U.S. Department of Energy
Hanford Site

November 23, 2021

21-SGD-003802

Ms. Laura Buelow, Remedial Project Manager
Superfund and Emergency Management Division
Site Cleanup Section 4
U.S. Environmental Protection Agency
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Richland, Washington 99352

Dear Ms. Buelow:

183.1KE HEADHOUSE SOIL FLUSHING SAMPLING AND ANALYSIS PLAN, DOE/RL-2021-31, DRAFT A

This letter transmits the183.1KE Headhouse Soil Flushing Sampling and Analysis Plan, DOE/RL-2021-31, Draft A, for review. The U.S. Department of Energy has worked collaboratively with the U.S. Environmental Protection Agency to develop this document. Your review is requested 45 days from receipt of this letter, per the Hanford Federal Facility Agreement and Consent Order.

If you have any questions please contact me, or you may contact Ellwood Glossbrenner, Project Lead, Soil and Groundwater Division, on (509) 376-5828.

Sincerely,

MICHAEL CLINE Digitally signed by MICHAEL CLINE
Date: 2021.11.23 11:02:37 -08'00'

Michael W. Cline, Director
Soil and Groundwater Division

SGD:ETG

Attachment

cc: See page 2

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Attachment
21-SGD-003802

183. 1KE Headhouse Soil Flushing Sampling and Analysis Plan
DOE/RL-2021-31 Draft A

(71 pages including cover sheet)

DOE/RL-2021-31
Draft A

183.1KE HEADHOUSE SOIL FLUSHING SAMPLING AND ANALYSIS PLAN

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Assistant Secretary for Environmental Management

U.S. DEPARTMENT OF ENERGY | Richland Operations Office
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Release Approval Date

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Signature Sheet

Title: *183.1KE Headhouse Soil Flushing Sampling and Analysis Plan*

_____	_____	_____
Print Name U.S. Department of Energy, Richland Operations Office	Signature	Date

_____	_____	_____
Print Name U.S. Environmental Protection Agency	Signature	Date

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Terms

ALARA	as low as reasonably achievable
AWLN	automated water-level network
bgs	below ground surface
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/CAP-AP	U.S. Department of Energy Consolidated Audit–Accreditation Program
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOT	U.S. Department of Transportation
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
EB	equipment blank
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERT	electrical resistivity tomography
FSO	Field Sample Operations
FTB	full trip blank
FWS	Field Work Supervisor
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Document*
HEIS	Hanford Environmental Information System
IATA	International Air Transportation Association
MB	method blank
MS	matrix spike
MSD	matrix spike duplicate
OU	operable unit
P&T	pump and treat
PRZ	periodically rewetted zone
QA	quality assurance

QAPjP	quality assurance project plan
QC	quality control
RAO	remedial action objective
RD/RAWP	Remedial Design/Remedial Action Work Plan
ROD	record of decision
RUM	Ringold Formation upper mud
Rwie	Ringold Formation member of Wooded Island – unit E
SAF	sample authorization form
SAP	sampling and analysis plan
SME	subject matter expert
SMR	Sample Management and Reporting
SPLIT	field split
SUR	surrogate
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*

1 Introduction

The 100-KR-4 Groundwater Operable Unit (OU) contains groundwater contaminated by releases associated with past operation of the 105KE and 105KW Reactors. Hexavalent chromium (Cr(VI)) was identified in EPA/ROD/R10-96/134, *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units Interim Remedial Actions, Hanford Site, Benton County, Washington* (hereinafter referred to as the interim action record of decision [ROD]), as the primary groundwater contaminant of concern in the 100-KR-4 OU.

This document presents the groundwater sampling and analysis plan (SAP) for soil flushing treatment at the former 183.1KE Headhouse (KE Headhouse) area, which is a continuing source of groundwater contamination. Soil flushing will be completed to enhance ongoing groundwater pump and treat (P&T) remediation in the 105KE Reactor area. Current P&T activities are operating under DOE/RL-2013-33, *Remedial Design/Remedial Action Work Plan for the 100-KR-4 Groundwater Operable Unit Interim Action* (RD/RAWP). Soil flushing at the KE Headhouse will be incorporated into the ROD via explanation of significant difference, followed by a *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a; Tri-Party Agreement) change notice against the RD/RAWP.

1.1 Project Scope and Objective

The 100-KR-4 OU is in the northern portion of the U.S. Department of Energy (DOE) Hanford Site (Figure 1-1). The 105KE Reactor, which operated from 1955 to 1971, resulted in cooling water treatment chemicals, including the concentrated acidic sodium dichromate solution used during that period, contaminating groundwater.

The presence of persistent Cr(VI) plumes in 100-KR-4 OU groundwater indicates continuing contribution of Cr(VI), likely from secondary sources within the vadose zone overlying the unconfined aquifer. Cr(VI) sources are described in SGW-64284, *100-K Area Continuing Hexavalent Chromium Sources*.

Beginning in 2019, a soil flushing treatability test was implemented in accordance with DOE/RL-2017-30, *KW Soil Flushing/Infiltration Treatability Test Plan,* at the 183.1KW Headhouse (KW Headhouse) area to address a continuing source of groundwater contamination. The goal of soil flushing was to remove Cr(VI) from the deep portions of the vadose zone by flushing contaminant mass into the groundwater and then capturing the mass with the active P&T system extraction wells to remove it from the groundwater. Based on measurement and observation collected between May 28, 2019, and December 31, 2019, soil flushing was effective in removing mobile Cr(VI) from the vadose zone at the KW Headhouse. Results of the continued soil flushing treatment are presented in DOE/RL-2019-77, *KW Soil Flushing Treatability Test Report*.

In situ treatment via soil flushing/infiltration to remove contaminants from the vadose zone and periodically rewetted zone (PRZ) was a retained component for optimized groundwater P&T for the 100-K Area, as identified in DOE/RL-2018-22, *Feasibility Study for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, Draft B.

Four soil flushing events have been completed at the KW Headhouse, and it is currently in a rebound monitoring phase. Based on results of the soil flushing at the KW Headhouse, soil flushing will be implemented at the KE Headhouse location to enhance current groundwater remediation under a proposed update to the RD/RAWP to include the KE Headhouse location. Figure 1-2 identifies the general proposed infiltration area (infiltration footprint) and nearby groundwater monitoring wells that will be sampled as a part of this SAP.

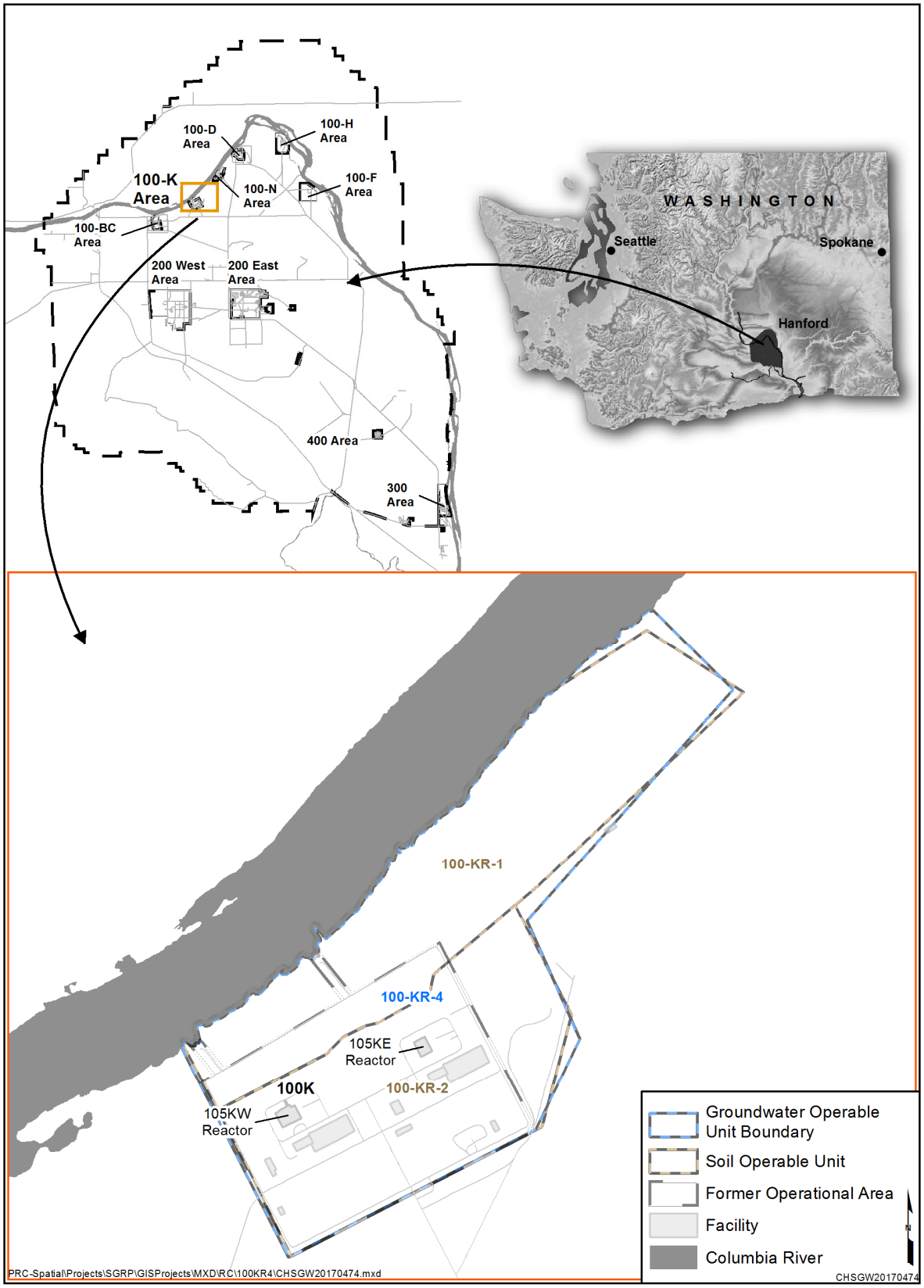

Figure 1-1. 100-K Area and OUs

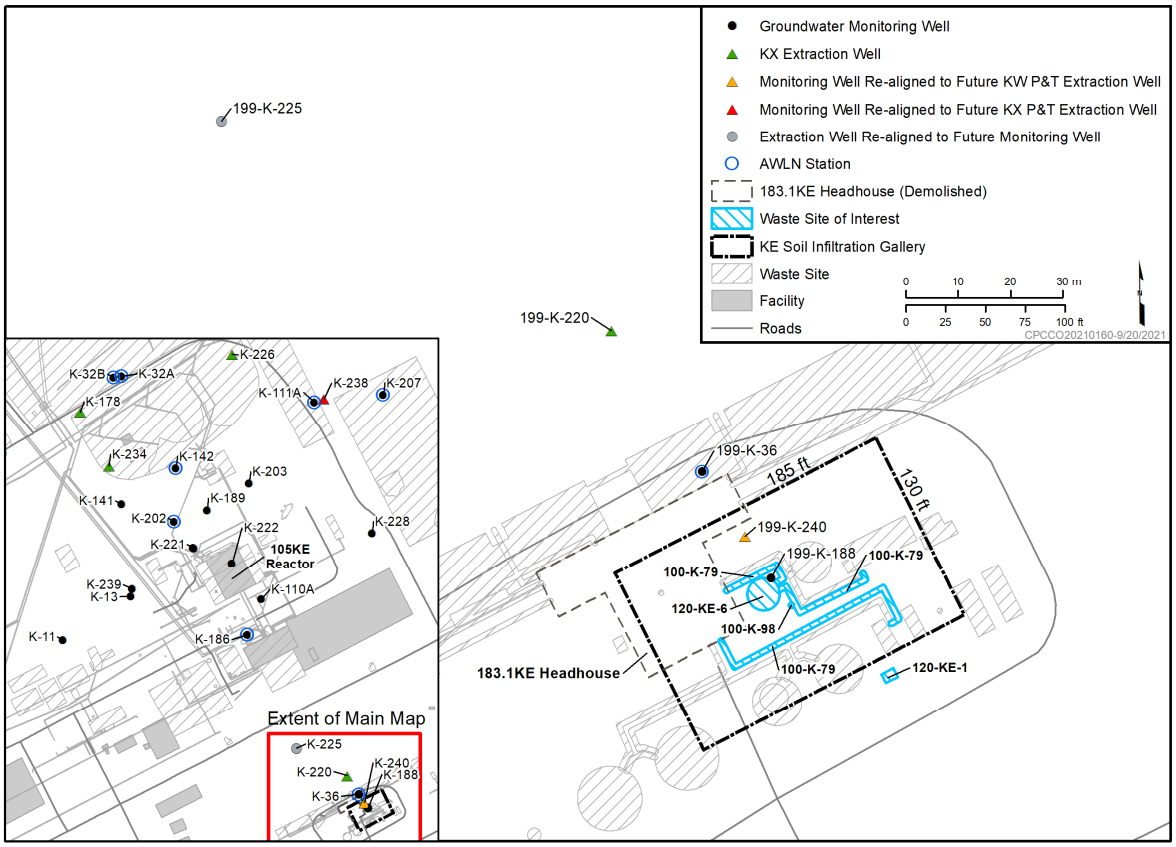

Figure 1-2. 183.1KE Headhouse Soil Flushing Area

As presented in this SAP, the infiltration gallery is the area where KW P&T effluent will be applied to the ground surface for infiltration into the subsurface. The KW P&T discharge water will migrate through the vadose zone to cause a saturated wetting front, extending from the infiltration distribution system to the underlying water table. The general proposed infiltration footprint as presented in Figure 1-2 will include the infrastructure for the infiltration gallery piping, instrumentation and associated equipment, any security barriers, etc., as needed. The final infiltration gallery design will be presented under a separate report cover and will be discussed in the updates to the RD/RAWP.

1.2 Background

The following documents contain requirements for groundwater P&T remediation:

- DOE/RL-2013-33, *Remedial Design/Remedial Action Work Plan for the 100-KR-4 Groundwater Operable Unit Interim Action*
- DOE/RL-2013-48, *Operations and Maintenance Plan for the 100-KR-4 Pump and Treat Systems*
- DOE/RL-2013-29, *Sampling and Analysis Plan for the 100-KR-4 Groundwater Operable Unit Monitoring*
- DOE/RL-97-01, *Interim Action Waste Management Plan for the 100-HR-3 100-HR-4 Operable Units*
- DOE/RL-2019-16, *Well Installation Sampling and Analysis Plan for 100-KR-4 Groundwater Operable Unit*

Historical site operations, geological conditions and conceptual site model are discussed in detail within the following 100-KR-4 documents:

- SGW-64284, *100-K Area Continuing Hexavalent Chromium Sources*
- DOE/RL-2010-97, *Remedial Investigation for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, Draft B
- DOE/RL-2018-22, *Feasibility Study for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, Draft B
- DOE/RL-2019-66, *Hanford Site Groundwater Monitoring Report for 2019*

This SAP is intended to be implemented in conjunction with the above referenced documents and to enhance current remedial actions.

