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MEETING NOTES
Data Quality Objectives for the Waste Management Area A-AX

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MEETING NUMBER: WMA-A-AX-DQO-2017-9
MEETING DATE: August 7, 2017
LOCATION: 3110 Port of Benton Blvd, Room 2407

ATTENDEES:

Jim Alzheimer (Ecology)	Jim Field (WRPS)	MD Rahman (INTERA)
Mike Barnes (Ecology)	Bob Hiergesell (WRPS)	Julie Robertson (Freestone)
Marcel Bergeron (WRPS)	RD Hildebrand (DOE-RL)	Beth Rochette (Ecology)
Jan Bovier (DOE-ORP)	Melissa Holm (WRPS)	Kim Schuyler (Freestone)
Ryan Childress (Terra Graphics)	Scott Luke (WRPS)	Kristin Singleton (WRPS)
Roberta Day (CHPRC)	Jeremy Lynn (CHPRC)	Harold Sydnor (WRPS)
Kathi Dunbar (WRPS)	Jeff Lyon (Ecology)	Cindy Tabor (WRPS)

BACKGROUND INFORMATION: These meetings are to promote discussions among Washington State Department of Ecology (Ecology), the U.S. Environmental Protection Agency (EPA), the U.S. Department of Energy Office of River Protection (DOE-ORP), and Washington River Protection Solutions (WRPS) to develop data quality objectives (DQO) for Waste Management Area (WMA) A-AX vadose zone soil. Representatives from the DOE Richland Operations Office (DOE-RL) and the Central Plateau contractor (CH2MHILL Plateau Remediation Contractor [CHPRC]), were invited to participate to promote integration. A DQO process for the same purpose was started in 2011 but was suspended prior to completion in May 2011. Agreements and progress made as part of the 2011 effort will be leveraged in support of the current DQO process.

Lists of agreements and actions (including the status of any actions) are documented in the meeting notes.

PURPOSE OF MEETING: This meeting was called to continue the WMA A-AX vadose zone characterization DQO process initiated in January 2017.

STATUS OF PREVIOUS MEETING NOTES: Ms. Robertson stated that the notes for the May 25, 2017, and June 15, 2017 meetings were entered into the Administrative Record. The notes from the July 13, 2017 meeting were signed at the August 7, 2017 meeting. The notes from the July 24, 2017, meeting were with Ecology for review through August 11, 2017.

REVIEW OF UNRESOLVED (OR UPDATED) DQO PROCESS STEPS: Ms. Robertson provided Handout #1 to support the discussion. Ms. Robertson, Ms. Schuyler, and Ms. Tabor reviewed changes to the handout that had been made since the July 13, 2017, meeting. The changes were shown in purple on the handout.

- Background Information: A bullet was added under the DQO Scope to close Action 2017-07-13-06. The bullet states that groundwater data requirements will be addressed through the groundwater operable units associated with WMA A-AX. Mr. Lyon stated that information about the groundwater will be required for the Phase 2 WMA A-AX RFI/CMS effort, and asked for clarification regarding how that information will be provided. Ms. Tabor took an action to develop the

requested clarification so that it can be included in the WMA A-AX DQO summary report (**ACTION 2017-08-07-01**).

- Step 2: The generic, introductory text shown in italicized font was updated for clarification. Two bullets related to development of estimation statements for WMA A-AX were also added and reflect information in Table 3 of Handout #1 that had been agreed to previously. Mr. Lyon requested clarification of the text at the end of the second bullet regarding evaluation of where waste may have passed through the soil. Ms. Tabor took the action to develop clarifying text and to ensure that PSQ #4 and ES #4 in Table 3 are revised accordingly (**ACTION 2017-08-07-02**). The final sentence under Step 2 was revised to close Action 2017-07-13-07.

- Step 3: The final paragraph under Step 3 (page 13 of Handout #1) was revised to close Action 2017-07-13-08 and to reflect Agreement 16 regarding physical properties. Ms. Schuyler provided Handout #2, containing Tables 6, 8, 9, and 10, and noted revisions related to the addition of physical properties.

- Step 4: Text on page 14 of Handout #1 regarding the horizontal boundary was updated to reflect agreement reached during the July 24, 2017, meeting (Agreement 5). Figure 1 on page 16 of Handout #1 was revised to reflect the updated horizontal boundary agreement. Related to Table 7 on page 15 of Handout #1, Mr. Barnes asked whether there would be issues with WHC replacing ATL (e.g., radiological methods). Ms. Tabor responded that additional issues may get identified during the development of the sampling and analysis plan.

- Steps 5 and 6:
    - Although not shown entirely in purple text, the generic, introductory text on pages 17 and 19 of Handout #1 was updated.
    - In Step 5, page 17 of Handout #1, the first bullet specific to WMA A-AX was revised to refer specifically to Tables 8, 9, and 10 (provided in Handout #2).
    - The attendees discussed changes made to Tables 8, 9, and 10 related to Actions 2017-07-13-01, 2017-07-13-02, and 2017-07-13-03. Ms. Tabor noted that footnotes in all three tables were changed to reflect a change in the laboratory contracts from ATL to WHC. She also noted that due to the contract change, the laboratory preparation method for hexavalent chromium will need to be developed to perform the analysis. As a result, the detection limit included in Table 8 was an approximation and may need to be adjusted later. Ms. Rochette took an action to review changes made to Table 8 by August 21, 2017 (**ACTION 2017-08-07-03**)
    - In Table 11 of Handout #1, DR#1 was revised to eliminate reference to using the 95% UCL to close Action 2017-07-13-04. Under Step 6, page 19 of Handout #1, the first bullet specific to WMA A-AX outputs was revised to eliminate reference to using the 95% UCL to close Action 2017-07-13-04. Ms. Rochette expressed concern about the proposed 95% UCL replacement language and took an action to review the text and provide feedback by August 21, 2017 (**ACTION 2017-08-07-04**). Ms. Tabor took an action to provide Ms. Rochette with related text used for the Phase 2 investigation at WMA C (**ACTION 2017-08-07-05**).

- Step 7:
    - The Handout #1 content for Step 7 was revised to incorporate information shared at the July 24, 2017, WMA A-AX DQO meeting. Mr. Childress noted the addition of Table 13 to the

handout, and the correction of a typographical error within the content of Table 13 (under the approximate location of direct push #1).

- On page 23 of Handout #1, more complete information was added regarding drywell corrosion observations. Mr. Lyon asked for clarification about how drywell corrosion would be "evaluated during the field investigation," and Mr. Childress took an action to provide clarification (**ACTION 2017-08-07-06**). The word "logging" was added to the final sentence on page 23 of Handout #1 for clarification about where electrodes can be installed.

AGREEMENTS AND ACTIONS: A summary of agreements and actions is provided in the tables below. Action 2017-06-15-06 (Ecology discussion of inclusion of volatile organics and semivolatile organics) was closed, but two associated follow-on actions (**ACTIONS 2017-08-07-07** and **2017-08-07-08**) were created. Additionally, new **ACTION 2017-08-07-09** was created to support closure of ACTION 2017-04-13-02. The attendees discussed the need to correct the existing Agreements list to reflect updates to older agreements at more recent meetings. Those corrections are captured in these notes for the August 07, 2017 meeting.

JAN BOVIER	Jan B Bovier	9/7/2017
DOE Project Manager (print)	DOE Project Manager (signature)	Date
Michael W Barnes	Michael W Barnes	9-11-2017
Ecology Project Manager (print)	Ecology Project Manager (signature)	Date

DATE	AGREEMENTS (2 pages)
01/26/2017	1. DOE-ORP acknowledged the need for a Phase 2 RFI at WMA A-AX.
01/26/2017	2. Available tank waste and concrete condition information will be considered for inclusion in the RFI/CMS report(s).
01/26/2017	3. **Problem Statement**: "Vadose zone contamination in and adjacent to the A-AX Tank Farms may pose a current and future risk to human health and the environment, including groundwater, that requires corrective action to support closure."
03/30/2017; 07/13/2017	4. The DQO will move forward with a modified scope. The DQO Revision 0 will evaluate the Tank 241-A-104/105 focus area. It is agreed that there is a priority to collect additional information from the release areas associated with Tanks 241-A-104 and -105 in order to assess the movement of contamination in the environment. Information from the resulting investigation will inform the development of the model being developed for the 241-A/AX performance assessment.

