognormal and normal distributions were rejected for cadmium, copper, selenium, vanadium, chloride, and fluoride; the Z-statistic was used for statistical evaluations of these compounds.

Selenium did not pass the WAC three-part test that determined if the 95% UCL was above cleanup limits, greater than 10% of results were above cleanup limits, and/or if any sample result was greater than two times the cleanup limit. The project will perform a detailed assessment for this compound. All other constituents were acceptable and meet project needs.

100-K-60:1. The lognormal and normal distributions were rejected for arsenic, barium, cadmium, cobalt, copper, lead, nickel, selenium, zinc, and chloride; the Z-statistic was used for statistical evaluations of these compounds.

Lead, manganese, and selenium did not pass the WAC three-part test that determined if the 95% UCL was above cleanup limits, greater than 10% of results were above cleanup limits, and/or if any sample result was greater than two times the cleanup limit. The project will perform a detailed assessment for these compounds. All other constituents were acceptable and meet project needs.

100-K-60:1 OB. The lognormal and normal distributions were rejected for arsenic and chloride; the Z-statistic was used for statistical evaluations of these compounds.

Selenium did not pass the WAC three-part test that determined if the 95% UCL was above cleanup limits, greater than 10% of results were above cleanup limits, and/or if any sample result was greater than two times the cleanup limit. The project will perform a detailed assessment for this compound. All other constituents were acceptable and meet project needs.

6 Conclusions

The 100 Area SAP (DOE/RL-96-22) required preparation of a DUA consisting of a review of validated data results and an evaluation of DQIs, which includes evaluating the precision, accuracy, representativeness, completeness, and comparability parameters. While portions of EPA/240/B-06/002 guidance were used for a statistical evaluation under this study, the SAP did not require a formal data quality assessment to be performed.

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 usable for their intended purposes. Samples were collected and analyzed as specified in the 100 Area SAP (DOE/RL-96-22) and WI No. RA-00438 verification sampling. Sample results accurately indicate the presence or absence of target analyte contamination at sample locations. Per the statistical evaluation, all constituents except lead, manganese, selenium, and silver meet the project required detection limits or were below background levels. Further assessment is needed for lead, manganese, selenium, and silver as not all the requirements on the WAC three-part test were passed.

Laboratory and matrix accuracy and precision were in control overall and, other than a possible high bias for antimony, 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 datapoints). 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. Tritium results were all nondetects with MDCs greater than the cleanup level of 12.6 pCi/g; however, MDCs met current contract limits.

Based on nondetect values reported, this is not expected to impact usability of the tritium data. The conclusions of this DUA are the data that have been collected are of the right type, quality, and quantity for direct regulatory use (for example, for assessment of remediation systems).

Lastly, the 5% 100 Area SAP (DOE/RL-96-22) requirement for data validation for data packages was satisfied.

7 References

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