Due to the similarities between the operational and release histories of sodium dichromate solution at the KE and KW Headhouses, it is expected that the former KE Headhouse has a similar Cr(VI) continuing source to that found at the KW Headhouse. The locations of the KE and KW Headhouses exhibit the same geological and hydrogeological conditions, as well as similar soil remediation and backfilling histories. The vadose zone is composed primarily of unconsolidated gravel and sand of the Hanford formation, as well as underlying Ringold Formation member of Wooded Island – unit E (Rwie). During remediation, soils were excavated to a depth of 14 m (46 ft) below ground surface (bgs) at the KW Headhouse, while remedial soil excavation at the KE Headhouse was completed to 12.8 m (42 ft) bgs.

A summary of site geology and contaminant sources is presented in Sections 1.2.1 and 1.2.2, respectively.

1.2.1 Site Geology/Hydrology

The geology and hydrogeology of the 100-K Area, including the KE Headhouse area, is summarized below and described in detail in the following documents:

- DOE/RL-2010-97
- WHC-SD-EN-TI-155, *Geology of the 100-K Area, Hanford Site, South-Central Washington*

Four stratigraphic units are relevant to the context of the KE soil flushing area and include (from youngest to oldest) the following:

- Recent eolian or backfill material (sand, sand and gravel)
- Hanford formation (gravel and sand)
- Rwie (sand and gravel)
- Ringold Formation upper mud (RUM) unit (silt, fine sand, and clay)

The unconfined aquifer in the KE Headhouse area is about 25 m (82 ft) thick based on drilling of well 199-K-240 and is present in the Rwie (Figure 1-3). This unit is overlain by backfill material from the surface to about 7.6 m (25 ft) bgs, and the gravel and interbedded sand and silt of the Hanford formation from 7.6 to 18.3 m (25 to 60 ft) bgs, which constitutes the bulk of the vadose zone. The vadose zone in the 100-K Area ranges from <1 m (3 ft) thick near the Columbia River to 32 m (105 ft) thick inland and is about 30 m (100 ft) thick in the KE Headhouse location. The uneven surface of the silt- and clay-rich RUM forms the bottom of the unconfined aquifer. Contaminant concentrations are generally highest within the uppermost portion of the aquifer near the water table; however, mobile contaminants (e.g., Cr(VI)) have been detected over the entire aquifer thickness, particularly near source areas. Appendix C of DOE/RL-2010-97, Draft B, includes hydrogeologic cross sections for the 100-KR-4 OU.

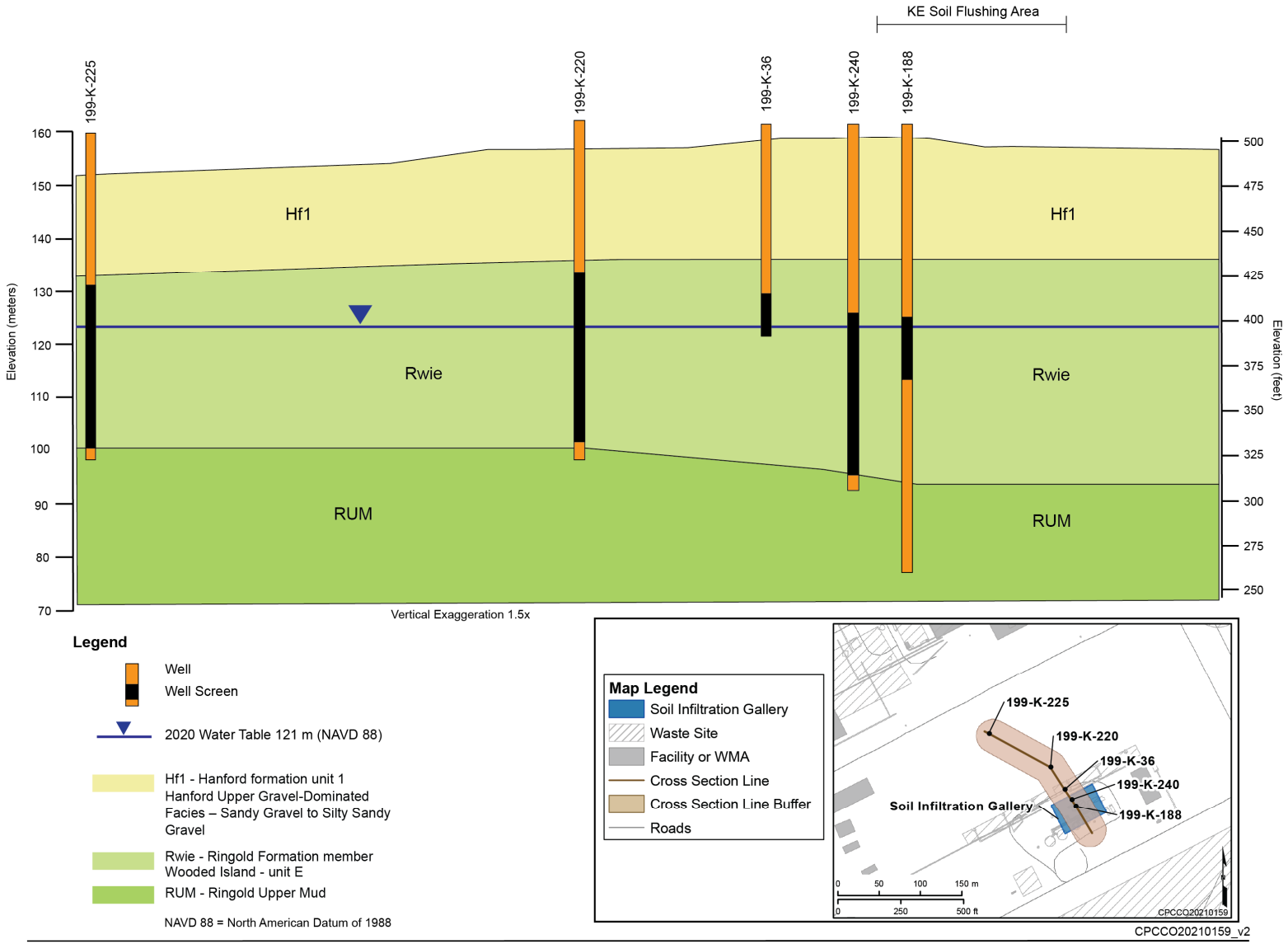

Figure 1-3. Geologic Cross Section of 183.1KE Headhouse Soil Flushing Area

1.2.2 Contaminant Sources

The KE Headhouse was demolished in 2011. Based on observation of conditions following demolition of the KE Headhouse, some quantity of sodium dichromate dihydrate solution apparently remained in tank farm pipeline(s) and was released during demolition (DOE/RL-2017-22, *Remaining Site Verification Package for the 14 183.1-KE Headhouse Waste Sites*). Contaminated soil was subsequently removed in 2016 to a depth of 12.8 m (42 ft) bgs.

Due to the nature of releases of Cr(VI) to the soil, concentrations of Cr(VI) in the form of metal chromate salts likely remain in the deep vadose zone beneath the excavation area. This residual contamination represents a known continuing source of Cr(VI) to the KE Plume. Figure 1-4 shows the 2019 Cr(VI) plume originating from the KE Headhouse. Figure 1-5 shows observed Cr(VI) trends in wells located near the KE Headhouse relative to decontamination and decommissioning and waste site remediation activities.

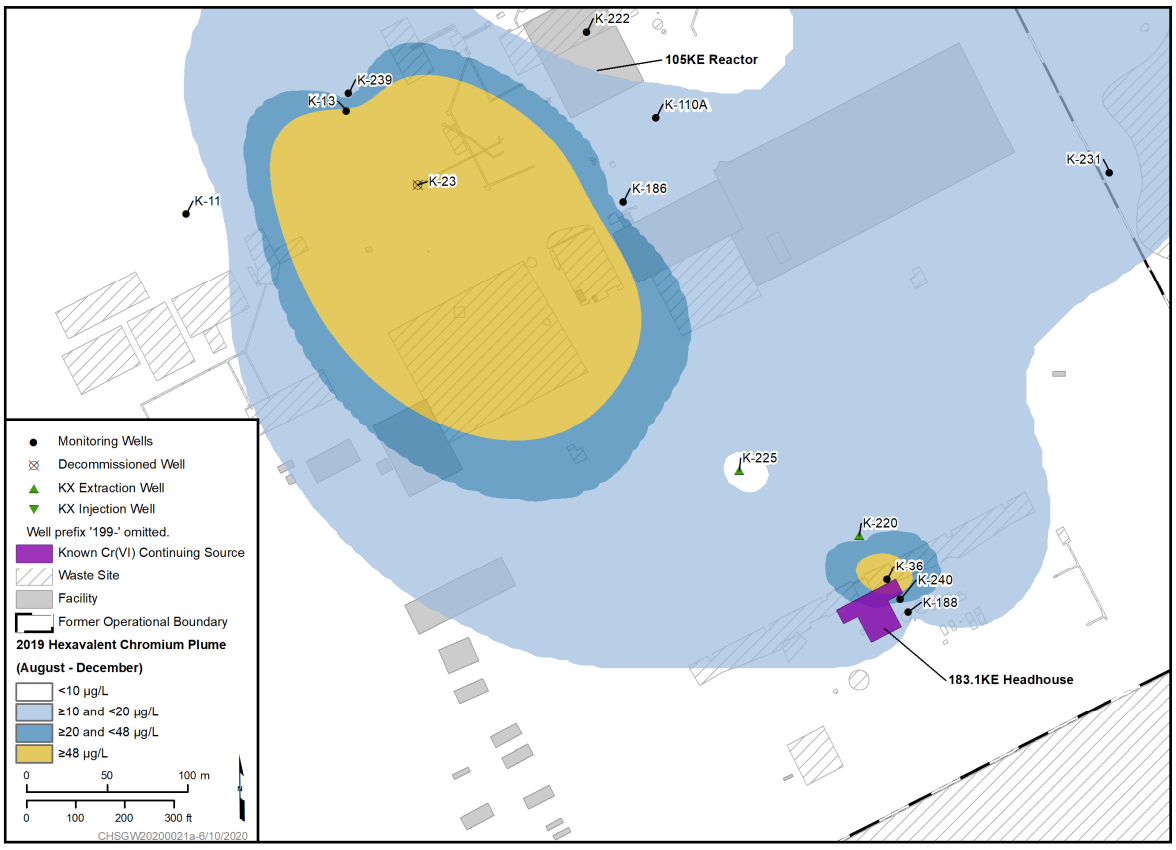

Figure 1-4. Cr(VI) Plume Originating from the 183.1KE Headhouse

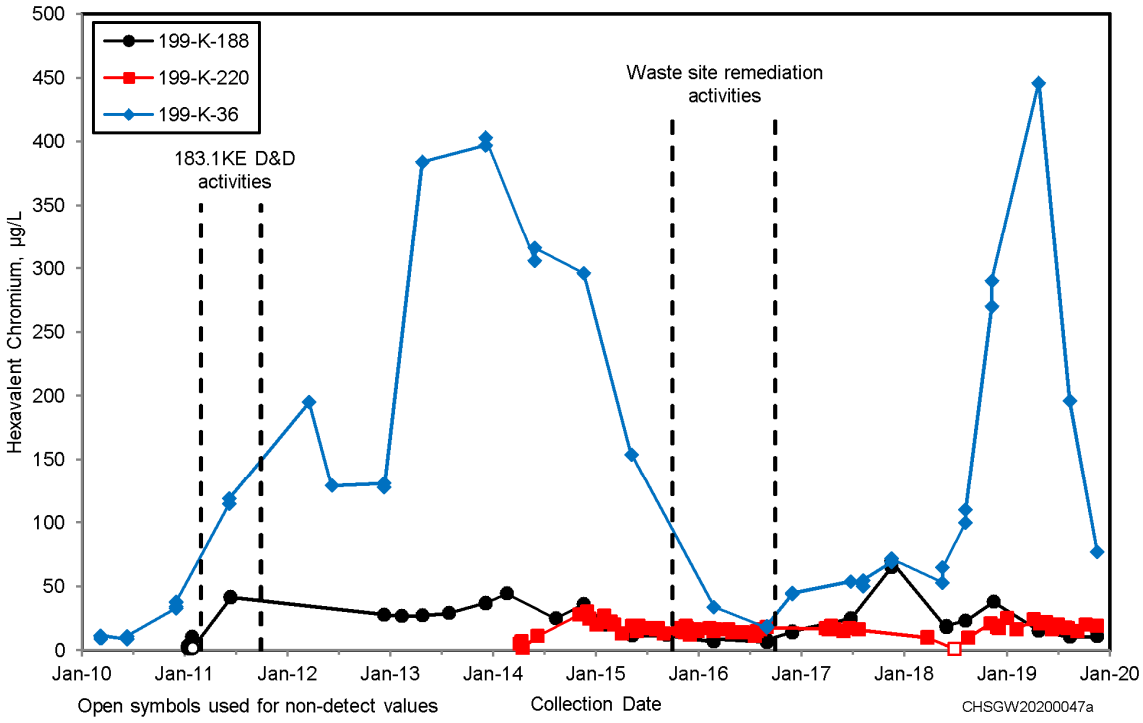

Figure 1-5. Cr(VI) Trends in Wells near 183.1KE During Waste Site Remediation Activities

1.3 Systematic Planning Summary

The systematic planning process is a strategic planning approach for defining the criteria that a data collection design should satisfy. This process is used to ensure that the type, quantity, and quality of collected data will be appropriate for the intended application. The systematic planning process will be used to document characterization needs and sample design, with the goal of meeting the remedial action objectives (RAOs) for the OU.

The RAOs for 100-KR-4 OU from the interim action ROD (EPA/ROD/R10-96/134) are as follows:

- **RAO 1:** Protect aquatic receptors in the river bottom substrate from contaminants in groundwater entering the Columbia River.
- **RAO 2:** Protect human health by preventing exposure to contaminants in the groundwater.
- **RAO 3:** Provide information that will lead to the final remedy.

Samples collected and analyzed as part of this SAP will provide information to support operations of the KE Headhouse infiltration gallery. For this SAP, a limited systematic planning process was used to address the following project-related questions:

1. What issue or problem requires new data to make a decision?
2. What data are needed to support the decision?
3. How will the data be used to resolve the problem or issue?
4. What are the acceptable ranges for data collection?
5. What are the action levels for the contaminant data being collected?
6. What is the acceptable error for the contaminant data being collected?

A large body of knowledge already exists for the contaminants in the OU, as well as lessons learned from the KW Headhouse soil flushing event (DOE/RL-2019-77). Systematic planning questions 1, 2, 3, and 5 are addressed below. Questions 4 and 6 are addressed in Chapter 2.

What issue or problem requires new data to make a decision?