DATE	AGREEMENTS (2 pages)
05/25/2017; 07/24/2017	5. **Boundaries**: The parties agreed to revise Tank A-104/105 focus area horizontal boundary as shown on the first page of Handout #1 attached to the 05/25/2017 DQO meeting notes, a vertical boundary extending from ground surface to the groundwater, and a temporal boundary driven by planned retrieval operations. **Note**: The parties agreed to revise the Tank A-104/105 focus area horizontal boundary as shown in Figure 2 of Handout #1 attached to the 07/24/17 meeting notes.
05/25/2017; 07/13/2017 08/07/2017	6. The parties agreed to the **scope, objectives, and DQO approach**: as described in Handout #2 attached to the 05/25/2017 DQO meeting notes. **Note**: Scope was subsequently modified as described in Agreement 4. Bullets describing the scope were modified to clarify that the WMA A-AX DQO process will not address data requirements for groundwater modification, as shown in Handout #1 attached to the 08/07/2017 meeting notes.
05/25/2017; 07/13/2017	7. The parties agreed to the **Goal of the Study** as described in Handout #2 attached to the 05/25/2017 DQO meeting notes (Step 2). **Note**: The Goal of the Study was subsequently modified as documented in Handout #2 of the DQO meeting notes dated 07/13/2017 (see Agreement 12).
06/15/17; 08/07/2017	8. The parties agreed to use the list of constituents contained in Handout #1 attached to the 06/15/2017 meeting notes, except that further discussion is required regarding volatile organics and semi-volatile organics. **Note**: Hexavalent chromium was added to the list as shown in the DQO meeting notes dated 08/07/2017.
06/15/2017	9. The parties agreed to the information in Handout # 2 attached to the 06/15/2017 meeting notes, describing the **basis for identification and setting of acceptable levels for decision and estimation statements**.
06/15/2017	10. The parties agreed to the information in Handout # 3 attached to the 06/15/2017 meeting notes, describing the **number of samples** that will be taken. Clarification will be provided regarding duplicate sampling at 25% of surface sample locations.
06/15/2017	11. The parties agreed to the **Step 4** information on pages 10-12 of Handout # 5 attached to the 06/15/2017 meeting notes, describing the **sampling unit, constraints to sampling/data collection**, and **smallest decision unit**. The second bullet under **Study Boundaries** will be corrected to reflect that samples taken at depths <15 ft bgs also support the ecological assessment.
07/13/2017 08/07/2017	12. The parties agreed on the contents of **Step 2** as modified in the 07/13/17 meeting (Handout #2). **Note**: The parties agreed at the 08/07/2017 DQO meeting that clarification of PSQ #4 and associated ES#4 is needed.
07/13/2017	13. The parties accepted Table 5 (**Potentially Appropriate Field and Analytical Methods for Vadose Zone Soil for Characterization**) as shown in Handout #2 attached to the 07/13/2017 DQO meeting notes.

DATE	AGREEMENTS (2 pages)
07/13/2017; 07/24/2017 08/07/2017	14. The parties agreed on the contents of **Step** 4 as shown in Handout #2 attached to the 07/13/2017 DQO meeting notes. **Note**: The **horizontal boundary** defined under Step 4 was subsequently modified as documented under Agreement 5. **Note**: A typographical error under "**Smallest decision unit**" was corrected as shown in Attachment #1 to the DQO meeting notes dated 08/07/2017.
7/24/2017; 8/7/2017	15. **Step 7**: Sampling **Strategy, General Collection, and Design**: The parties agreed to the field methodologies (sampling and logging), direct push locations for logging and sampling, drywell logging locations, and SGE electrode installation as described in the 7/24/2017 DQO meeting notes. **Note**: Minor corrections and clarifications are described in the meeting notes dated 08/07/2017. The need for clarification on how borehole corrosion will be evaluated was agreed upon at the 08/07/2017 meeting.
7/24/2017	16. **Step 3**: As described in the 7/24/2017 DQO meeting notes, the parties agreed on **physical properties** to be added to Table 6 (see Handout #3 attached to the 7/13/2017 DQO meeting notes) and Table 8 (see Handout #1 attached to the 07/13/2017 DQO meeting notes).

ACTIONS (3 pages)			
Action Number	**Actionee**	**Description**	**Status**
2017-03-30-03	Lyon/Bovier	Ecology and DOE-ORP will identify whether there are other potential 241-A/AX focus areas of interest and their level of interest in other focus areas relative to the Tanks A-104/105 focus area.	Open. Ecology identified the areas near Tanks A-103, AX-102, and AX-104 as being of interest.
2017-04-13-02	Bovier/Lyon	Discuss how DQO Step 4, define the boundaries of the study, will be addressed for the whole of WMA A-AX.	Open. See related Action 2017-08-07-09.
2017-05-25-01	Tabor	Evaluate borehole placement/configuration after getting updated GPR results.	Open. On hold until conduct GPR study.
2017-05-25-02	Levitt	Evaluate whether microgravity is applicable next to tanks and at what distance it might be applicable.	Closed at 8/7/2017 meeting. Not applicable at A-AX due to incompatibly high levels of background "noise"/activity (vibrations).

ACTIONS (3 pages)			
Action Number	**Actionee**	**Description**	**Status**
2017-06-15-06	Lyon	Ecology review basis for retaining or eliminating **volatile organics** and **semi-volatile organics** in preparation for further discussion with DOE and WRPS.	Closed at 8/7/2017 meeting. See related Actions 2017-08-07-07 and 2017-08-07-08.
2017-07-13-01	Rahman	Investigate whether there is an unrestricted level for lead that should be included in Table 8.	Closed at 8/7/17 meeting. Unrestricted level for lead was added to Table 8.
2017-07-13-02	Rochette and Barnes	Review Tables 8, 9, and 10 and provide feedback regarding "acceptable levels" by 07/24/17.	Closed at 8/7/17 meeting. Suggested changes were made to Table 8. No changes were made to Tables 9 or 10 pursuant to this action.
2017-07-13-03	Gassman	Work with lab to identify an achievable detection limit for hexavalent chromium.	Closed at 8/7/17 meeting. The detection limit of 0.09 mg/kg was added to Table 8. A related footnote indicates that detection limit values may change due to laboratory preparation methods needing to be developed.
2017-07-13-04	Bergeron	Review proposal to delete Decision Rule 1 (Table 11/Step 5) language regarding use of maximum concentration or use of 95% UCL.	Closed at 8/7/17 meeting. Propose closure at 8/7/2017 meeting. Table 11 has been updated to remove reference to 95% UCL.
2017-07-13-05	Tabor	Provide figures from EA-1 identifying where data is being gathered near WMA A-AX.	Closed at 8/7/17 meeting. Figures provided by email dated 7/26/2017.
2017-07-13-06	Robertson	Add bullet on page 1 of Handout #2 (scope) to clarify that groundwater characterization is outside the scope of this DQO process	Closed at 8/7/17 meeting. See Handout.
2017-07-13-07	Robertson	Change last sentence on page 3 of 11 of Handout #2 to state "Data supporting the DQO effort (collected prior to and collected using this DQO process) will be used to develop and refine the conceptual site model."	Closed at 8/7/17 meeting. See Handout.
2017-07-13-08	Robertson	Update last sentence on page 7 of 11 of Handout #2 to delete hexavalent chromium.	Closed at 8/7/17 meeting. See Handout.

ACTIONS (3 pages)			
Action Number	**Actionee**	**Description**	**Status**
2017-08-07-01	Tabor	Develop draft DQO summary report text about where groundwater info will be provided to share with DOE then Ecology.	New.
2017-08-07-02	Tabor	Clarify text in 2nd bullet under Step 2 on page 4 of Handout #1; revise PSQ #4 and ES#4 in Table 3 of Handout #1 accordingly.	New.
2017-08-07-03	Rochette	Review proposed changes to Table 8 of Handout #2 by August 21, 2017.	New.
2017-08-07-04	Rochette	Review proposed text changes on pages 18 and 19 of Handout #1 related to use of 95% UCL.	New.
2017-08-07-05	Tabor	Provide Ecology WMA Phase 2 language regarding use of 95% UCL.	New.
2017-08-07-06	Childress	Clarify what is meant by "evaluated" on page 23 of Handout #1.	New.
2017-08-07-07	Lyon	Ecology will meet to discuss need for VOA/SVOA analysis at the A-104/105 focus area.	New.
2017-08-07-08	Rochette	Review Table 6 in Handout #1 to specify organics to retain for overall WMA A-AX DQO, and provide rationale.	New.
2017-08-07-09	Bovier/ Hildebrand	To support Action 2017-04-13-02, DOE representatives will meet to discuss how to address areas outside the WMA A-AX fenceline that are not yet identified in the 200-IS-1 Operable Unit.	New.

Handout #1
Data Quality Objectives Process Summary

WMA A-AX DATA QUALITY OBJECTIVES (DQO) PROCESS SUMMARY
Hand Out for August 7, 2017

BACKGROUND INFORMATION

NOTE: REVISION 0 OF THIS DQO SUMMARY REPORT IS ASSOCIATED WITH FOCUS AREA TANKS A-104 AND A-105.

DQO Process

The DQO development is a seven-step process. The DQO process for WMA A-AX will be iterative, with revisions being prepared to address focus areas, as needed. It will be setup to ensure that the data needs to support the performance assessment (PA) and risk-informed retrieval process and ultimately the Phase 2 RFI/CMS efforts are achieved. The steps and the manner in which they will be applied at WMA A-AX are identified in Table 1 (**WMA-A/AX-DQO-2017-4**).

DQO Scope and objectives

The DQO scope was outlined as follows (**WMA-A/AX-DQO-2017-1** and **WMA-A/AX-DQO-2017-6**):

- The DQO process will address vadose zone contamination in and around WMA A-AX to support the RCRA Facility Investigation (RFI).
- Data will be used to develop an assessment of risk to human health and the environment, including the future risk to groundwater to support the RFI and Appendix I Performance Assessment (IPA).
- If the risk assessment indicates a need to reduce risk to human health or the environment, the data will be used to evaluate alternatives in a CMS.
- The corrective action decisions supported by the data collected under this DQO will be consistent with and support final closure of WMA A-AX.
- This DQO will not address data requirements of SST residual waste sampling and analysis or other data required to address closure associated with ancillary equipment in the tank farm. These data requirements will be addressed in a separate DQO for the closure of the SST system.
- This DQO will not address data requirements for groundwater characterization. These data requirements will be addressed through the groundwater operable units associated with WMA A-AX.

DQO objectives (**WMA-A-AX-DQO-2017-3** for bullets 2 and 3, and **WMA-A/AX-DQO-2017-4** for bullet 1):

- Define the WMA A-AX vadose zone characterization data necessary to guide planning to make vadose zone soil remedial decisions, support an evaluation of risks by direct contact and to ecological receptors, and support integration of vadose zone and groundwater decisions.
- Optimize a data collection program that will be used to support the Phase 2 RFI/CMS characterization of WMA A-AX and to support risk-informed retrieval efforts.
- Support refining the preliminary conceptual site model (CSM).

Table 1. WMA A-AX DQO Approach		
Step	**Purpose of Step**	**WMA A-AX DQO Document Information**
1	**State the Problem** *Define the problem that necessitates the study, identify the planning team, examine budget, and schedule.*	**The problem statement will be the same for each revision of the DQO.** It will address the overall issue of collecting WMA A-AX data to support the PA, retrieval, and RFI/CMS.
2	**Identify the Goal of the Study** *State how environmental data will be used in meeting objectives and solving the problem, identify study questions, define alternative outcomes.*	**The goal of the study will be the same for each revision of the DQO.** It will address the overall issue of collecting WMA A-AX data to support the PA, retrieval, and RFI/CMS.
3	**Identify Information Inputs** *Identify data and information needed to answer study questions.*	**The information inputs will be the same for each revision of the DQO.** It will address the overall issue of collecting WMA A-AX data to support the PA, retrieval, and RFI/CMS.
4	**Define the Boundaries of the Study** *Specify the target population and characteristics of interest, define spatial and temporal limits, scale of inference.*	**Each revision will be specific to a focus area.**
5	**Develop the Analytical Approach** *Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions and findings.*	**The analytical approach will be the same for each revision of the DQO.** It will address the overall issue of collecting WMA A-AX data to support the PA, retrieval, and RFI/CMS.
6	**Specify Performance or Acceptance Criteria** *Specify probability limits for false acceptance decision errors.*	**Performance/Acceptance Criteria will be the same for each revision of the DQO.** It will address the overall issue of collecting WMA A-AX data to support the PA, retrieval, and RFI/CMS.
7	**Develop the Plan for Obtaining Data** *Select the resource-effective sampling and analysis plan that meets the performance criteria*	**Each revision will be specific to a focus area.**

Note: Steps that reflect the "overall issue of collecting WMA A-AX data to support the PA, retrieval, and RFI/CMS" will be reviewed to determine if any specifics are needed for Focus Area Evaluation.

STEP 1 – DEFINE THE PROBLEM

Step 1 of the seven-step DQO process is to clearly define the problem (the reason analytical data are needed) so that the focus of the project is clear.

DQO problem statement

Considering the DQO scope, and after review of available information, the concise statement of the problem was identified as follows (**WMA-A-AX-2017-1**):

> ***Vadose zone contamination in and adjacent to the A-AX tank farm may pose a current and future risk to human health and the environment, including groundwater, which requires corrective action to support closure.***

The DQO project team is identified as follows (**WMA-A-AX-2017-1**; modifications proposed **WMA-A-AX-2017-5**):

Table 2. DQO Planning Team Members

Organization	Name	Function/Decision Authority
U.S. Department of Energy – Office of River Protection (ORP)	Jan Bovier	ORP Project Lead
U.S. Department of Energy – Operations Office (RL)	Doug Hildebrand	RL Lead - Integration with 200-EA-1 and Groundwater OUs
Washington State Department of Ecology (Ecology)	Mike Barnes Jeff Lyon Joe Caggiano Elizabeth Rochette Marysia Skorska Jim Alzheimer	Lead WMA A-AX DQO Tank Farms Project Manager Technical Support Technical Support Technical Support Technical Support
Washington River Protection Solutions	Scott Luke Paul Rutland Cindy Tabor/Ryan Childress Julie Robertson Jim Field Robin Varljen Kristin Singleton/Marcel Bergeron Harold Sydnor Kathi Dunbar Steve McKinney/Paul Gassman Bob Hiergesell Duc Nguyen	DQO Facilitator Vadose Zone Project Director Project Lead Regulatory Support Leak Assessments and Process Knowledge Regulatory Compliance Risk Assessment Field Characterization/Sampling and Analysis QA Laboratory Interface WMA A-AX PA Integration DQO Oversight
CHPRC	Bert Day Mark Byrnes/Phil Burke Lee Brouilland/Jeremy Lynn Greg Thomas Curt Wittreich	200-EA-1 and 200-IS-1 200-DV-1 200-PO-1 200-BP-5 Groundwater OU Integration

STEP 2 – IDENTIFY THE GOALS OF THE STUDY

Step 2 identifies the decisions or estimates that require new environmental data to solve the "problems" identified in Step 1. For a decision problem, the decision statement links a principal study question (PSQ) with a range of alternative actions that can occur upon answering the question. For an estimation problem, the estimation statement identifies what needs to be estimated or studied and possible study outcomes and key assumptions.