- Is the infiltration wetting front flowing through the projected area of impact?
- Is the infiltration gallery located within or does it encompass the entirety of the area of concern?
- Is soil flushing resulting in collocated contaminants increasing above applicable drinking water standards in groundwater?
- Is soil flushing resulting in increased mobilization and capture of Cr(VI) mass via P&T systems?
- Are post soil flushing conditions resulting in an increase (i.e., rebound) of Cr(VI) concentrations above cleanup values?

What data are needed to support the decision?

- Electrical resistivity tomography (ERT) will be needed to monitor the infiltration wetting front. The ERT system induces an electrical current into the soil at various locations and intervals over time, with simultaneous measurements of electrical resistivity collected at alternate locations and intervals, allowing for mapping and tracking of infiltration water through the vadose zone.
- Analytical results of groundwater samples collected from monitoring and extraction wells, as well as source water from the KW P&T effluent, as described in Section 1.5, will be needed to monitor effectiveness of soil flushing.
- Groundwater elevation data for extraction wells 199-K-220 and 199-K-240 and for monitoring wells 199-K-36, 199-K-188, and 199-K-225 will be needed to monitor changes in groundwater gradients and flow directions during and post soil flushing.

How will data be used to resolve the problem or issue?

- ERT results will be used to evaluate migration of infiltration wetting front and document footprint of saturation within the vadose zone and PRZ.
- Data from groundwater samples collected from monitoring and extraction wells will be used to evaluate if additional contaminant mass is located in the vadose zone beyond the soil flushing footprint.
- Data from groundwater samples from monitoring and extraction wells as well as source water from the KW P&T effluent will be collected at an increased frequency during initial soil flushing and used to determine if concentrations of collocated contaminants increase above concentrations of concern.
- Data from groundwater samples from monitoring and extraction wells, as well as source water from the KW P&T effluent, will be used to document mobilization, capture, and estimated mass removal of Cr(VI).
- Groundwater elevation data will be used to support evaluation of contaminant migration and capture of infiltration water via the P&T system.

- Groundwater samples from monitoring and extraction wells will continue to be collected after active soil flushing and used to determine whether Cr(VI) contaminant mass in the vadose zone and PRZ has decreased sufficiently for protection of groundwater.

What are the action levels for the contaminant data being collected?

- Soil flushing is intended to enhance the current interim action remedy via P&T under the 100-KR-4 interim action ROD (EPA/ROD/R10-96/134). Decisional logic for initiating project rebound studies will utilize Washington State Department of Ecology (Ecology) Model Toxics Control Act Method B (WAC 173-340-720, "Model Toxics Control Act—Cleanup," "Groundwater Cleanup Standards") groundwater concentration for human health protection for Cr(VI) of 48 µg/L and consider the state surface water quality standard of 10 µg/L.

1.4 Summary of Soil Flushing Implementation and Design

Implementation of this SAP is anticipated to begin in fiscal year 2022. Due to cold weather concerns specific to soil flushing and infiltration of treated KW P&T effluent and aquifer levels, soil flushing is planned to begin in April to May and stop once freezing conditions decrease the effectiveness of the infiltration gallery.

Existing wells and ERT will be used to monitor the soil flushing. Samples collected and analyzed as part of this SAP are designed to track the Cr(VI) mass removal via soil flushing and capture through the groundwater P&T system.

Figure 1-6 presents the decision logic for infiltration gallery operation and duration. The decision logic will be used as the guiding framework for infiltration and rebound durations and potential modifications to the infiltration gallery.

1.4.1 Extraction Well Capture Modeling

A particle-track modeling package was completed for evaluation of infiltration water capture via the P&T system. The modeling includes release of particles under multiple scenarios, including expansion of the infiltration area (footprint) and variable extraction well pumping rates. The modeling results will be used to guide infiltration and flow rate decisions during active soil flushing. Modeling results are presented in ECF-100KR4-21-0088, *183.1 KE Headhouse Soil Flushing Sampling and Analysis Plan*.

Multiple scenarios were evaluated in the model and included expected potential infiltration and extraction flow rates, as well as planned infiltration areas. As presented in Section 1.0 of ECF-100KR4-21-0088, scenarios included the following:

- Scenario 1: original flushing area footprint, with a flushing rate of 760 L/min (200 gal/min) and total extraction rate of 890 L/min (235 gal/min) at downgradient extraction wells 199-K-220 and 199-K-240
- Scenario 2a: expanded flushing area footprint, with a flushing rate of 850 L/min (225 gal/min) and total extraction rate of 890 L/min (235 gal/min) at downgradient extraction wells 199-K-220 and 199-K-240
- Scenario 2b: expanded flushing area footprint, with a flushing rate of 760 L/min (200 gal/min) and total extraction rate of 890 L/min (235 gal/min) at downgradient extraction wells 199-K-220 and 199-K-240
- Scenario 3: expanded flushing area footprint, with a flushing rate of 1,135 L/min (300 gal/min) and total extraction rate of 890 L/min (235 gal/min) at downgradient extraction wells 199-K-220 and 199-K-240

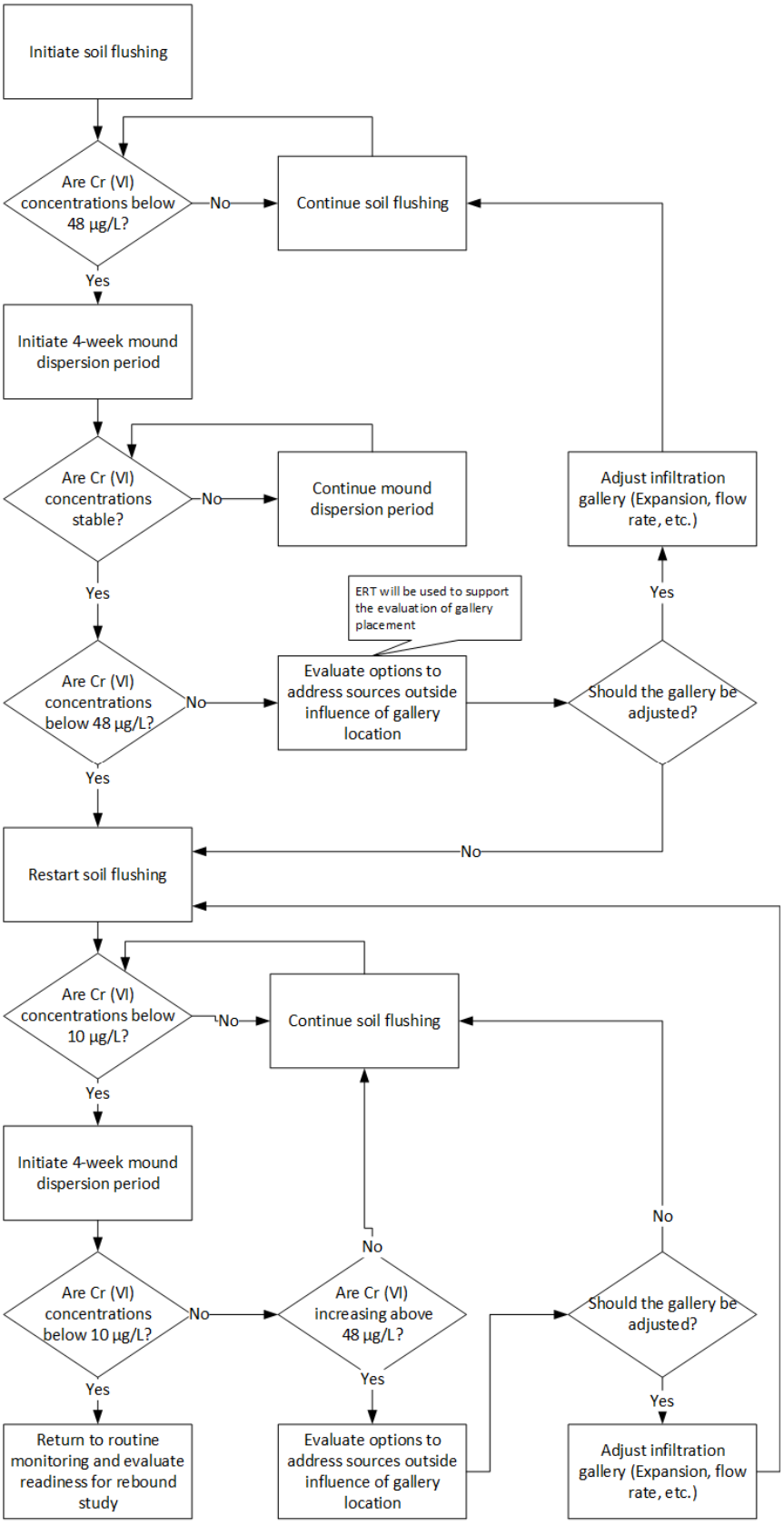

Figure 1-6. Decisional Logic for Infiltration Gallery Operation and Duration

Infiltration rates are expected to range between 475 to 850 L/min (125 and 225 gal/min); however, an additional scenario was included with an infiltration rate of 1,135 L/min (300 gal/min) to evaluate capture at higher than anticipated flow rates. The extraction rates are based on and limited to current operational limitations and aquifer yield in wells 199-K-220 and 199-K-240.

Results of the modeling indicate that reasonable capture is maintained with the planned infiltration area, and expanded infiltration area, where infiltration flow rates do not exceed 850 L/min (225 gal/min).

1.4.2 Monitoring of Mass Removal to 48 µg/L Threshold

During the initial phase, a sufficient volume of effluent from the KW P&T facility will be applied to the land surface to cause a saturated wetting front, extending from the infiltration gallery, through the vadose zone, and to the underlying water table. This application will target approximately 475 to 850 L/min (125 to 225 gal/min) at maximum flow rate; however, lower flow rates will be used during the following scenarios:

- Initial flushing to evaluate flow pathways and capture via extraction wells
- Where field conditions indicate need for reduced flows
- Due to operational conditions of the P&T systems

Based on estimates from the KW Headhouse soil flushing event, water released at the ground surface is expected to infiltrate through the vadose zone and reach the water table within about 1 week. As infiltration occurs, samples from existing extraction wells and monitoring wells will be collected and analyzed for Cr(VI).

Performance monitoring data will be evaluated within extraction and monitoring wells until peak Cr(VI) concentrations are observed. Subsequently, monitoring frequencies will be reduced and may result in adjustments to infiltration rates.

Infiltration and performance monitoring will continue until a peak concentration of Cr(VI) is observed and a concentration of less than 48 µg/L is achieved within the extraction and monitoring wells as determined by the OU Technical Lead. Once the threshold concentration is observed, infiltration will be shut down and the aquifer mound allowed to disperse for a minimum of 1 month. During the shutdown period, sampling frequency will be further reduced and effectiveness of the treatment evaluated. Changes to the infiltration gallery footprint may be implemented based on data evaluation.

Targeting an initial shutdown and mound dispersion once concentrations of less than 48 µg/L are observed will allow for a period of evaluation of the infiltration gallery location and area, as well as allow for any adjustments to optimize the system prior to restarting the system.

1.4.3 Monitoring of Mass Removal to 10 µg/L Threshold

Once concentrations below 48 µg/L are determined by the OU Technical Lead and/or changes to the infiltration gallery footprint are made, soil flushing will resume. Sample frequency will be consistent with the startup of the initial phase and decrease after peak concentrations are observed. Infiltration will continue until a Cr(VI) concentration of 10 µg/L is achieved within the extraction and monitoring wells as indicated by the groundwater sample results and determined by the OU Technical Lead.

Once the threshold concentration is observed, infiltration will again be shut down and the aquifer mound allowed to disperse for a minimum of 1 month. During the shutdown period, sampling frequency will be reduced and effectiveness of the treatment evaluated. Further changes to the infiltration gallery footprint may be implemented based on data evaluation.

Once Cr(VI) concentrations are stable and below 10 µg/L during the shutdown period, soil flushing activities will cease and groundwater monitoring will revert to 100-KR-4 groundwater monitoring criteria specified in DOE/RL-2013-29.

If concentrations of Cr(VI) become stable below 48 µg/L and above 10 µg/L in extraction and monitoring wells, then further evaluation of system performance and potential changes will be made in consultation with the U.S. Department of Energy, Richland Operations Office (DOE-RL) and the U.S. Environmental Protection Agency (EPA).

1.5 Contaminants of Concern/ Contaminants of Potential Concern/Target Analytes

Selected analytes are based on the systematic planning process for the KW Headhouse soil flushing as presented in DOE/RL-2019-77. Selected analytes under this SAP include analytes within the KW soil flushing SAP (DOE/RL-2018-10, *KW Soil Flushing/Infiltration Treatability Test Plan Sampling and Analysis Plan*) with the exception of aluminum, manganese, and lead, which did not provide meaningful data during the KW Headhouse soil flushing event. Alkalinity was added to the KW Headhouse soil flushing SAP after initial startup as a determined data need for tracking of groundwater flow and has been included within this SAP. Table 1-1 presents groundwater and KW P&T effluent analytes retained. Table 1-2 presents a summary of data needs and associated target analytes. Mobile constituents, where referenced, include Cr(VI) and supporting constituents sodium, sulfate, and chloride.

Table 1-1. Groundwater and KW P&T Facility Effluent Analytes to Support Soil Flushing

Analyte	CAS Number
General Chemical Parameters	
Alkalinity	N/A
Chloride	16887-00-6
Sulfate	14808-79-8
Cr(VI)	18540-29-9
Inorganics – Metals[a]	
Copper	7440-50-8
Mercury	7439-97-6
Sodium	7440-23-5
Field Measurements[b]	
Specific conductance	N/A
pH	13967-14-1
Dissolved oxygen	7782-44-7
Turbidity	N/A
Temperature	N/A

Table 1-1. Groundwater and KW P&T Facility Effluent Analytes to Support Soil Flushing

Analyte	CAS Number
Cr(VI)	18540-29-9

a. Analyses to be performed on both filtered and unfiltered aliquots.

b. In-plant process monitoring in addition to parameter monitoring conducted during well purging/sampling in accordance with applicable standard operating procedures.