Estimation problem key information needs and assumptions:

- Data on vadose zone soil and tank waste chemical and physical properties are needed to evaluate contaminant mobility in soil.
- Data are need on naturally occurring vadose zone soil constituents that could potentially be altered by contact with tank waste and on tank waste constituents that may remain in soil at detectable levels after the bulk of the waste has passed through the soil to evaluate where tank waste may have passed through soil and could still exist elsewhere in the environment.

Goal of the study (WMA-A-AX-2017-1)

The goal is to ensure the appropriate vadose zone soil characterization data needs are identified to support corrective measure decisions for WMA A-AX.

The following note will be included in the DQO summary report: "It is recognized that there is a need to integrate characterization and closure actions with ongoing and nearby operations and waste site/groundwater remedial actions."

The Principal Study Questions, Alternative Actions, and Decision/Estimation Statements are described in Table 3. Data supporting the DQO effort (collected prior to and collected using this DQO process) will be used to develop and refine the conceptual site model.

Table 3. Principal Study Questions, Alternative Actions, and Decision/Estimation Statements		
Principal Study Question (PSQ)	**Proposed Alternative Actions (AA)**	**Decision/Estimation Statement (DS/ES)**
#1— Does contamination in the WMA A-AX vadose zone soil exceed acceptable levels?	If contamination exceeds acceptable levels, evaluate the need for corrective measures; otherwise, document that corrective action is not required.	**#DS 1** — Determine whether contamination exceeds acceptable levels and, therefore, whether there is a need to evaluate corrective measures.
#2 – Is information available to define the chemical/physical properties of WMA A-AX vadose zone soil that can impact contaminant movement through the WMA A-AX vadose zone soil?	Not applicable for estimation statement.	**#ES 2** – The chemical/physical properties of A-AX vadose zone soil that can impact contaminant movement through the soil will be defined and estimated. It is expected that vadose zone soil will be shown to have chemical and physical properties that can affect contaminant movement through the soil.
#3 – Is information available to define the chemical/physical properties of tank waste that can impact contaminant movement through the WMA A-AX vadose zone soil?	Not applicable for estimation statement.	**#ES 3** – The chemical/physical properties of A-AX tank waste that can impact contaminant movement through the soil will be defined and estimated. It is expected that tank waste will be shown to have chemical and physical properties that can affect contaminant movement through the soil.
#4 – Is information available to define whether, and where, tank waste passed through WMA A-AX vadose zone soil and, therefore, could exist elsewhere in the environment?	Not applicable for estimation statement.	**#ES 4** – Chemicals and radionuclides in tank waste, as well as naturally occurring vadose zone soil constituents that are altered in the presence of tank waste in the environment, will be identified and their concentrations estimated. It is expected that tank waste contains indicator constituents that would remain in soil at detectable levels even after the bulk of the waste has passed through. Their detectable presence in the soil, even at low concentrations, could indicate that waste passed through the soil at the location and so could exist elsewhere in the environment. It is also expected that as tank waste passed through the vadose zone soil, chemical reactions may have altered the levels of naturally occurring vadose zone soil constituents, potentially indicating that waste passed through the soil at the location.
Note: Estimation Statements for Focus Area Tanks A-104/105 support the continued development of the conceptual site model, support risk informed retrieval, and evaluate leak assessment interpretation.		

STEP 3 - DATA INPUTS

This step identifies the specific data required to answer the study questions, also identified as DQO data inputs.

Per EPA QA/G4 the major outputs of Step 3 are:

- *Identification of the **types** (e.g., chemical/physical properties), **as well as sources** of information needed to resolve the decision or estimates*
- *Identification of the **basis** of information (e.g., regulations, guidance, and permits) that will guide or support choices to be made in later steps of the DQO process; information on the number of variables (analytes) that will need to be collected; and types of information (e.g., action limits, uncertainty requirements) needed to meet performance or acceptance criteria*
- *Selection of, and information on the performance of, appropriate **sampling and analysis methods** for generating the information.*

Table 4 identifies bases for identification and setting of acceptable levels for the WMA A-AX decision and estimation statements. The contents of Table 4 were presented for discussion during DQO meeting **WMA-A-AX-DQO-2017-6** and were accepted as presented.

Table 5 identifies a range of field and analytical methods (e.g., ground penetrating radar, geophysical logging, and direct push) that could be used for vadose zone soil characterization. The contents of Table 5 were presented for discussion during DQO meeting **WMA-A-AX-DQO-2017-4**.

Table 4. Basis for Identification and Setting of Acceptable Levels for Decision and Estimation Statements				
PSQ	**Type of Data**		**Potential Sources for Information Inputs**	**Basis for Setting Acceptable Levels**
#1 Does contamination in the WMA A-AX vadose zone soil exceed acceptable levels?	Radionuclide (Analytical and geophysical)	Shallow zone (<4.6m [<15 ft] bgs)	• Previously reported analytical data • Previously reported geophysical data • Collect additional soil samples for laboratory analysis • Perform additional geophysical logging • Field screening with radiological detection equipment	CERCLA • Ecological protection • Human health soil direct contact o Residential[1] o Tribal[1] o Outdoor worker
		Deep zone (>4.6m [>15 ft] bgs)	• Previously reported analytical data • Previously reported geophysical data • Collect additional soil samples for laboratory analysis • Perform additional geophysical logging • Field screening with radiological detection equipment	CERCLA • Human health soil direct contact o Construction worker
		Ground surface to water table	• Previously reported analytical data • Collect additional soil samples for laboratory analysis	CERCLA • Groundwater Protection – Site specific model

Table 4. Basis for Identification and Setting of Acceptable Levels for Decision and Estimation Statements				
PSQ	**Type of Data**		**Potential Sources for Information Inputs**	**Basis for Setting Acceptable Levels**
#1 Does contamination in the WMA A-AX vadose zone soil exceed acceptable levels?	Chemical (Analytical and geophysical)	Shallow zone (<4.6m [<15 ft] bgs)	• Previously reported analytical data • Collect additional soil samples for laboratory analysis	CERCLA • Ecological protection • Human health soil direct contact o Residential[1] o Tribal[1] o Outdoor worker WAC • Unrestricted Land Use - Soil (WAC 173-340-740 and -750) • Industrial Properties – Soil (WAC 173-340-745 and -750)
		Ground surface to water table	• Previously reported analytical data • Collect additional soil samples for laboratory analysis	WAC • Groundwater Protection - Fixed parameter 3-phase partitioning model (WAC 173-340-747(4)) • Groundwater Protection – Site specific model

Table 4. Basis for Identification and Setting of Acceptable Levels for Decision and Estimation Statements			
PSQ	**Type of Data**	**Potential Sources for Information Inputs**	**Basis for Setting Acceptable Levels**
Estimation			
#2 — Is information available to define the chemical/physical properties of WMA A-AX vadose zone soil that can impact contaminant movement through the WMA A-AX vadose zone soil?	• Physical properties (e.g., bulk density and pH) • Technical Evaluation (e.g., hydraulic properties)	• Information from previous investigations • Collect additional soil samples • Batch and column leach tests • Sequential extraction tests	Acceptable levels do not apply for preliminary conceptual site model evaluation. This is a judgmental assessment.
#3 — Is information available to define the chemical/physical properties of tank waste that can impact contaminant movement through the WMA A-AX vadose zone soil?	• Leaching characteristics of tank waste based on batch and column leaching tests • Sequential extraction to estimate the labile fraction (readily leachable fraction) of constituents • Mineral phase identification within the tank waste residuals • Physical properties (e.g., bulk density and pH)	• Process history • Residual waste inventory • Batch leaching kinetics and partitioning behavior of tank waste • Leaching kinetics of tank waste	Acceptable levels do not apply for preliminary conceptual site model evaluation. This is a judgmental assessment.