CAS = Chemical Abstracts Service

N/A = not applicable

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Table 1-2. 100-KE Soil Flushing/Infiltration Data Needs

Data Need	Media of Interest	Location	Sampling Method	Action Level	Frequency	Practical Constraints	Analytical Method	Potential Source of Data
Presence of mobile constituents and water quality in infiltration water and groundwater underlying within the soil flushing area prior to active flushing	Infiltration water and groundwater	KW P&T effluent; extraction wells 199-K-220 and 199-K-240; and monitoring wells 199-K-36, 199-K-188, and 199-K-225	Pumped samples from wells, filtered and unfiltered aliquots collected from in-plant sample taps for the extraction wells and process effluent; and from a depth of <1 m (3.3 ft) below the water table from monitoring wells. Monitoring wells 199-K-36 and 199-K-188 will be sampled via a remote sampling port constructed outside of the ERT array and infiltration gallery footprint.	Concentration increase of mobile constituents above that observed prior to initiating vadose flush activity	One time event prior to or at time of startup	Will require coordination between plant operation staff and groundwater sampling personnel	Laboratory Cr(VI) analysis from filtered aliquots Laboratory analysis for chloride, sulfate, sodium, and alkalinity from unfiltered aliquots Field measurements for specific conductance, temperature, turbidity, dissolved oxygen, and pH.	Sampling and analysis of water samples from specified locations
Cr(VI) concentration time series in groundwater following application of vadose flush action and after peak concentrations are observed	Infiltration water and groundwater	KW P&T effluent; extraction wells 199-K-220 and 199-K-240; and monitoring wells 199-K-36, 199-K-188, and 199-K-225	Pumped samples from wells, filtered aliquots collected from in-plant sample taps for the extraction wells and process effluent; and from a depth of <1 m (3.3 ft) below the water table from monitoring wells. Monitoring wells 199-K-36 and 199-K-188 will be sampled via a remote sampling port constructed outside of the ERT array and infiltration gallery footprint.	Cr(VI) concentration in groundwater >48 µg/L during initial infiltration phase Cr(VI) concentration in groundwater >10 µg/L during subsequent infiltration phase(s)	Daily Hach® kit measurements beginning at start of vadose flush activity and continuing until a peak concentration is observed for Cr(VI) in extraction wells 199-K-220 and 199-K-240; and monitoring wells 199-K-36 and 199-K-188; then reduce to weekly. KW effluent will maintain weekly samples (per DOE/RL-2013-48). Daily measurements are based on a Monday to Thursday work week. Weekly laboratory measurement beginning at start of vadose flush activity and continuing until a peak concentration is observed for Cr(VI) in extraction wells 199-K-220 and 199-K-240; and monitoring wells 199-K-36, 199-K-188, and 199-K-225; then reduce to monthly.	Will require coordination between plant operation staff and groundwater sampling personnel	In-process Cr(VI) samples via Hach kit Laboratory Cr(VI) samples on filtered aliquots Field measurements for specific conductance, temperature, turbidity, dissolved oxygen, and pH	Sampling and analysis of water samples from specified locations
Concentration of suspended and dissolved nontarget toxic metals (i.e., mercury, and copper) and supporting constituents (chloride, sulfate, sodium, and alkalinity) in infiltration water and groundwater	Infiltration water and groundwater	KW P&T effluent; extraction wells 199-K-220 and 199-K-240; and monitoring wells 199-K-36, 199-K-188, and 199-K-225	Pumped samples from wells, filtered and unfiltered aliquots collected from in-plant sample taps for the extraction wells and process effluent; and from a depth of <1 m (3.3 ft) below the water table from monitoring wells. Monitoring wells 199-K-36 and 199-K-188 will be sampled via a remote sampling port constructed outside of the ERT array and infiltration gallery footprint.	Detectable and increasing above preflushing concentrations	Weekly measurement at KW P&T effluent; extraction wells 199-K-220 and 199-K-240; and monitoring wells 199-K-36, 199-K-188, and 199-K-225. Weekly measurements will be limited to the initial flushing period until peak concentrations are identified, and will be reduced to monthly frequency.	Will require coordination between plant operation staff and groundwater sampling personnel	Total metals in filtered and unfiltered aliquots Supporting constituents on unfiltered aliquots	Sampling and analysis of water samples from specified locations

Table 1-2. 100-KE Soil Flushing/Infiltration Data Needs

Data Need	Media of Interest	Location	Sampling Method	Action Level	Frequency	Practical Constraints	Analytical Method	Potential Source of Data
Post soil flushing concentrations of Cr(VI) to confirm depletion of secondary source material	Groundwater	Extraction wells 199-K-220 and 199-K-240; and monitoring wells 199-K-36, 199-K-188, and 199-K-225	Pumped samples from wells, filtered aliquots collected from in-plant sample taps for the extraction wells and from a depth of <1 m (3.3 ft) below the water table from monitoring wells. Monitoring wells 199-K-36 and 199-K-188 will be sampled via remote sampling port constructed outside of the ERT array and infiltration gallery footprint.	Stable trends	In-process Cr(VI) samples collected every other day for a minimum of one month at extraction wells 199-K-220 and 199-K-240; and monitoring wells 199-K-36 and 199-K-188. Measurements every other day are based on a Monday to Thursday work week. Laboratory measurements of Cr(VI) collected monthly at extraction wells 199-K-220 and 199-K-240; and monitoring wells 199-K-36, 199-K-188 and 199-K-225.	None noted	In-process Cr(VI) samples via Hach kit Laboratory Cr(VI) samples on filtered aliquots Field measurements of specific conductance, temperature, turbidity, dissolved oxygen, and pH	Sampling and analysis of water samples from specified locations
Post soil flushing concentrations of suspended and dissolved nontarget toxic metals (i.e., mercury and copper) and supporting constituents chloride, sulfate, sodium, and alkalinity	Groundwater	Extraction wells 199-K-220 and 199-K-240; and monitoring wells 199-K-36, 199-K-188, and 199-K-225	Pumped samples from wells, filtered and unfiltered aliquots collected from in-plant sample taps for the extraction wells and from a depth of <1 m (3.3 ft) below the water table from monitoring wells. Monitoring wells 199-K-36 and 199-K-188 will be sampled via remote sampling port constructed outside of the ERT array and infiltration gallery footprint.	Stable trends	Laboratory measurements monthly for a minimum of one month at extraction wells 199-K-220 and 199-K-240; and monitoring wells 199-K-36, 199-K-188 and 199-K-225	None noted	Total metals in filtered and unfiltered aliquots Supporting constituents from unfiltered aliquots	Sampling and analysis of water samples from specified locations

Reference: DOE/RL-2013-48, *Operations and Maintenance Plan for the 100-KR-4 Pump and Treat Systems*.

ERT = Electrical Resistivity Tomography

P&T = pump and treat

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2 Quality Assurance Project Plan

A quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection. It includes planning, implementation, and assessment of sampling tasks, field measurements, laboratory analysis, and data review. This chapter describes the applicable environmental data collection requirements and controls based on the quality assurance (QA) elements found in EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5), and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD). DoD/DOE QSM, *Department of Defense/Department of Energy Consolidated Quality System Manual for Environmental Laboratories*, is also discussed. Section 7.8 of the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b; hereinafter called the Tri-Party Agreement Action Plan) requires the QA/quality control (QC) and sampling and analysis activities to specify the QA requirements for Past-Practice Processes. This QAPjP also describes applicable requirements and controls based on guidance in Ecology Publication No. 04-03-030, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies,* and EPA/240/R-02/009, *Guidance for Quality Assurance Project Plans* (EPA QA/G-5). This QAPjP supplements the contractor's environmental QA program plan.

The QAPjP references are included in Chapter 6. The QAPjP includes the following sections, which describe the quality requirements and controls applicable to Hanford Site OU sampling activities:

- Section 2.1, "Project Management"
- Section 2.2, "Data Generation and Acquisition"
- Section 2.3, "Assessment and Oversight"
- Section 2.4, "Data Review and Usability"
- Section 2.5, "Reporting"

2.1 Project Management

This section includes project goals, planned management approaches, and planned output documentation.

2.1.1 Project/Task Organization

The project organization is described in the following sections and illustrated in Figure 2-1.

2.1.1.1 Regulatory Lead

The lead regulatory agency for the 100-KR-4 OU is EPA. The lead regulatory agency is responsible for regulatory oversight of cleanup projects and activities. EPA retains approval authority for all SAPs. EPA works with DOE-RL to resolve concerns over the work described in this SAP in accordance with the Tri-Party Agreement (Ecology et al., 1989a).

2.1.1.2 DOE-RL Manager

Hanford Site cleanup in the 100-KR-4 OU is the responsibility of DOE-RL. The DOE-RL Manager is responsible for authorizing the contractor to perform activities described within this SAP at the Hanford Site under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; *Resource Conservation and Recovery Act of 1976*; *Atomic Energy Act of 1954*; and the Tri-Party Agreement (Ecology et al., 1989a).

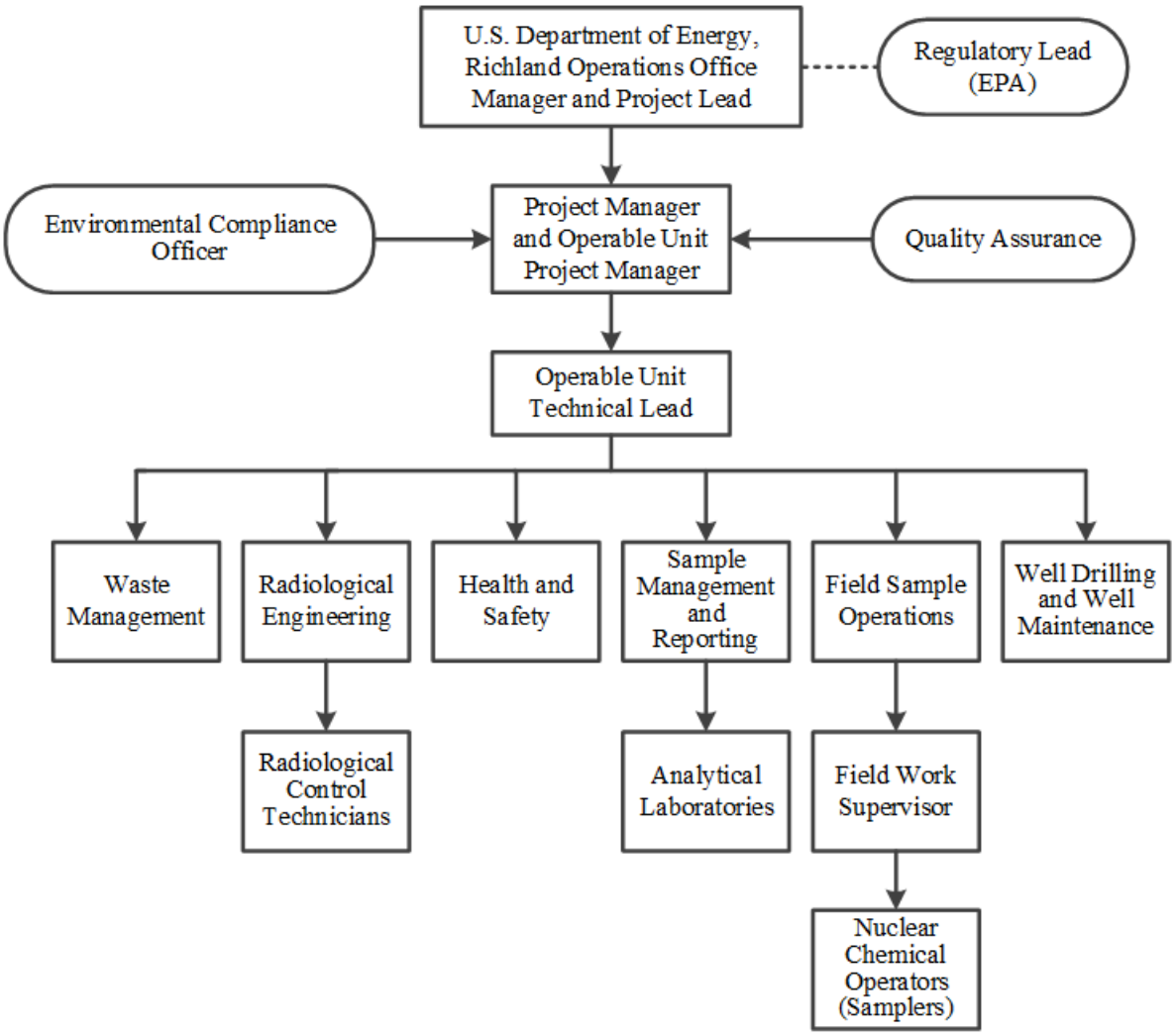

Figure 2-1. Project Organization

2.1.1.3 DOE-RL Project Lead

The DOE-RL Project Lead is responsible for providing day-to-day oversight of the contractor's performance of the work scope, working with the contractor to identify and work through issues, and providing technical input to DOE-RL management.

2.1.1.4 Regulatory Strategy and Integration Regulatory Document Delivery Manager

The Regulatory Strategy and Integration Regulatory Document Delivery Manager (Project Manager in Figure 2-1) provides oversight and coordinates with DOE-RL and primary contractor management in support of sampling and reporting activities. The Regulatory Strategy and Integration Regulatory Document Delivery Manager also provides support to the OU Project Manager to ensure that work is performed safely and cost effectively.

2.1.1.5 Operable Unit Project Manager

The OU Project Manager (or designee) is responsible and accountable for project-related activities including coordinating with DOE-RL, regulators, and contractor management in support of sampling activities to ensure work is performed safely, compliantly, and cost effectively. In addition, the OU

Project Manager (or designee) is also responsible for managing sampling documents and requirements, field activities, subcontracted tasks, and for ensuring the project file is properly maintained.

2.1.1.6 Operable Unit Technical Lead

The OU Technical Lead is responsible for developing specific sampling design, analytical requirements, and QC requirements, either independently or as defined through a systematic planning process. The OU Technical Lead ensures that sampling and analysis activities as delegated by the OU Project Manager are carried out in accordance with the SAP and works closely with the Environmental Compliance Officer, QA, Health and Safety, the Field Work Supervisor (FWS), and the Sample Management and Reporting (SMR) group to integrate these and other technical disciplines in planning and implementing the work scope.

2.1.1.7 Sample Management and Reporting

The SMR group oversees offsite analytical laboratories, coordinates laboratory analytical work to ensure that laboratories conform to the requirements of this plan, and verifies that laboratories are qualified for performing Hanford Site analytical work. The SMR group generates field sampling documents, labels, and instructions for field sampling personnel and develops the sample authorization form (SAF), which provides information and instruction to the analytical laboratories. The SMR group ensures that field sampling documents are revised to reflect approved changes. The SMR group receives analytical data from the laboratories, ensures the data are appropriately reviewed, performs data entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation and recordkeeping. The SMR group is responsible for resolving sample documentation deficiencies or issues associated with Field Sample Operations (FSO), laboratories, or other entities. The SMR group is responsible for informing the OU Project Manager of any issues reported by the analytical laboratories.

2.1.1.8 Field Sampling Operations

FSO is responsible for planning and coordinating field sampling resources. The FWS directs the nuclear chemical operators (samplers), who collect samples in accordance with this sampling plan and corresponding standard methods and work packages. The FWS ensures that deviations from field sampling documents or issues encountered in the field are documented appropriately (e.g., in the field logbook). The FWS ensures that samplers are appropriately trained and available. Samplers collect samples in accordance with sampling requirements. Samplers also complete field logbooks, data forms, and chain-of-custody forms, including any shipping paperwork, and enable delivery of the samples to the analytical laboratory.

Prejob briefings are conducted by FSO, in accordance with work management and work release requirements, to evaluate activities and associated hazards by considering the following factors:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required

2.1.1.9 Quality Assurance

The QA point of contact provides independent oversight and is responsible for addressing QA issues on the project, overseeing implementation of the project QA requirements. Responsibilities include reviewing project documents including the QAPjP and participating in QA assessments on sample collection and analysis activities, as appropriate.

2.1.1.10 Environmental Compliance Officer

The Environmental Compliance Officer provides technical oversight, direction, and acceptance of project and subcontracted environmental work and also develops appropriate mitigation measures with the goal of minimizing adverse environmental impacts.

2.1.1.11 Health and Safety

The Health and Safety organization is responsible for coordinating industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulation or internal primary contractor work requirements.

2.1.1.12 Radiological Engineering

Radiological Engineering is responsible for the following:

- Radiological engineering and project health physics support
- Conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization
- Identifying radiological hazards and ensuring appropriate controls are implemented to maintain worker exposures to hazards at ALARA levels
- Interfacing with the project Health and Safety representative and other appropriate personnel, as needed, to plan and direct project radiological control technician support

2.1.1.13 Waste Management

Waste Management is responsible for identifying waste management sampling/characterization requirements to ensure regulatory compliance and for interpreting data to determine waste designations and profiles. Waste Management communicates policies and practices and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner.

2.1.1.14 Analytical Laboratories

The analytical laboratories accept, manage, prepare, and analyze samples in accordance with established methods and the requirements of their subcontract, and provide necessary data packages containing analytical and QC results. Laboratories provide explanations of results to support data review and in response to resolution of analytical issues. Laboratory quality requirements are consistent with HASQARD (DOE/RL-96-68). The laboratories are evaluated under the U.S. Department of Energy Consolidated Audit–Accreditation Program (DOE/CAP-AP) to U.S. Department of Defense (DoD)/DOE, 2019 Quality Systems Manual (QSM) requirements. HASQARD requirements, beyond those within the DoD/DOE QSM, are also evaluated under the DOE/CAP-AP. Laboratories are accredited by Ecology for the analyses performed under this SAP.

2.1.1.15 Well Drilling and Well Maintenance

The well drilling and maintenance and well coordination and planning managers are responsible for the following:

- Planning, coordinating, and executing drilling construction
- Well maintenance activities
- Coordinating with the OU Technical Lead about field constraints that could affect sampling design
- Coordinating well decommissioning with DOE-RL in accordance with the substantive standards of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

2.1.2 Quality Objectives and Criteria

The QA objective of this plan is to ensure the generation of analytical data of known and appropriate quality is acceptable and useful in order to meet the evaluation requirements stated in the sampling plan. Data descriptors known as data quality indicators (DQIs) help determine the acceptability and usefulness of data to the user. The principal DQIs (precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity) are defined for the purposes of this document in Table 2-1.

Table 2-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Precision (field duplicates, laboratory control sample duplicate, laboratory sample duplicates, and matrix spike duplicates)	Precision measures the agreement among a set of replicate measurements. Field precision is assessed through the collection and analysis of field duplicates. Analytical precision is estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples, and/or field samples. The most commonly used estimates of precision are the relative standard deviation and, when only two samples are available, the relative percent difference.	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory. Acquire replicate field samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	If duplicate data do not meet objective: • Evaluate apparent cause (e.g., sample heterogeneity). • Request reanalysis or remeasurement. • Qualify the data before use.
Accuracy (laboratory control samples, matrix spikes, surrogates, carriers, and tracers)	Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. QC analyses used to measure accuracy include laboratory control samples, spiked samples, and surrogates.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample).	If recovery does not meet objective: • Qualify the data before use. • Request reanalysis or remeasurement. • Evaluate instrumentation and recalibrate, if necessary.

Table 2-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Representativeness (field duplicates)	Sample representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. It is dependent on the proper design of the sampling program and will be satisfied by ensuring that the approved plans were followed during sampling and analysis.	Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	If results are not representative of the system sampled: • Identify the reason for results not being representative. • Flag for further review. • Review data for usability. • If data are usable, qualify the data for limited use and define the portion of the system that the data represent. • If data are not usable, flag as appropriate. • Redefine sampling and measurement requirements and protocols. • Resample and reanalyze, as appropriate.
Comparability (field duplicate, field splits, laboratory control samples, laboratory control sample duplicates, matrix spikes, and matrix spike duplicates)	Comparability expresses the degree of confidence with which one data set can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied. Further, when assessing comparability, data sets should be of known and documented quality.	Use identical or similar sample collection and handling methods, sample preparation and analytical methods, holding times, and QA protocols.	If data are not comparable to other data sets: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Qualify the data as appropriate. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future comparability.
Completeness (no QC element; addressed in data usability assessment)	Completeness is a measure of the amount of valid data collected compared to the amount planned. Measurements are considered to be valid if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (data quality objectives or performance/ acceptance criteria).	If data sets do not meet the completeness objective: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future completeness.

Table 2-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Bias (equipment blanks, field transfer blanks, full trip blanks, laboratory control samples, matrix spikes, and method blanks)	Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (e.g., the sample measurement is consistently lower than the sample's true value). Bias can be introduced during sampling, analysis, and data evaluation. Analytical bias refers to deviation in one direction (i.e., high, low, or unknown) of the measured value from a known spiked amount.	Sampling bias may be revealed by analysis of replicate samples. Analytical bias may be assessed by comparing a measured value in a sample of known concentration to an accepted reference value or by determining the recovery of a known amount of contaminant spiked into a sample (matrix spike).	For sampling bias: • Properly select and use sampling tools. • Institute correct sampling and subsampling practices to limit preferential selection or loss of sample media. • Use sample handling practices, including proper sample preservation, that limit the loss or gain of constituents to the sample media. • Analytical data that are known to be affected by either sampling or analytical bias are flagged to indicate possible bias. • Laboratories that are known to generate biased data for a specific analyte are asked to correct their methods to remove the bias as best as practicable. Otherwise, samples are sent to other laboratories for analysis.
Sensitivity (no QC element; addressed via method detection limit, practical quantitation limit, and relative percent difference)	Sensitivity is an instrument's or method's minimum concentration that can be reliably measured (i.e., instrument detection limit or limit of quantitation).	Determine the minimum concentration or attribute to be measured by an instrument (instrument detection limit) or by a laboratory (limit of quantitation). The lower limit of quantitation[b] is the lowest level that can be routinely quantified and reported by a laboratory.	If detection limits do not meet objective: • Request reanalysis or remeasurement using methods or analytical conditions that will meet required detection or limit of quantitation. • Qualify/reject the data before use.

Note: Based on SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*.

a. Acceptance criteria for QC elements are provided in Table 2-5.

b. For purposes of this sampling plan, the lower limit of quantitation is interchangeable with the practical quantitation limit.

QA = quality assurance

QC = quality control

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Data quality is defined by the degree of rigor in the acceptance criteria assigned to the DQIs. The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are dictated by the intended use of the data and the requirements of the analytical method. DQIs are evaluated during a process to assess data usability (Section 2.4.3).

2.1.3 Methods-Based Analysis

Laboratory testing for analytes described in Section 2.2.1 may include nontarget analytes that are part of the analytical method (i.e., methods-based reporting). The additional constituents that are part of the method and reported by the laboratory are for informational purposes. Analytical performance requirements will be applicable only to the analytes specific to this SAP. Poor QC related to nontarget analyte results would not result in any required corrective action by the laboratory, except for the application of proper result qualification flags.

2.1.4 Analytical Priority

If sample volume is insufficient to analyze for all analytes listed for a given well, the sampling priority will be determined by the OU Technical Lead. In general, the highest priority analytes critical for supporting groundwater decisions are required to be analyzed. While insufficient sample volume is not expected to be a concern, priority is first given to Cr(VI), second to water quality constitutes, and third to nontarget toxic metals.

2.1.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility for collecting and transporting samples and compliant with applicable DOE orders and government regulations. The FWS, in coordination with line management, will ensure that special training requirements for field personnel are met.

Training has been instituted by the contractor management team to meet training and qualification programs that satisfy multiple training drivers imposed by applicable DOE, *Code of Federal Regulations*, and *Washington Administrative Code* requirements.

Training records are maintained for each employee in an electronic training record database. The contractor's training organization maintains the training records system. Line management confirms that an employee's training is appropriate and up to date prior to performing work under this SAP.

2.1.6 Documents and Records

The OU Project Manager (or designee) is responsible for ensuring the current version of the SAP is being used and providing any updates to field personnel. Version control is maintained by the administrative document control process. Table 2-2 defines the types of changes that may impact the sampling and the associated approvals, notifications, and documentation requirements.

Table 2-2. Change Control for Sampling Projects

Type of Change[a]	Action	Documentation
Minor Field Change. Changes that have no adverse effect on the technical adequacy of the sampling activity or the work schedule.	The field personnel recognizing the need for a field change will consult with the OU Project Manager (or designee) prior to implementing the field change.	Minor field changes will be documented in the field logbook. The logbook entry will include the field change, the reason for the field change, and the names and titles of those approving the field change.
Minor Change. Changes to approved plans that do not affect the overall intent of the plan or schedule.	The OU Project Manager will inform DOE-RL and the Regulatory Lead of the change. EPA determines there is no need to revise the document.	Documentation of this change approval would be in the Unit Manager's Meeting minutes or comparable Tri-Party Agreement Change Notice[b].
Revision Necessary. Lead regulatory agency determines changes to approved plans require revision to document.	If it is anticipated that a revision is necessary, the OU Project Manager will inform DOE-RL and the Regulatory Lead. EPA determines the change requires a revision to the document.	Formal revision of the sampling document.

References: DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents*.

Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*.

Ecology et al, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*.

a. Consistent with DOE/RL-96-68 and Sections 9.3 and 12.4 of Ecology et al., 1989b.

b. The Tri-Party Agreement Action Plan, Section 9.3, defines the minimum elements of a change notice.

DOE-RL = U.S. Department of Energy, Richland Operations Office

EPA = U.S. Environmental Protection Agency

OU = operable unit

Tri-Party Agreement = *Hanford Federal Facility Agreement and Consent Order*

Regarding minor field changes, the project scientist in coordination with the soil and groundwater subject matter expert (SME) will approve deviations from the SAP that do not have an adverse effect on the technical integrity or adequacy of the sampling activity. Below are examples of minor field changes:

During groundwater sampling, most groundwater samples will be pumped, although use of another method may be authorized by the OU Technical Lead.

The sample depths provided in this SAP are estimated based on known characterization data and geology collected from nearby wells. For this reason, adjustments to the sample depths are anticipated. The sample depths may be altered during drilling in consultation with the OU Technical Lead.

Groundwater samples may not be collected before a minimum of three well casing volumes have been purged and water chemistry (e.g., temperature, pH, and conductivity) has stabilized within 10% variance over three consecutive measurements unless approved by the OU Technical Lead. Note that no minimum purge volume is required for sampling from operating extraction wells.

Regarding minor changes, the OU Technical Lead in coordination with the soil and groundwater SME will consult with DOE-RL and the Regulatory Lead when deviations from the SAP do not affect the overall intent of the plan. Below are examples of minor changes:

1. The addition of monitoring wells to the sampling program.
2. The modification of groundwater sampling frequency.

The OU Technical Lead in coordination with the soil and groundwater SME will inform DOE-RL and EPA of deviations from the SAP that do affect the overall intent and schedule, which may require revision to the approved plan.

Logbooks and data forms are required for field activities. The logbook must be identified with a unique project name and number. Only authorized individuals may make entries into the logbooks. Logbooks and data forms will be controlled in accordance with internal work requirements and processes.

The FWS and SMR are responsible for ensuring that the field instructions are maintained and aligned with any revisions or approved changes to the SAP. The SMR will ensure that any deviations from the SAP are reflected in revised field sampling documents for the samplers and the analytical laboratory. The FWS will ensure that deviations from the SAP or problems encountered in the field are documented appropriately (e.g., in the field logbook).

The OU Project Manager, FWS, or designee, is responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities. The OU Project Manager is also responsible for ensuring that project files are appropriately set up and maintained. The project files will contain project records or references to their storage locations. Project files may include the following information:

- Operational records and logbooks
- Data forms
- Global positioning system data (a copy will be provided to SMR)
- Inspection or assessment reports and corrective action reports
- Field summary reports
- Interim progress reports
- Final reports
- Photographs

The following records are managed and maintained by SMR personnel:

- Completed field sampling logbooks
- Field drilling and analytical data
- Groundwater sample reports and field sample reports
- Completed chain-of-custody forms
- Sample receipt records
- Laboratory data packages
- Analytical data verification and validation reports
- Analytical data “case file purges” (i.e., raw data purged from laboratory files) provided by the offsite analytical laboratories

Convenience copies of laboratory analytical results are maintained in the HEIS database. Records may be stored in either electronic (e.g., in the managed records area of the Integrated Document Management System) or hard copy format (e.g., DOE Records Holding Area). Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement (Ecology et al., 1989a) will be managed per Tri-Party Agreement requirements.

2.2 Data Generation and Acquisition

This section addresses data generation and acquisition to ensure that the project's methods for sampling measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented. Requirements for instrument calibration and maintenance, supply inspections, and data management are also addressed.

2.2.1 Analytical Methods Requirements

Table 2-3 provides information regarding analytical method requirements for samples collected. Updated EPA methods and nationally recognized standard methods may be substituted for the analytical methods identified in Table 2-3 in order to follow changed requirements in the method update. The new method shall achieve project data quality objectives (DQOs) as well as or better than the replaced method.

Table 2-3. Performance Requirements for Sample Analysis

Constituent	CAS Number/ Constituent ID	MCL or *Washington Administrative Code* (µg/L)[a]	Analytical Method[b]	PQL for Water (µg/L)[c]
General Chemistry Parameters, Unfiltered Except Cr(V)				
Alkalinity	ALKALINITY	N/A	Method 310.1	5,250
Chloride	16887-00-6	250,000	Method 300.0	400
Sulfate	14808-79-8	250,000	Method 300.0	1,050
Cr(VI)	18540-29-9	48/10	Method 7196	5
Inorganics – Metals, Filtered and Unfiltered				
Mercury	7439-97-6	2	Method 7470	0.5
Copper	7440-50-8	640	Method 6020	10
Sodium	7440-23-5	—	Method 6010	1,050
Field Measurements				
Dissolved oxygen	7782-44-7	N/A	Method 360.1	N/A
pH measurement	13967-14-1		Method 150.1	
Specific conductance	CONDUCT		Method 120.1	
Temperature	TEMPERATURE		Method 170.1	
Turbidity	TURBIDITY		Method 180.1	

Table 2-3. Performance Requirements for Sample Analysis

Constituent	CAS Number/ Constituent ID	MCL or *Washington Administrative Code* (µg/L)[a]	Analytical Method[b]	PQL for Water (µg/L)[c]
Cr(VI)	18540-29-9	48/10	Method 7196	N/A

a. WAC 173-340-720, "Model Toxics Control Act—Cleanup," "Groundwater Cleanup Standards," Method B. MCLs include both primary standards and secondary standards for aluminum, chloride, and sulfate where these values are lower than the Method B values.

b. For EPA Method 300.0, see EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*. For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*. Equivalent methods may be substituted.

c. PQLs are specified in contracts with analytical laboratories. Actual PQLs vary by laboratory and may be lower. Method detection limits are three to five times lower than quantitation limits.