Table 4. Basis for Identification and Setting of Acceptable Levels for Decision and Estimation Statements			
PSQ	**Type of Data**	**Potential Sources for Information Inputs**	**Basis for Setting Acceptable Levels**
#4 — Is information available to define whether, and where, tank waste passed through WMA A-AX vadose zone soil and, therefore, could exist elsewhere in the environment?	Fate and transport inputs: • Evaluation of mineralogical changes due to waste-sediment interaction and mineral phase identification • Determination of vertical and lateral extent of contamination based on evaluation of pore water chemistry and sediment (by performing sequential extraction such as water extraction, bicarbonate extraction, acetic acid extraction, oxalic acid extraction, and total digestion) • pH variations	• Documentation and history of releases from SSTs • Documentation of Unplanned Releases • Documentation and history of other releases • Previous investigations: o RPP-14430, *Subsurface Conditions Description of the C and A-AX Waste Management Area* o RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX* • Conduct additional surface geophysical exploration • Results and conclusions resulting from any new geophysical logging or soil sample collection	Acceptable levels do not apply for preliminary conceptual site model evaluation. This is a judgmental assessment.

Note: Relevant background level information is contained in the following documents:

- DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*
- DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*
- ECF-HANFORD-11-0038, *Soil Background for Interim Use at the Hanford Site*

[1.] Residential and tribal scenarios will be evaluated to assist interested parties in providing input on the remedial alternatives as part of the CERCLA modifying criteria.

Table 5. Potentially Appropriate Field and Analytical Methods for Vadose Zone Soil for Characterization		
Potentially Appropriate Field Method/Analytical Method	**Parameter**	**Possible Limitations**
Ground Penetrating Radar (GPR): Radar-reflection surface geophysical survey technique that detects contrasts in di-electric constants in the below-grade environments from the surface.	Underground structures or interferences	Requires subjective interpretation of the reflected signals. Lack of reflective below-grade surfaces or the presence of interfering matrices can complicate or invalidate the findings. The presence of nearby buildings and utilities can interfere with reflected signals. Fines (e.g., clay and heavy fly ash) can act as a reflector to the radar signal.
Electromagnetic Induction (EMI): Surface geophysical survey technique that measures electrical conductivity in below-grade soils based on detected changes in electrical fields. Generally used to support the interpretation of GPR surveys.		The presence of nearby buildings and utilities can interfere with reflected signals.
Surface Geophysical Exploration: Electrical Resistivity Imaging can be acquired to develop shallow and deep, 2-dimensional and 3-dimensional images.	Resistivity (conductivity)	Results are impacted by interference from infrastructure such as pipelines, tanks, buildings, and other large features.
Large Diameter Hole (LDH) Conventional Drilling (e.g., cable tool):	Geophysical Logging and Laboratory Analysis	Most drilling methods have difficulty in cobbles and boulders. Waste/tailings are brought to the surface and need to be properly contained and disposed, increasing cost and risk of exposure to workers. Not viable for new exploration in the tank farms due to waste generation and logistics (e.g., dome loading and access).
LDH Geophysical Logging	Gross and isotopic gamma emissions	Larger size instrument has lower detection limits (more sensitive) but does not fit into a small diameter hole (SDH) (<3-inch); therefore, is not a compatible technology for use with direct push methods. The count rate can effect accuracy and precision of measurements.

Table 5. Potentially Appropriate Field and Analytical Methods for Vadose Zone Soil for Characterization		
Potentially Appropriate Field Method/Analytical Method	**Parameter**	**Possible Limitations**
	Gamma emissions from fission products, Am-241, Pu-239, and Np-237 It is considered by some to be more accurate than sampling and laboratory assay because the assay is performed in situ with less disturbance of the sample, there is higher vertical spatial resolution, and the sample size is much larger. This method may also be more economical than traditional sampling and analysis.	This method does not assess radionuclides or daughter products that do not emit gamma rays. The gamma energies from these isotopes are at the low end of the spectrum, which results in high numerical minimum detectable activities and possible matrix effects from other isotopes. This technique requires the use of a single casing (installed by drilling or driving) in contact with the soil formation. The detector is too large to fit in a SDH (<3-inch); therefore, is not a compatible technology for use with direct push methods.
	Neutron emissions from plutonium	Because of the very low incidence of spontaneous plutonium fission and alpha-N reactions, the passive neutron profile is orders of magnitude lower than the gamma emission. The detector is too large to fit in a SDH (<3-inch); therefore, is not a compatible technology for use with direct push methods.
	Active neutron emissions from transuranics	Although neutron activation methods have been developed, they are not expected to be useful for this initial characterization effort. At present, these techniques are too expensive and time consuming, and logistical problems are associated with the handling of intense sources or generators. The detector is too large to fit in a SDH (<3-inch); therefore, is not a compatible technology for use with direct push methods.
	Beta emissions	Not a fully developed technology.
	Neutron moisture	Moisture zones can be very thin and can be missed based on data collection intervals (distance and time).
	Temperature	Difficult differentiating/determining source and extent of high temperatures (e.g., soil versus infrastructure).
Laboratory Analysis for LDH	Chemical and radiological constituents and physical properties	Highly contaminated samples may require use of on-site laboratories, with associated impacts (e.g., high cost, reduced analyte lists, matrix effects, degraded detection limits, and long turnaround times). Lower contamination levels may allow use of offsite laboratories, avoiding these limitations.
Small Diameter Hole (SDH) Direct Push	Geophysical Logging and Laboratory Analysis	Direct-push methods may be ineffective in cobbly or rocky soils.

Table 5. Potentially Appropriate Field and Analytical Methods for Vadose Zone Soil for Characterization		
Potentially Appropriate Field Method/Analytical Method	**Parameter**	**Possible Limitations**
SDH Geophysical Logging	Gross and isotopic gamma emissions	The smaller diameter detectors are not as sensitive as those used in LDH (Detection limits are not as low from instruments used in LDH.)
	Beta emissions	Not a fully developed technology.
	Neutron moisture	Moisture zones can be very thin and can be missed based on data collection intervals (distance and time).
	Temperature	Difficult differentiating/determining source and extent of high temperatures (e.g., soil versus infrastructure).
Laboratory Analysis for SDH	Chemical and radiological constituents and physical properties	Small sample size leads to difficulty to with large analysis list and low detection limits.
Note: Reinterpreting available data (e.g., surface geophysical exploration data) and/or determine if analysis on existing cores could be performed.		

Table 6 identifies the constituents of interest at the A-104/105 focus area and provides the rationale for inclusion or exclusion of specific constituents from the list. The contents of Table 6 were presented for discussion during DQO meeting **WMA-A-AX-DQO-2017-6**, and several changes were incorporated as a result of the discussion. Additional discussion is needed to reach consensus regarding VOAs and SVOAs. Inclusion of physical properties was discussed and agreed upon in DQO meeting **WMA-A-AX-DQO-2017-8.**

STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

Identify the target population of interest and specify the spatial and temporal features pertinent for decision making or estimation.

Per EPA QA/G-4, the major outputs of this step are as follows:

- *Definition of the target population with detailed descriptions of geographic limits (spatial boundaries)*
- *Detailed descriptions of what constitutes a sampling unit*
- *Time frame appropriate for collecting data and making the decision or estimate, together with those practical constraints that may interfere with data collection*
- *The appropriate scale for decision making or estimation.*

Focus Area

Around Tanks A-104 and A-105

Target Population

Vadose zone soil (surface to groundwater)

Study Boundaries (WMA-A/AX-DQO-2017-5; WMA-A/AX-DQO-2017-6, WMA-A/AX-DQO-2017-8)

Vertical spatial area of interest is soil depths from the following:

- <15 ft to support ecological, direct contact assessment, and groundwater assessment
- >15 ft to support groundwater assessment.