CAS = Chemical Abstracts Service
EPA = U.S. Environmental Protection Agency
ID = identification
MCL = maximum contaminant level
N/A = not applicable
PQL = practical quantitation limit

2.2.2 Field Analytical Methods

Field screening and survey data will be measured consistent with HASQARD (DOE/RL-96-68). Field analytical methods are performed in accordance with the manufacturers' manuals. Table 2-3 provides the parameters (if any) for field measurements. Section 3.3 further discusses field measurements.

2.2.3 Quality Control

The QC requirements specified in the SAP must be followed in the field and analytical laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to sampling variability. Laboratory QC samples estimate the precision, bias, and matrix effects of the analytical data. Field and laboratory QC samples are summarized in Table 2-4. Acceptance criteria for field and laboratory QC are shown in Table 2-5. Data will be qualified and flagged in the HEIS database, as appropriate.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The contract laboratories participate in national studies such as the EPA-sanctioned water pollution and water supply performance evaluation studies.

Table 2-4. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Field Quality Control		
Equipment blank	Contamination from nondedicated sampling equipment	1 in 20 samples when nondedicated equipment is used[a,b]
Full trip blank	Contamination from containers, preservative reagents, storage, or transportation	1 per 20 sampling events (well trips[c] or other media samples)
Field duplicate samples	Reproducibility/sampling precision	1 in 20 sampling events (well trips or other media samples[c])

Table 2-4. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Field split samples	Inter-laboratory comparability	As needed
Laboratory Batch Quality Control[d]		
Method blanks	Laboratory contamination	1 per analytical batch[e]
Laboratory sample duplicate	Laboratory reproducibility and precision	1 per analytical batch[e]
Matrix spikes	Matrix effect/laboratory accuracy	1 per analytical batch[e]
Matrix spike duplicate	Laboratory reproducibility, and method accuracy and precision	1 per analytical batch[e]
Surrogates	Recovery/yield for organic compounds	Added to each sample and quality control
Laboratory control	Method accuracy	1 per analytical batch[e]

Note: The information in this table does not represent U.S. Environmental Protection Agency or Washington State Department of Ecology requirements; it is intended solely as guidance.

a. For portable Grundfos® pumps, equipment blanks are collected 1 per 20 well trips. Whenever a new type of nondedicated equipment is used, an equipment blank shall be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination procedure for the nondedicated equipment.

b. Vendor-provided borehole equipment is considered dedicated equipment and equipment blanks are not typically acquired in this instance.

c. A "well trip" is defined as any time a well is accessed for sampling. For groundwater monitoring, field duplicates and full trip blanks are run at a frequency of 1 in 20 well trips (i.e., 5% of the well trips) for all groundwater monitoring wells sampled within any given month (not just those restricted to a single treatment, storage, and disposal unit). For example, if a month has 181 wells scheduled, then 10 field duplicates will be collected.

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

e. Unless not required by or different frequency is called out in laboratory analysis method.

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Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	Quality Control Element	Acceptance Criteria (Water)	Corrective Action
General Chemistry Parameters			
Alkalinity	MB	<MDL OR <5% sample concentration	Flag with "C"
	LCS	80%–120% recovery	Flag with "o"[a]
	DUP[b] or MS/MSD[c]	≤20% RPD	Review data[d]
	MS/MSD[c]	75%–125% recovery	Flag with "N"
	EB, FTB	<MDL OR <5% sample concentration	Flag with "Q"
	Field duplicate[b]	≤20% RPD	Review data[d]
Anions by IC	MB	<MDL or <5% sample concentration	Flag with "C"

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	Quality Control Element	Acceptance Criteria (Water)	Corrective Action
Chloride Sulfate	LCS	80%–120% recovery	Flag with "o"[a]
	DUP[b] or MS/MSD[c]	≤20% RPD	Review data[d]
	MS/MSD[c]	75%–125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[b]	≤20% RPD	Review data[d]
Hexavalent chromium	MB	<MDL or <5% sample concentration	Flag with "C"
	LCS	80%–120% recovery	Flag with "o"[a]
	DUP[b] or MS/MSD[c]	≤20% RPD	Review data[d]
	MS/MSD[c]	75%–125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[b]	≤20% RPD	Review data[d]
Inorganics – Metals			
ICP-AES metals	MB	<MDL or <5% sample concentration	Flag with "C"
	LCS	80%–120% recovery	Flag with "o"[a]
	DUP[b] or MS/MSD[c]	≤20% RPD	Review data[d]
	MS/MSD[c]	75%–125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[b]	≤20% RPD	Review data[d]
ICP-MS metals	MB	<MDL or <5% sample concentration	Flag with "C"
	LCS	80%–120% recovery	Flag with "o"[a]
	DUP[b] or MS/MSD[c]	≤20% RPD	Review data[d]
	MS/MSD[c]	75%–125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[b]	≤20% RPD	Review data[d]

Notes: The information in this table does not represent U.S. Environmental Protection Agency requirements but is intended solely as guidance. The table is consistent with SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*, and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document*.

This table only applies to laboratory analyses. Depth to groundwater, dissolved oxygen, pH, specific conductance, temperature, and turbidity are not listed because they are measured in the field.

a. The reporting laboratory will apply the "o" flag with SMR concurrence.

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	Quality Control Element	Acceptance Criteria (Water)	Corrective Action

b. Applies when at least one result is greater than the laboratory practical quantitation limit (chemical analyses) or greater than five times the MDC (radiochemical analyses).

c. Either a sample duplicate or an MSD is to be analyzed to determine measurement precision (if there is insufficient sample volume, a laboratory control sample duplicate is analyzed with the acceptance criteria defaulting to the DUP/MSD criteria).

d. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data.

DUP = laboratory sample duplicate
EB = equipment blank
FTB = full trip blank
IC = ion chromatography
ICP-AES = inductively coupled plasma – atomic emission spectroscopy
ICP-MS = inductively coupled plasma – mass spectrometry
LCS = laboratory control sample
MB = method blank
MDC = minimum detectable activity
MDL = method detection limit
MS = matrix spike
MSD = matrix spike duplicate
RPD = relative percent difference
SMR = Sample Management and Reporting

Data Flags:

C = possible laboratory contamination: analyte was detected in the associated method blank
o = result may be biased: associated laboratory control sample result was outside the acceptance limits – laboratory applied
N = result may be biased: associated matrix spike result was outside the acceptance limits
Q = problem with associated field QC blank: results were out of limits

2.2.3.1 Field Quality Control Samples

Field QC samples are collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability and laboratory performance to help ensure reliable data are obtained. Field QC samples include field duplicates, field split (SPLIT) samples, and two types of field blanks (equipment blanks [EBs] and full trip blanks [FTBs]). Field blanks are typically prepared using high-purity reagent water[1]. QC sample definitions for collection are described below.

Field duplicates: Independent samples collected as close as possible to the same time and same location as the schedule sample, and intended to be identical. Field duplicates are placed in separate sample containers and analyzed independently. Field duplicates are used to determine precision for both sampling and laboratory measurements.

Field splits (SPLITs): Two samples collected as close as possible to the same time and same location and intended to be identical. SPLITs will be stored in separate containers and analyzed by different laboratories for the same analytes. SPLITs are inter-laboratory comparison samples used to evaluate comparability between laboratories.

[1] Reagent water is high-purity water that is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques (DOE/RL-96-68).

Equipment blanks (EBs): Samples of high-purity water passed through or poured over decontaminated sampling equipment prior to collecting the samples. EBs are collected and placed in sample containers, as identified on the SAF. EB sample bottles are placed in the storage containers with samples from the associated sampling event and are analyzed for the same constituents as samples from the sampling event. EBs are used to evaluate decontamination process effectiveness; these samples are not required for disposable sampling equipment.

Full trip blanks (FTBs): Bottles prepared by the sampling team before travel to the sampling site. The preserved bottle set is either for volatile organic analysis only or identical to the set that will be collected in the field. It is filled with high-purity water and the bottles are sealed and transported (unopened) to the field in the same storage containers used for samples collected that day. Collected FTBs are typically analyzed for the same constituents as the samples from the associated sampling event. FTBs are used to evaluate potential sample contamination from the sample bottles, preservative, handling, storage, and transportation.

2.2.3.2 Laboratory QC Samples

Internal QA/QC programs are maintained by laboratories used by the project. Laboratory QA includes a comprehensive QC program that includes the use of laboratory control samples, laboratory sample duplicates, matrix spikes (MSs), matrix spike duplicates (MSDs), method blanks (MBs), and surrogates (SURs). These QC analyses are required by EPA methods (e.g., those in the SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*), and will be run at the frequency specified in the respective references unless superseded by agreement. QC checks outside of control limits are documented in analytical laboratory reports during data usability assessments, if performed. Laboratory QC checks and their typical frequencies are listed in Table 2-4. Acceptance criteria are shown in Table 2-5. Following are descriptions of the various types of laboratory QC samples.

Laboratory control sample: a control matrix (e.g., reagent water) spiked with analytes representing the target analytes or certified reference material used to evaluate laboratory accuracy.

Laboratory sample duplicate: an intra-laboratory replicate sample that is used to evaluate the precision of a method in a given sample matrix.

Matrix spike (MS): an aliquot of a sample spiked with a known concentration of target analyte(s). The MS is used to assess the bias of a method in a given sample matrix. Spiking occurs prior to sample preparation and analysis.

Matrix spike duplicate (MSD): a replicate spiked aliquot of a sample that is subjected to the entire sample preparation and analytical process. MSD results are used to determine the bias and precision of a method in a given sample matrix.

Method blank (MB): an analyte-free matrix to which the same reagents are added in the same volumes or proportions as used in the sample processing. The MB is carried through the sample preparations and analytical procedure and is used to quantify contamination resulting from the analytical process.

Surrogate (SUR): a compound added to every sample in the analysis batch (field samples and QC samples) prior to preparation. SURs are typically similar in chemical composition to the analyte being determined, but they are not normally encountered. SURs are expected to respond to the preparation and measurement systems in a manner similar to the analytes of interest. Because SURs are added to every standard, sample, and QC sample, they are used to evaluate overall method performance in a given matrix. SURs are used only in organic analyses.

Laboratories are required to analyze samples within the holding times specified in Table 2-6. In some instances, constituents in the samples not analyzed within the holding times may be compromised by volatilization, decomposition, or by other chemical changes. Data from samples analyzed outside of the holding times are flagged in the HEIS database with an "H."

Table 2-6. Holding Time Guidelines for Laboratory Analytes

Constituent/Parameter	Preservation[a]	Holding Time
General Chemistry Parameters		
Alkalinity	Cool ≤6°C	14 days
Chloride and sulfate	Cool ≤6°C	28 days
Hexavalent chromium	Cool ≤6°C	24 hours
Metals		
ICP-AES metals/ICP-MS metals	HNO3 to pH <2	6 months

Notes: Holding times and preservation methods are dependent on the constituent, and are consistent with U.S. Environmental Protection Agency guidance and approved analytical methods.

Container types and volumes will be identified on the chain-of-custody form.

This table only applies to laboratory analyses. Depth to groundwater, dissolved oxygen, pH, specific conductance, temperature, and turbidity are not listed because they are measured in the field.

a. For preservation identified as stored at <6°C, the sample should be protected against freezing unless it is known that freezing will not impact the sample integrity.

ICP-AES = inductively coupled plasma – atomic emission spectroscopy
ICP-MS = inductively coupled plasma – mass spectrometry

2.2.4 Measurement Equipment

Each measuring equipment user is responsible to ensure the equipment is functioning as expected, properly handled, and properly calibrated at required frequencies per methods governing control of the equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance will be recorded in accordance with approved methods. Field screening instruments will be used, maintained, and calibrated in accordance with the manufacturer's specifications and other approved methods.

2.2.5 Instrument and Equipment Testing, Inspection, and Maintenance

Collection, measurement, and testing equipment should meet applicable standards (e.g., ASTM International, formerly the American Society for Testing and Materials) or have been evaluated as acceptable and valid in accordance with instrument-specific methods, requirements, and specifications. Software applications will be acceptance tested prior to use in the field.

Measurement and testing equipment used in the field or in the laboratory will be subject to preventive maintenance measures to ensure minimization of downtime. Laboratories must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and onsite organization's QA plan or operating protocols, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with HASQARD (DOE/RL-96-68) requirements.

2.2.6 Instrument/Equipment Calibration and Frequency

Field equipment calibration is discussed in Section 3.5. Analytical laboratory instruments are calibrated in accordance with the laboratory's QA plan and applicable Hanford Site requirements.

2.2.7 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed in accordance with internal requirements and will be appropriate for their use. Supplies and consumables used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes. Responsibilities and interfaces necessary to ensure that items procured/acquired for the contractor meet the specific technical and quality requirements must be in place. The procurement system ensures purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

2.2.8 Nondirect Measurements

Data obtained from sources such as computer databases, programs, literature files, and historical databases will be technically reviewed to the same extent as data generated as part of any sampling and analysis QA/QC effort. Data used in evaluations will be identified by source.

2.2.9 Data Management

The SMR group, in coordination with the OU Project Manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with applicable programmatic requirements governing data management methods.

Electronic data access, when appropriate, will be through a Hanford Site database (e.g., HEIS). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b).

Laboratory errors are reported to the SMR group through an established process. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with applicable methods. This process is used to document analytical errors and to establish their resolution with the OU Project Manager. The sample issue resolution forms become a permanent part of the analytical data package for future reference and for records management.

2.3 Assessment and Oversight

Assessment and oversight activities address the effectiveness of project implementation and associated QA/QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

2.3.1 Assessments and Response Actions

Assessments may be performed to verify compliance with the requirements outlined in this SAP, project field instructions, the QAPjP, methods, and regulatory requirements. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. The project line management chain coordinates the corrective actions/deficiency resolutions in accordance with the QA program, the corrective action management program, and associated methods implementing these programs. When appropriate, corrective actions will be taken by the OU Project Manager (or designee). A data usability assessment may be performed for the identified SAP activities. The data usability assessment results will be provided to the OU Project Manager. No other planned assessments have been identified. If circumstances arise in the field dictating the need for additional assessments, then additional assessments will be performed.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. The SMR group oversees offsite analytical laboratories and verifies the laboratories are qualified to perform Hanford Site analytical work.

2.3.2 Reports to Management

Program and project management (as appropriate) will be made aware of deficiencies identified by assessments and oversight. Issues reported by the laboratories are communicated to SMR, which then initiates a sample issue resolution form. The process is used to document analytical or sample issues and to establish resolution with the OU Project Manager. If an assessment finding results in sampling issues that affect a regulatory requirement, DOE would be informed and the matter discussed with the regulatory agencies.

2.4 Data Review and Usability

This section addresses QA activities that occur after data collection. Implementation of these activities determines whether the data conform to the specified criteria, thus satisfying the project objectives.