The vertical boundary is from the ground surface to the capillary fringe immediately above groundwater.
The horizontal spatial boundary for this focus area is the soil near Tanks A-104 and A-105 as shown in Figure 1 as agreed to during DQO meeting **WMA-A/AX-DQO-2017-8**.

The temporal boundary for data collection for this focus area is prior to retrieval of Tanks A-104 and A-105.
The temporal boundary for the overall data collection in the WMA A-AX area will be the final CMS for WMA A-AX. Because the data will represent the condition of the contamination in the vadose zone between now and when the final CMS is completed, the timing of the sample collection must reflect these conditions. It is anticipated that this DQO will be in effect until the sampling and analysis for the soil remedy selection for WMA A-AX is complete.

Note that sampling or other data collection can be performed any time during the DQO affectivity period and should be integrated with similar activities whenever possible to realize efficiencies.

Sampling Unit

The smallest sampling unit is the volume of material needed to conduct analytical testing. Note that there are various constraints that can impact the amount of volume that can be collected within tank farms. Table 7 identifies the practical constraints on data collection. The contents of Table 7 were presented for discussion during DQO meeting **WMA-A-AX-DQO-2017-6** and were accepted as presented.

Constraints to sampling/data collection (WMA-A-AX-DQO-2017-6)

The practical constraints associated with data collection are shown in Table 7.

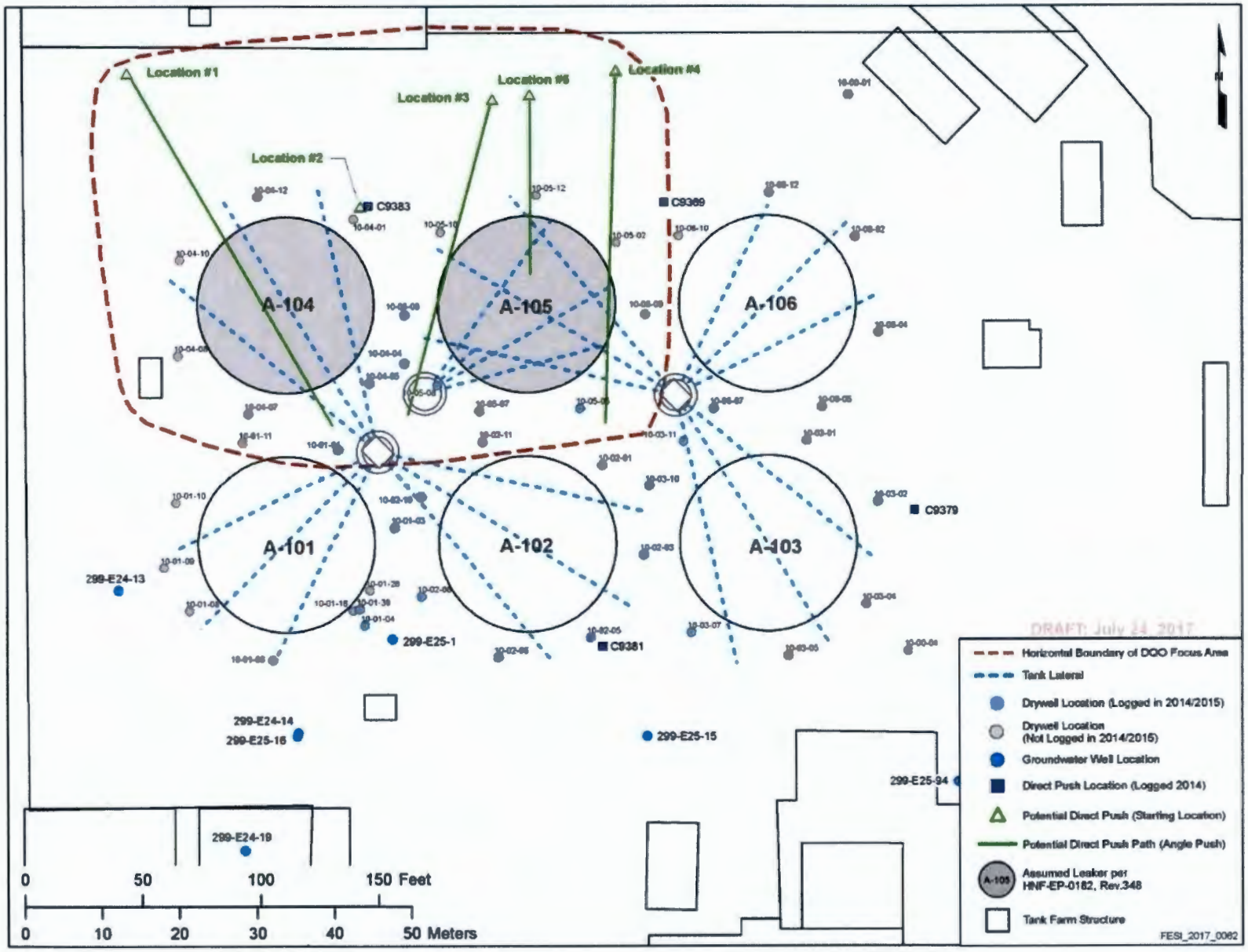
Smallest decision unit

The smallest unit, for decisions or estimates, is considered to be a release site (i.e., an area in the vadose zone where there has potentially been an impact from a known or suspected release associated WMA A-AX).

Table 7. Practical Constraints on Data Collection

Constraint	Details
Physical access	Placing driven soil probes, borings, or excavations near tank farm system structures (i.e., SSTs, lines, diversion boxes, catch tanks) will pose additional access challenges because of the following: • Limited access to some locations because of topography. • Surface and subsurface obstructions.
Methods	The methods selected for investigations, such as excavations (e.g., trenching, test pits), driven soil probes, or borings, will influence the following: • An investigative method is selected depending on data needs (sample volume, number of samples, depth, potential radiological content, instrumentation installed, geophysical logging needs, location, groundwater well installed, etc.) not vice versa.
Radiological controls	Radiological issues that could influence the ability to perform the work involve the following: • Handling contaminated samples (high or very high radiation).
Field screening techniques	The ability of field screening to meet quality assurance/QC or detection requirements may be limited as follows: • Gross gamma logging in soils may be limited by background radiation levels from adjacent structures (e.g., pipelines or diversion boxes). Small diameter gross gamma tool has a higher quantification level than the large diameter spectral tools. Therefore, very low levels of cobalt will not be detected by a small diameter logging tool. • Passive neutron logging may be limited because of lower than expected quantities of neutron-emitting isotopes.
Analytical laboratory capabilities	Radiological controls and constraints at the sampling location (primarily high contamination levels) that delay delivery of the samples to the laboratory, causing exceedance of hold time limits. • Radiological controls and constraints at the laboratory (primarily high contamination levels) that delay analysis, causing exceedance of hold time limits. • Highly contaminated samples may require substantial dilution causing inability to analyze other contaminants effectively (e.g., reduced contaminant concentrations below detection limits).

Figure 1. Depiction of Horizontal Boundary of A-104/105 DQO Focus Area (WMA-A/AX-DQO-2017-8)



STEP 5 – DEVELOP THE ANALYTIC APPROACH (WMA-A-AX-DQO-2017-7)

The purpose of Step 5 is to develop an analytic approach that will guide how to analyze the study results and draw conclusions from the data.

The major outputs of Step 5 are as follows.

- *For decision problems, choose an **acceptable level** (using information identified in Step 3) that sets the boundary between one outcome of the decision process and an alternative. Verify that there are sampling and analysis methods with detection limits below acceptable levels. Specify the **population parameter** (e.g., maximum, mean, percentile) considered to be important to make inferences about the analytical data. Develop **decision rules** by constructing "if...then..." statements by combining the selected population parameter; the acceptable level, the scale of decision making, and the alternative actions.*
- *For evaluation problems, develop **specification of the estimators** (using information identified in Step 3) by identifying the type of data being estimated and determining the best representative measurement for this data type. Note there are no acceptable levels associated with these evaluation problems.*

Step 5 identifies the information necessary to determine if corrective measures are required, or if conceptual site model need to be revised.