2.4.1 Data Review and Verification

Data review and verification are performed to confirm that sampling and chain-of-custody documentation are complete. This review includes linking sample numbers to specific sampling locations, and reviewing sample collection dates and sample preparation and analysis dates to assess whether holding times, if any, have been met. Furthermore, review of QC data is used to determine whether analyses have met the data quality requirements specified in this SAP.

The criteria for verification include, but are not limited to, review for contractual compliance (samples were analyzed as requested), use of the correct analytical method, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Field QA/QC results will be reviewed to ensure they are usable.

The OU Technical Lead performs data reviews to help determine if observed changes reflect potential data errors, which may result in submitting a request for data review on questionable data. The laboratory may be asked to check calculations or reanalyze the sample. In extreme cases, another sample may be collected. Results of the request for the data review process are used to flag the data appropriately in the HEIS database and/or to add comments.

2.4.2 Data Validation

Data validation is an independent assessment to ensure the reliability of the data. Analytical data validation provides a level of assurance that an analyte is present or absent. Validation may also include the following:

- Verification of instrument calibrations
- Evaluation of analytical results based on MBs
- Recovery of various internal standards
- Correctness of uncertainty calculations
- Correctness of identification and quantification of analytes
- The effect of quality deficiencies on data reliability

The contractor follows the data validation process described in EPA-540-R-2017-001, *National Functional Guidelines for Inorganic Superfund Methods Data Review*, and EPA-540-R-2017-002, *National Functional Guidelines for Organic Superfund Methods Data Review*, adjusted for use with SW-846,

HASQARD (DOE/RL-96-68), and radiochemistry methods. The criteria for data validation are based on a graded approach using five levels of validation: Levels A through E. Level A is the lowest level and is the same as verification. Level E is a 100% review of all data (e.g., calibration data and calculations of representative samples from the data set). Data validation may be performed to Level C, which is a review of the QC data. Level C validation consists of a review of the QC data and specifically requires verification of deliverables; requested versus reported analytes; and qualification of the results based on evaluation of analytical holding times, MB results, MS/MSD results, surrogate recoveries, and duplicate sample results. Level C data validation is generally equivalent to Level 2A in EPA 540-R-08-005, *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use*. Level C data validation, if required, will be performed on at least 5% of the data by matrix and analyte group under the direction of SMR. Analyte group refers to categories such as radionuclides, volatile chemicals, semivolatiles, metals, and anions. The goal is to include each of the various analyte groups and matrices during the data validation process. The DOE-RL Project Lead or OU Project Manager may specify a higher percentage of data to be validated or that data validation be performed at higher levels.

2.4.3 Reconciliation with User Requirements

The purpose of reconciliation with user requirements is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project data needs. Sampling design used in this sampling is judgment based and DQIs will be used to determine data quality and usability. The data quality assessment (DQA) process is the scientific and statistical evaluation of previously verified and validated data to determine if information obtained from environmental data operations are of the right type, quality, and quantity to support their intended use (usability). When judgmental (focused) sampling designs are implemented in the field, DQIs such as precision, accuracy, representativeness, comparability, completeness, and sensitivity for the specific data sets (individual data packages) will be evaluated in accordance with EPA/240/R-02/004, *Guidance on Environmental Data Verification and Data Validation* (EPA QA/G-8). Data verification and data validation are integral to both the statistical DQA data evaluation process and the DQI evaluation process. Results of the DQA or DQI (data usability assessment) processes will be used by the contractor OU Project Manager to interpret the data and determine if the DQOs for this activity have been met.

2.5 Reporting

In general, measurement data will be reviewed as they are received and will be verified through assessment against DQOs and measurement performance metrics. Corrective actions may be implemented as indicated based on the data review. Section 1.1 of this SAP identifies the primary objectives and goals for KE Headhouse soil flushing.

2.5.1 Data Interpretation

Data from measurements and observations will be used to interpret groundwater conditions in the area where KW soil flushing/infiltration will be conducted. Interpretive techniques include, but are not limited to, the following:

- **Hydrographs:** Graph water levels versus time to evaluate decreases and increases in groundwater levels in response to vadose zone flushing or drainage periods.
- **Water table maps:** Use water table elevations from multiple wells to construct limited-area contour maps and estimate flow directions under transient conditions. Use information to verify or support groundwater capture by the existing KW P&T system.

- **Trend plots:** Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. Concentrations may be used to estimate/quantify and graph the mass of secondary source materials removed from the vadose zone and PRZ.

- **Plume maps:** Map distributions of chemical constituent concentrations in the project area to evaluate response of mass transfer from the vadose zone to groundwater.

2.5.2 Reporting and Notification

Groundwater monitoring results are summarized in annual groundwater monitoring reports (e.g., DOE/RL-2019-66) and annual P&T reports (e.g., DOE/RL-2019-67, *Calendar Year 2019 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater Remediation*). The results of groundwater monitoring in regard to the KE Headhouse soil flushing will be presented in annual reports, and informal status updates will be provided to DOE-RL and EPA approximately monthly or as appropriate based on phase of soil flushing and frequency of data collection.

If Cr(VI) concentrations at monitoring locations outside of the apparent capture area of the operating extraction wells increases and exceeds the interim remedial action groundwater target concentration of 20 µg/L, the DOE-RL project manager and EPA project lead will be notified. The condition will be evaluated, and a collaborative decision will be made regarding the potential need to optimize the P&T system.

Following completion of soil flushing, a technical report will be prepared describing the study and test conditions. The technical report will summarize measurements and observations and provide recommendations for actions related to the interim remedial action.

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3 Field Sampling Plan

This chapter identifies project sampling and analysis activities that will be performed specifically for groundwater and infiltration water sampling conducted during soil flushing activities at KE Headhouse as presented in Section 1.4.

To avoid potential issues associated with operating the system during freezing condition, the soil flushing is anticipated to begin in the spring.

3.1 Sampling Objectives/Design

Groundwater sampling and analysis supporting this project will be conducted to monitor the effects on underlying groundwater due to migration of residual secondary source materials within the vadose zone and PRZ using infiltration effluent from the KW P&T system. This SAP addresses the groundwater contamination that has previously been observed in this area.

Groundwater monitoring will continue as a part of the 100-KR-4 OU as specified in DOE/RL-2013-29, DOE/RL-2013-33, and DOE/RL-2013-48.

No new wells are planned to be installed for the planned soil flushing at the KE Headhouse. Changes to the monitoring schedule or analytes will be made through change notices in accordance with Section 9.3 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b) or through a revision of this SAP.

3.2 Sample Location, Frequency, and Constituents to be Monitored

Tables 3-1 and 3-2 identify the selected monitoring locations (i.e., wells and KW P&T facility), frequency, and analytes during soil flushing and aquifer mound dispersion periods, respectively. Contaminant measurements identified to support this study are anions and metals (primarily Cr(VI)) in groundwater. Additional measurements include pH, specific conductance, temperature, turbidity, and dissolved oxygen.

Groundwater samples will be collected on a schedule that is tied to soil flushing phases and the relative proximity of monitoring locations to the soil flushing area. Sampling will be evaluated at the end of each phase to ensure the frequency of monitoring is appropriate. Groundwater elevation within monitoring wells will be measured manually during each groundwater sampling event. Existing automated water-level network (AWLN) stations will remain in service and will record hourly groundwater elevation measurements. Water-level measurements will be collected in operating extraction wells via dedicated P&T pressure transducers. Pressure transducers may additionally be installed in monitoring wells sampled via remote manifold array and not accessible for collection of manual water-level measurements.

Data obtained during flushing events and following flushing will be evaluated to identify and quantify the effects of apparent depletion of secondary source materials present within the vadose zone. Based on data collected during the flushing phases and simultaneous evaluations, additional flushing phases may be added or shortened to meet the overall project DQOs.

Figure 1-2 shows the groundwater sampling locations and the proposed soil flushing footprint.

Existing KE P&T extraction and monitoring network wells (199-K-36, 199-K-188, 199-K-220, 199-K-225, and 199-K-240) will be monitored. Table 3-3 provides the attributes for these wells. Wells 199-K-205 and 199-K-224 will continue as extraction wells during the duration of soil flushing.

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Table 3-1. Sample Locations, Frequencies, and Analytes During Infiltration Gallery Operation

Location Name	Well ID	Plant ID	Location Type	Hexavalent Chromium (Hach® Kit – In-Process)[a]	Metals (Filtered and Unfiltered)				Anions		General Chemical Parameters	Groundwater Properties					
					Hexavalent Chromium (Filtered Only)	Copper	Mercury	Sodium	Chloride	Sulfate	Alkalinity	Dissolved Oxygen	Temperature	Turbidity	pH	Specific Conductance	Water Level
199-K-36	A4662	N/A	Current monitoring well downgradient of soil flushing footprint	D/W	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	AWLN/W[b]
199-K-188	C7688	N/A	Current monitoring well in soil flushing footprint	D/W	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	AWLN/W[b]
199-K-220	C8795	XE5	Current extraction well downgradient of soil flushing footprint	D/W	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	SCDA[b]
199-K-225	C9597	XE8 Realign to N/A	Current extraction well downgradient of soil flushing footprint. Realign as monitoring well.	N/A	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M
199-K-240	D0090	Realign to WE13	Current monitoring well in soil flushing footprint. Realign as extraction well.	D/W	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	SCDA[b]
KW P&T facility[c]	N/A	T-03	Effluent tank	W[c]	N/A	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	W/M	N/A

a. Initial sampling of hexavalent chromium at the extraction wells and well 199-K-36 and 199-K-188 will be on a daily basis until peak concentration is observed or as determined by the Operable Unit Technical Lead. Sampling will continue every other day for 2 weeks, then weekly. EPA Method 7196 is included in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*.

b. Groundwater properties and water levels will be measured every well trip. Well 199-K-36 is also monitored by the AWLN. An existing AWLN station from another 100-K well location is anticipated to be selected and relocated to the 199-K-188 well location. Water levels in extraction wells will be collected via P&T transducers.

c. Samples from KW P&T facility effluent will be obtained from in-plant sample taps; Weekly sample collected per DOE/RL-2013-48, *Operations and Maintenance Plan for the 100-KR-4 Pump and Treat Systems*.

AWLN = automated water-level network
D = daily measurements until a peak concentration is observed or as determined by the Operable Unit Technical Lead
EPA = U.S. Environmental Protection Agency
ID = identification
M = monthly
N/A = not applicable
P&T = pump and treat
SCDA = Supervisory Control and Data Acquisition
W = weekly (Supporting constituents copper, mercury, sodium, chloride, sulfate, and alkalinity will be sampled weekly until peak concentration of hexavalent chromium is observed, or as determined by the Operable Unit Technical Lead.)

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Table 3-2. Sample Locations, Frequencies, and Analytes During Aquifer Mound Dispersion

Location Name	Well ID	Plant ID	Location Type	Hexavalent Chromium (Hach® Kit – In-Process)[a]	Metals (Filtered and Unfiltered)				Anions		General Chemical Parameters	Groundwater Properties					
					Hexavalent Chromium (Filtered Only)	Copper	Mercury	Sodium	Chloride	Sulfate	Alkalinity	Dissolved Oxygen	Temperature	Turbidity	pH	Specific Conductance	Water Level
199-K-36	A4662	N/A	Current monitoring well in soil flushing footprint	ED	M	M	M	M	M	M	M	M	M	M	M	M	AWLN/M[b]
199-K-188	C7688	N/A	Current monitoring well downgradient of soil flushing footprint	ED	M	M	M	M	M	M	M	M	M	M	M	M	AWLN/M[b]
199-K-220	C8795	XE5	Current extraction well in soil flushing footprint	ED	M	M	M	M	M	M	M	M	M	M	M	M	SCDA[b]
199-K-225	C9597	XE8 Realign to N/A	Current extraction well downgradient of soil flushing footprint. Realign as monitoring well.	N/A	M	M	M	M	M	M	M	M	M	M	M	M	M[b]
199-K-240	D0090	Realign to WE13	Current monitoring well downgradient of soil flushing footprint. Realign as extraction well.	ED	M	M	M	M	M	M	M	M	M	M	M	M	SCDA[b]
KW P&T facility[c]	N/A	T-03	Effluent tank	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

a. EPA Method 7196 is included in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*.

b. Groundwater properties and water levels will be measured every well trip. Well 199-K-36 is also monitored by the AWLN. An existing AWLN station from another 100-K well location is anticipated to be selected and relocated to the 199-K-188 well location. Water levels in extraction wells will be collected via P&T transducers.

c. Samples from KW P&T facility effluent will be obtained from in-plant sample taps.

AWLN = automated water-level network
ED = every other day (twice per week)
EPA = U.S. Environmental Protection Agency
ID = identification
M = monthly
N/A = not applicable
P&T = pump and treat
SCDA = Supervisory Control and Data Acquisition

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Table 3-3. Attributes of Wells to be Monitored

Monitoring Location Name	Construction Date	Easting[a]	Northing[a]	Ground Surface Elevation[b] (m amsl)	Top of Screen (m [ft] bgs)	Bottom of Screen (m [ft] bgs)	Depth to Water (m [ft] bgs)	Depth to Water Date
199-K-36	8/24/1992	569373.69	146390.47	150.6	27.13 (89.00)	33.22 (109.00)	29 (96)	March 2021
199-K-188	2/17/2011	569386.9	146370.05	150.7	28.29 (92.80)	38.95 (127.80)	30 (98)	November 2020
199-K-220	6/09/2014	569356.26	146417.51	150.0	21.06 (69.10)	50.03 (164.10)	29 (94)	August 2018
199-K-225	8/04/2016	569281.56	146457.77	148.1	21.22 (69.63)	48.67 (159.69)	27 (87)	August 2018
199-K-240	3/04/2020	569381.94	146378.11	150.6	27.39 (89.87)	54.85 (179.96)	30 (98)	November 2020

a. Coordinates are in NAD 83, *North American Datum of 1983*.

b. Elevations are in NAVD 88, *North American Vertical Datum of 1988*.

amsl = above mean sea level

bgs = below ground surface

3.3 Sampling Methods

In general, this study will use dedicated pumps in wells located in the ERT array area where accessibility is limited. Dedicated or portable pumps will be used in remaining wells outside of the ERT array area. The boundaries of the ERT array will be designed based on site area limitations and coordinated with the design for a remote sampling manifold for the wells located within the array. Infiltration water will be sampled via the in-process sampling port located on the KW P&T effluent tank. The primary target depth interval for collecting groundwater samples from the wells is within the upper 0.6 m (2 ft) of the aquifer below the water table. The depth to water in wells will be determined during each sampling event, and the pump will be placed approximately 0.6 m (2 ft) below the observed water table depth. Sampling may include but is not limited to the following methods:

- Field screening measurements
- Groundwater sampling
- Water-level measurements

Groundwater samples will be collected in accordance with the current revision of applicable operating methods. Groundwater samples are collected after field measurements of purged groundwater have stabilized:

- pH – two consecutive measurements agree within 0.2 pH units.
- Temperature – two consecutive measurements agree within 0.2°C (0.4°F).
- Conductivity – two consecutive measurements agree within 10% of each other.
- Turbidity – less than 5 nephelometric turbidity units prior to sampling (or OU Technical Lead's recommendation).
- Dissolved oxygen – will be measured in the field in accordance with this SAP. Dissolved oxygen is not required to be stable prior to sample collection.