- Acceptable levels identified in Tables 8, 9, and 10, are risk-based standards established to meet requirements or agreements identified in Step 3, Table 4.
- Decision rule for PSQ# 1 will use acceptable levels to decide if evaluation of corrective measures is required.
- Acceptable levels do not apply to evaluations identified in ES#2, ES#3 or ES#4. The estimator will provide key information and assumptions necessary to obtain data needed to make these evaluations.
- Data obtained as a result of each PSQ may be used to support the evaluation of other PSQs.

Table 11. Decision Rules and Specification of the Estimator

Step 2		Step 5
Principal Study Question	**Decision/Estimation Statement (DS/ES)**	**Decision Rule/Specification of the Estimator (DR/E)**
#1— Does contamination in the WMA A-AX vadose zone soil exceed acceptable levels?	**#DS 1** — Determine whether contamination exceeds acceptable levels and, therefore, whether there is a need to evaluate corrective measures.	**#DR 1** IF the maximum detected concentrations for individual constituents exceed acceptable levels identified in Tables 8, 9 or 10, THEN further evaluation will be performed during the RFI/CMS.
#2 – Is information available to define the chemical/physical properties of WMA A-AX vadose zone soil that can impact contaminant movement through the WMA A-AX vadose zone soil?	**#ES 2** – The chemical/physical properties of A-AX vadose zone soil that can impact contaminant movement through the soil will be defined and estimated. It is expected that vadose zone soil will be shown to have chemical and physical properties that can affect contaminant movement through the soil.	**#E2** The best measurement of chemical and physical properties in WMA A-AX vadose zone soil (Table 4) that can impact contaminant movement through the soil will be estimated, and their impact on contaminant movement through the soil will be evaluated.
#3 – Is information available to define the chemical/physical properties of tank waste that can impact contaminant movement through the WMA A-AX vadose zone soil?	**#ES 3** – The chemical/physical properties of A-AX tank waste that can impact contaminant movement through the soil will be defined and estimated. It is expected that tank waste will be shown to have chemical and physical properties that can affect contaminant movement through the soil.	**#E3** The best available measurements of chemical and physical properties in WMA A-AX tank waste (Table 4) that can impact contaminant movement through the soil will be estimated, and their impact on contaminant movement through the soil will be evaluated.
#4 – Is information available to define whether, and where, tank waste passed through WMA A-AX vadose zone soil and, therefore, could exist elsewhere in the environment?	**#ES 4** – Chemicals and radionuclides in tank waste, as well as naturally occurring vadose zone soil constituents that are altered in the presence of tank waste in the environment, will be identified and their concentrations estimated. It is expected that tank waste contains indicator constituents that would remain in soil at detectable levels even after the bulk of the waste has passed through. Their detectable presence in the soil, even at low concentrations, could indicate that waste passed through the soil at the location and so could exist elsewhere in the environment. It is also expected that as tank waste passed through the vadose zone soil, chemical reactions may have altered the levels of naturally occurring vadose zone soil constituents, potentially indicating that waste passed through the soil at the location.	**#E4A** The concentrations of naturally occurring vadose zone soil constituents that are altered in the presence of tank waste in the environment will be estimated to evaluate where waste may have passed through the soil and so could exist elsewhere in the environment. **#E4B** The concentrations in vadose zone soil of chemicals and radionuclides that can act as tank waste markers will be estimated to evaluate where waste may have passed through the soil and so could exist elsewhere in the environment.

STEP 6 – SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA (WMA-A-AX-DQO-2017-7)

Step 6 examines consequences of making incorrect decisions, and identifying acceptable ranges associated with making decision errors.

The major outputs for Step 6 are:

- *Performance criteria (performance metric) to minimize errors for decision rules*
- *Performance criteria (performance metric) to keep uncertainties for the specification of the estimators within acceptable ranges.*

The Step 6 outputs for WMA A-AX are:

- Quality control acceptance criteria for each constituent is identified in Tables 8, 9, and 10. The maximum detected concentrations will initially be used for comparison to acceptable levels to identify constituents of potential concern.
- Where this DQO provides sample data for technical evaluations and not for direct comparison to acceptable levels, acceptance criteria for statistical uncertainty are not necessary.

Performance or acceptance criteria identified in Step 6 normally help determine sampling and analysis design, but because sampling will be judgmental and not use the probabilistic approach, Step 6 criteria have minimal impact on sample design.

Table 12 shows the tolerable limits on decision error based on the predicted consequences of making an incorrect decision. Data used for decision making are subject to various types of errors arising from how samples were collected or how measurements were made. Therefore, there is a chance that an erroneous decision will be made based on the collected data or that uncertainty in estimate is unacceptable.

Table 12. Tolerable Limits on Decision Errors

Action	Possible Decision Error	Severity of Consequences of Decision Error				Decision Error that has More Severe Consequences
		Far Below the Acceptable Level	Below but Near the Acceptable Level	Above but Near the Acceptable Level	Far Above the Acceptable Level	
Conduct corrective action	Remediate an uncontaminated site	Severe	Moderate	None	None	Not remediating a contaminated site
No corrective measure required	Failing to remediate a contaminated site	None	None	Moderate	Severe	

STEP 7 – DEVELOP THE PLAN FOR OBTAINING DATA (WMA-A-AX-DQO-2017-5, WMA-A-AX-DQO-2017-6, WMA-A-AX-DQO-2017-8)

Step 7 develops a sampling design that optimizes the data collection to meet data quality requirements specified in DQO Steps 1 through 6 and also takes into account the sampling boundaries and constraints identified in Step 4.

Per EPA QA/G-4, the major outputs of step 7:

- *Full documentation of the final sampling design along with key assumptions underlying the design,*
- *Details on how the design should be implemented together with contingency plan for unexpected events, and*
- *QA/QC performed to detect and correct problems and so ensure defensible results.*

Sampling Strategy and General Collection Techniques (WMA-A-AX-DQO-2017-8)

- Direct Push – Dual String sample collection
- Two direct push borings per location, one for geophysical logging and second for soil sampling
- Sample depth meetings after geophysical logging

Note: Gyroscope will be used on angle pushes to confirm borehole path

Sampling Design (WMA-A-AX-DQO-2017-8)

A random sampling strategy cannot be applied in WMA A-AX because of the extensive amount of interferences caused by buried infrastructure and topographic constraints. Therefore, a non-probabilistic (or judgmental) sampling strategy that targets locations based on existing knowledge will be used. This approach provides the highest potential for confirming and characterizing known and suspected releases in and around WMA-AX and will help refine the WMA-AX conceptual site models.

Location and Number of Direct Push Boreholes (WMA-A/AX-DQO-2017-5, WMA-A/AX-DQO-2017-8)

See Figure 1 (in Step 4) and Table 13.