Unless special requirements are requested from the OU Technical Lead, monitoring wells are typically purged using the equivalent volume as that of three borehole diameters multiplied by the length of the saturated portion of the well screen. Stable field readings are also required (as specified above). The default pumping rate is 7.6 to 45.4 L/min (2 to 12 gal/min) depending on the pump, although this is not practical at every well. On occasions when the purge volume is extraordinarily large, wells are purged for a minimum of 1 hour and are then sampled once stable field readings are obtained.

Field measurements (except for turbidity and field analysis of Cr(VI) via Hach® kit) are obtained using a flow-through cell. Groundwater is pumped directly from the well to the flow-through cell. At the beginning of the sample event, field crews attach a clean stainless-steel sampling manifold to the riser discharge. The manifold has two valves and two ports: one port is used only for purgewater and the other port is used to supply water to the flow-through cell. Probes are inserted into the flow-through cell to measure pH, temperature, conductivity, and dissolved oxygen. Turbidity is measured by inserting a sample vial into a turbidimeter. The purgewater is then discharged to the purgewater truck.

Once field measurements have stabilized, the hose supplying water to the flow-through cell is disconnected and a clean stainless-steel drop leg is attached for sampling. The flow rate is reduced during sampling to minimize loss of volatiles (if any) and prevent overfilling the bottles. Sample bottles are filled

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in a sequence designed to minimize loss of volatiles (if any). Filtered samples are collected after collection of the unfiltered samples. For some constituents (e.g., metals), both filtered and unfiltered samples are collected. If additional samples require filtration (e.g., at turbidity >5 nephelometric turbidity units), an inline disposable 0.45 µm filter is used.

Typically, three traditional types (i.e., Grundfos®, Hydrostar®, and submersible electrical pumps) of environmental-grade sampling pumps are used for groundwater sampling at Hanford Site monitoring wells. In addition, low-purge volume, adjustable-rate bladder pumps may be used. Individual pumps are selected based on the unique characteristics of the well and the sampling requirements; however, low-purge bladder pumps are not expected to be used under this SAP.

For certain types of samples, preservatives are required. Preservatives, based on the media type and analytical methods, are added to the collection bottles before their use in the field. Groundwater or surface water samples may require filtering in the field, as noted on the chain-of-custody form.

To ensure sample and data usability, the sampling associated with this SAP will be performed in accordance with HASQARD (DOE/RL-96-68) requirements for sample collection, collection equipment, sample handling, and sample shipment to the laboratory.

Sample preservation and holding-time requirements are specified for groundwater samples in Table 2-6. These requirements are in accordance with the analytical method specified in Table 2-3. The container types, preservatives, and volumes will be identified on the SAF and chain-of-custody form. This SAP defines a "sample" as a set of filled sample bottles for the purpose of beginning holding time restrictions.

Holding times are the maximum periods allowed between sample collection and lab analysis summarized in Table 2-6. Exceeding required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Required holding times depend on the constituent and are listed in analytical method compilations such as APHA/AWWA/WEF, 2012, *Standard Methods for the Examination of Water and Wastewater*, and SW-846. Recommended holding times are also provided in HASQARD (DOE/RL-96-68).

Monitoring wells, extraction wells, and KW P&T effluent will additionally be sampled for Cr(VI) by P&T operations staff via colorimetric field test per EPA Method 7196A criteria (Hach kit) (SW-846).

3.3.1 Decontamination of Sampling Equipment

Sampling equipment will be decontaminated in accordance with sampling equipment decontamination methods. To prevent potential contamination of the samples, care should be taken to use decontaminated equipment for each specific sampling activity.

Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)

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® Hydrostar is a registered trademark of KYB Corporation, Tokyo, Japan.

- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events

3.3.2 Radiological Field Data

Based on historical and recent radiological screening results from the project area, radiological screening will not be required to support groundwater sampling activities.

3.3.3 Water Levels

Using a calibrated depth measurement tape, the depth to water is recorded in each monitoring well prior to sampling. When two consecutive measurements are taken that agree within 6 mm (0.24 in.), the final determined measurement is recorded, along with the date and time for the specific event. The depth to groundwater is subtracted from the elevation of a reference point (usually the top of the casing) to obtain the water-level elevation. The top of the casing is a known elevation reference point because it has been surveyed to local reference data.

Water level measurements within monitoring wells 199-K-36 and 199-K-188 will additionally be collected via AWLN stations. The AWLN is an array of remote monitoring stations connected by a telemetry network to a central base station (SGW-53543, *Automated Water Level Network Functional Requirements*). Each monitoring station consists of a pressure transducer connected to a data collection telemetry unit. Hourly pressure data from the AWLN are used to calculate water levels, which are used to estimate the level of hydraulic containment achieved by P&T systems, determine hydraulic gradients in areas with variable conditions, and measure changes in the stage of the Columbia River in the 100 and 300 Areas.

3.4 Documentation of Field Activities

Logbooks and data forms are required for field sampling activities and will be used in accordance with HASQARD (DOE/RL-96-68) requirements. A logbook must be identified with a unique project name and number. Only authorized persons may make entries in logbooks. Logbook entries will be reviewed by the FWS, cognizant scientist/engineer, or other responsible manager; the review will be documented with a signature and date. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason. Entries will be made in indelible ink. Corrections will be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the changes.

Data forms may be used to collect field information; however, information recorded on data forms must follow the same requirements as those for logbooks. The data forms must be referenced in the logbooks.

A summary of information to be recorded in logbooks or on the data forms is as follows:

- Day and date; time task started; weather conditions; and names, titles, and organizations of personnel performing the task.
- Purpose of visit to the task area.
- Site activities in specific detail (e.g., maps and drawings) or the forms used to record such information (e.g., soil boring log or well completion log). Also, details of any field tests that were conducted; reference to any forms that were used, other data records, and methods followed in conducting the activity.

- Details of any field calibrations and surveys that were conducted. Reference any forms that were used, other data records, and the methods followed in conducting the calibrations and surveys.
- Details of any samples collected and the preparation (if any) of SPLITs, duplicates, MSs, or MBs. Reference the methods followed in sample collection or preparation; list location of sample collected, sample type, each label or tag number, sample identification, sample containers and volume, preservation method, packaging, chain-of-custody form number, and analytical request form number pertinent to each sample or sample set; and note the time and the name of the individual to whom custody of samples was transferred.
- Time, equipment type, serial or identification number, and methods followed for decontaminations and equipment maintenance performed. Reference the page number(s) of any logbook where detailed information is recorded.
- Any equipment failures or breakdowns that occurred, with a brief description of repairs or replacements.

3.4.1 Corrective Actions and Deviations for Sampling Activities

The OU Project Manager, FWS, appropriate field crew supervisors, and SMR personnel must document deviations from protocols, issues pertaining to sample collection, chain-of-custody forms, target analytes, contaminants, sample transport, or noncompliant monitoring. Examples of deviations include samples not collected due to field conditions.

As appropriate, such deviations or issues will be documented (e.g., in the field logbook) in accordance with internal corrective action methods. The OU Project Manager, FWS, field crew supervisors, or SMR personnel will be responsible for communicating field corrective action requirements and for ensuring corrective actions are applied to field activities as soon as practical.

Changes in sample activities that require notification, approval, and documentation will be performed as specified in Table 2-2.

3.5 Calibration of Field Equipment

Onsite environmental instruments are calibrated in accordance with the manufacturer's operating instructions, internal work requirements and processes, and/or field instructions that provide direction for equipment calibration or verification of accuracy by analytical methods. Calibration records shall include the raw calibration data, identification of the standards used, associated reports, date of analysis, and analyst's name or initials. The results from all instrument calibration activities are recorded in accordance with HASQARD requirements (DOE/RL-96-68).

Field instrumentation calibration and QA checks will be performed as follows:

- Prior to initial use of a field analytical measurement system.
- At the frequency recommended by the manufacturer or methods, or as required by regulations.
- Upon failure to meet specified QC criteria.
- Calibration of radiological field instruments on the Hanford Site is performed by the Hanford Mission Integration Solutions prime contractor, as specified by its calibration program.

- Daily calibration checks will be performed and documented for each instrument used. These checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data. Analysis times will be sufficient to establish detection efficiency and resolution.
- Using standards for calibration that are traceable to a nationally recognized standard agency source or measurement system. Manufacturer's recommendations for storage and handling of standards (if any) will be followed. Expired standards will not be used for calibration.

3.6 Sample Handling

Sample handling and transfer will be in accordance with established methods to preclude loss of identity, damage, deterioration, and loss of sample. Custody seals or custody tape will be used to verify that sample integrity has been maintained during sample transport. The custody seal will be inscribed with the sampler's initials and date. If during the chain-of-custody process it is discovered that the custody tape has been tampered with or broken on the sample bottle, the sample will be analyzed but the results will include a flag to indicate that custody was broken. If the custody tape has been tampered with or broken on the cooler, the sample custodian shall note this on the sample receiving documentation.

A sampling and analytical database is used to track samples from the point of collection through the laboratory analysis process.

3.6.1 Containers

Samples shall be collected, where and when appropriate, in break-resistant containers. The field sample collection record shall indicate the lot number of the bottles used in sample collection. When commercially precleaned containers are used in the field, lot identification shall be retained for documentation.

Containers shall be capped and stored in an environment that minimizes the possibility of sample container contamination. If contamination of the stored sample containers occurs, corrective actions shall be implemented to prevent reoccurrences. Contaminated sample containers cannot be used for a sampling event. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. Container types and sample amounts/volumes are identified on the chain-of-custody form.

If required, the Radiological Control organization will measure both the contamination levels and dose rates associated with the filled sample containers. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's radioactivity acceptance criteria. If the dose rate on the outside of a sample container or the curie content exceeds levels acceptable by an offsite laboratory, the FWS (in consultation with the SMR organization), can send smaller sample volumes to the laboratory.

3.6.2 Container Labeling

Each sample is identified by affixing a standardized label or tag to the container. This label or tag shall contain the sample identification number. The label shall identify or provide reference to associate the sample with the date and time of collection, preservative used (if applicable), analysis required, and collector's name or initials. Sample labels may be either preprinted or handwritten in indelible or waterproof ink.

3.6.3 Sample Custody

Sample custody will be maintained in accordance with existing protocols to ensure that sample integrity is maintained throughout the analytical process. Chain-of-custody protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each sample or set of samples shipped to any laboratory.

Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility for the custody of the sample changes, new and previous custodians will sign the record and note the date and time. The field sampling team will make a copy of the signed record before sample shipment and transmit the copy to the SMR group.

The following minimum information is required on a completed chain-of-custody form:

- Project name
- Collectors' names
- Unique sample number
- Date, time, and location (or traceable reference thereto) of sample collection
- Matrix
- Preservatives
- Chain-of-possession information (i.e., signatures and printed names of each individual involved in the transfer of sample custody and storage locations, and dates/times of receipt and relinquishment)
- Requested analyses (or reference thereto)
- Number of sample containers per unique sample identification number
- Shipped-to information (i.e., analytical laboratory performing the analysis)

Samplers should note any anomalies with the samples. If anomalies are found, samplers should inform the SMR group so special direction for analysis can be provided to the laboratory if deemed necessary.

3.6.4 Sample Transportation

Packaging and transportation instructions shall comply with applicable transportation regulations and DOE requirements. Regulations for classifying, describing, packaging, marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous wastes are enforced by the U.S. Department of Transportation (DOT) as described in 49 CFR 171, "Transportation," "General Information, Regulations, and Definitions," through 177, "Carriage by Public Highway."[2] Carrier-specific requirements defined in the current edition of International Air Transportation Association (IATA), 2013, *Dangerous Goods Regulations*, shall also be used when preparing sample shipments conveyed by air freight providers.

[2] Transportation regulations 49 CFR 174, "Carriage by Rail," and 49 CFR 176, "Carriage by Vessel," are not applicable, as these two transportation methods are not used.

Samples containing hazardous constituents above regulated amounts shall be considered hazardous material in transportation and transported according to DOT/IATA requirements. If the sample material is known or can be identified, then it will be packaged, marked, labeled, and shipped according to the specific instructions for that material. Appropriate laboratory notifications will be made, if necessary, through the SMR project coordinator.

Materials are classified by DOT/IATA as radioactive when the isotope specific activity concentration and the exempt consignment limits described in 49 CFR 173, "Shippers—General Requirements for Shipments and Packagings," are exceeded. Samples shall be screened, or relevant historical data will be used, to determine if these values are exceeded. When screening or historical data indicate samples are radioactive, they shall be properly classified, described, packaged, marked, labeled, and transported according to DOT/IATA requirements.

Prior to shipping radioactive samples to the laboratory, the organization responsible for shipping shall notify the laboratory of the approximate number and radiological levels of the samples. The laboratory is responsible for ensuring that the applicable license limits are not exceeded. Prior to sample receipt, the laboratory shall provide SMR with written acceptance for samples with elevated radioactive contamination or dose.

4 Management of Waste

Waste materials are generated during sample collection, processing, and subsampling activities. Waste will be managed in accordance with DOE/RL-97-01. For waste designation purposes, wells listed in Table 3-1 may be surveyed in the HEIS database, and the maximum concentration for each analyte within the most recent 5 years will be evaluated for use in creating a waste profile, if required.

Miscellaneous solid waste that has contacted suspect dangerous waste will be managed as dangerous waste. Purgewater and decontamination fluids will be collected and managed in accordance with DOE/RL-97-01. Packaging and labeling during waste storage and transportation will meet the applicable substantive federal and/or state requirements. Waste materials requiring collection will be placed in containers appropriate for the material and the receiving facility in accordance with the applicable waste management or waste control plan and applicable substantive federal and/or state requirements.

Offsite analytical laboratories are responsible for the disposal of unused sample quantities and wastes from analytical processes.

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5 Health and Safety

DOE established the hazardous waste operations safety and health program pursuant to the *Price-Anderson Amendments Act of 1988* to ensure the safety and health of workers involved in mixed-waste site activities. The program was developed to comply with the requirements of 10 CFR 851, "Worker Safety and Health Program," which incorporates the standards of 29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response"; 10 CFR 830, "Nuclear Safety Management"; and 10 CFR 835, "Occupational Radiation Protection." The health and safety program defines the chemical, radiological, and physical hazards and specifies the controls and requirements for daily work activities on the overall Hanford Site. Personnel training; control of industrial safety and radiological hazards; personal protective equipment; site control and general emergency response to spills, fire, accidents, injury, site visitors; and incident reporting are governed by the health and safety program. Site-specific health and safety plans will be used to supplement the general health and safety program.

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