Table 13. Direct Push Location Strategy for Tanks 241-A-104 and 241-A-105

Location #	Approximate Location	Input Factors Associated with Location **Reason for Sampling**	Target Depth (bgs) **Angle** Pipe Run *Minimum distance from Tank*
1	Northwest of Tank 241-A-104 (Angle push going southeast and directly under the tank)	• Tank A-104 designated as a leaker (~2,000 gallons) • Possible leak location area (RPP-ENV-37956, Rev. 2, Figure 4-1) • Higher temperature and gross gamma readings in laterals (14-04-01 and 14-04-02, RPP-ENV-37956, Rev. 2 [Figures B2-11 through B2-13]) • Higher temperature and gross gamma readings in drywells (10-04-04 and 10-04-05)	174 ft **45** 246 ft

Table 13. Direct Push Location Strategy for Tanks 241-A-104 and 241-A-105			
Location #	**Approximate Location**	Input Factors Associated with Location **Reason for Sampling**	Target Depth (bgs) **Angle** Pipe Run *Minimum distance from Tank*
		• Higher SGE conductivity area (RPP-ENV-37956, Rev. 2, Figure 3-9) **Assess Tank A-104 - magnitude and pathway of contamination for modeling, risk, and nature and extent.**	*15.75 ft*
2	North and between Tanks 241-A-104 and 241-A-105 (Vertical push)	• Tanks A-104 and A-105 designated as a leaker (~2,000 gallons and ~2,000 to 40,000 gallons, respectively) • Direct push log at Location C9383, temperature of ~120 ºF, ~50 ft bgs • Possible location for deep push ~285 ft bgs **Assess Tanks A-104 and A-105 - magnitude and pathway of contamination for modeling, risk, and nature and extent.**	285 ft **None** 285 ft *54 ft*
3	North of Tank 241-A-105 (Angle push towards southwest-side of tank	• Tanks A-104 and A-105 designated as a leaker (~2,000 gallons and ~2,000 to 40,000 gallons, respectively) • Possible leak location area (RPP-ENV-37956, Rev. 2, Figure 4-2) • Higher temperature and gross gamma readings in laterals (14-05-01,14-05-02, and 14-05-03, RPP-ENV-37956, Rev. 2 [Figures B3-18 through B3-19]) • Higher temperature readings in drywells (10-05-09, 10-04-04 and 10-04-05) • Abandoned drywell 10-05-11 indicated casing corrosion (~ 64 ft bgs) • Higher SGE conductivity area ((RPP-ENV-37956, Rev. 2, Figure 3-9) **Assess Tanks A-105 and A-104 - magnitude and pathway of contamination for modeling, risk, and nature and extent.**	241 ft **30** 279 ft *23 ft*
4	Northeast side of Tank 241-A-104 (Angle push going south and under the east-side of tank)	• Tank A-105 designated as a leaker (~2,000 to 40,000 gallons) • Possible leak location area (RPP-ENV-37956, Rev. 2, Figure 4-2) • Higher temperature and gross gamma readings in laterals (14-05-01,14-05-02, and 14-05-03, RPP-ENV-37956, Rev. 2 [Figures B3-18 through B3-19]) • Higher temperature readings in drywell (10-05-05)	127 ft **50** 197 ft

Table 13. Direct Push Location Strategy for Tanks 241-A-104 and 241-A-105			
Location #	**Approximate Location**	Input Factors Associated with Location **Reason for Sampling**	Target Depth (bgs) **Angle** Pipe Run *Minimum distance from Tank*
		• Abandoned drywell 10-05-02 indicated casing corrosion (~ 64 ft bgs) **Assess Tank A-105 - magnitude and pathway of contamination for modeling, risk, and nature and extent.**	*7.5 ft*
5	North of Tank 241-A-105 (Angle push going under the north side of tank	• Tank A-105 designated as a leaker (~2,000 to 40,000 gallons) • Higher temperature and gross gamma readings in laterals (14-05-01,14-05-02, and 14-05-03, RPP-ENV-37956, Rev. 2 [Figures B3-18 through B3-19]) • Corrosion observed at drywells 10-05-02 and 10-05-10 **Assess Tank A-105 - magnitude and pathway of contamination for modeling, risk, and nature and extent.**	285 ft **15** 295.29 ft *29 ft*

Recommended Number of Samples Collected From WMA A-AX Per Direct Push Location (WMA-A/AX-DQO-2017-6, WMA-A/AX-DQO-2017-8)

- Each sampling location consists of one surface sample, two additional shallow (0 to 15 ft bgs) samples, and at least seven deep (>15 ft bgs) samples.
- A duplicate sample will be collected at 25% of the surface sample locations (i.e., a duplicate surface sample will be collected at one in four surface locations).
- Shallow samples taken from below the surface will be taken at ~7 to 9 ft bgs and ~12 to 14 ft bgs. The purpose of collecting samples in the first 15 ft is to provide data for the direct exposure pathway and to provide initial data for ecological risk.
- Deep samples will be taken down to a depth of ~240 to 285 ft bgs or refusal. The depths for sampling individual horizons will be selected by reviewing the gamma, temperature, and moisture logs of the first direct push and the following information: any leak loss inventory information pertinent to the site, geologic summary of the area, operational history, and historical characterization data at that site.

Summary:

- 3 Shallow Samples (0 to 15 ft bgs)
- 7 Deep Samples (>15 ft bgs to Total Depth).

Note: Proposed Vertical Total Depths for 5 boreholes are 127, 174, 241, and 285 ft bgs (two locations).

Physical Sample Yield

- Three 6" x 1.08" ID stainless steel liners
- One 4" x 1.08" ID sampler shoe
- 16.5 cubic inches total in liners, and 3.65 cubic inches in shoe
- Results in 20.15 cubic inches (330 cc) of material
- Using the average density of Hanford soils (1.8 g/cc) = 594 g sampled materials at 100% recovery

Logging (WMA-A/AX-DQO-2017-8)

Direct Push

- Gross Gamma
- Spectral Gamma Logging System
- Neutron Moisture
- Temperature
- Gyroscope

Drywells

- Spectral Gamma Logging System
- Neutron Moisture
- Temperature
- Borehole Camera

Refer to Figure 1 (Step 4) for Drywell Logging Locations.

> Note: There was observed corrosion in drywells (10-05-10 [casing was pulled and replaced], 10-05-02, and 10-06-12). Two drywells are in the focus area (10-05-10 and 10-05-02). These will be evaluated during the field investigation to determine if they can be logged.

SGE (WMA-A/AX-DQO-2017-8)

Electrode Installment

- During decommissioning in Direct Push logging borings an electrode can be installed at low cost.

Handout #2
Data Quality Objectives Process Summary Tables 6, 8, 9, and 10

Table 6. WMA A-AX Analyte Rationale

Constituent	Data Quality Objectives Report Phase 2 Characterization for Waste Management Area C RCRA Field Investigation/ Corrective Measures Study (RPP-RPT-38152, Rev 0)[a]	Single-Shell Tank Component Closure Data Quality Objectives (RPP-23403, Rev. 6)	Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area A-AX (DOE/RL-2009-70) and Hanford Atomic Energy Act Sitewide Groundwater Monitoring Plan (DOE/RL-2015-56, Rev 0)	Standard Best-Basis Inventory Constituents	Recommendation	Rationale for Decision
Metals						
Aluminum – Al	P (E, R, W)	X		X	Retain	Constituent listed in WMA C and SST DQO.
Antimony – Sb	P (E, R, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Arsenic – As	P (A, E, U, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Barium – Ba	P (A, E, U, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Beryllium – Be	P (E, U, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Bismuth – Bi	S	X		X	Retain	Constituent listed in WMA C and SST DQO.
Boron – B	S	X			Retain	Constituent listed in WMA C and SST DQO.
Cadmium – Cd	P (A, E, U, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Calcium - Ca	S	X		X	Retain	Constituent listed in WMA C and SST DQO.
Cerium – Ce	S	X			Retain	Retained based on tank waste and self boiling tanks. The rare earths are naturally occurring in the vadose zone.
Chromium – Cr	P (A, E, U, W)	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Chromium - hexavalent CrVI	P				**Retain (Can be Analyzed rather than Estimated from Total Chromium)**	**Constituent of interest due to toxicity. The holding time for soil samples is 30 days from collection to analysis.**
Cobalt – Co	P (E, R, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Copper – Cu	P (E, R, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Europium – Eu	S	X			Eliminate	The rare earths are naturally occurring in the vadose zone.
Iron – Fe	P (R, W)	X		X	Retain	Constituent listed in WMA C and SST DQO.
Lanthanum – La	S	X		X	**Retain**	**Retain based on BBI detections.**
Lead – Pb	P (A, E, U, W)	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Lithium - Li	S	X			Retain	Constituent listed in WMA C and SST DQO. **Not part of tank waste but added as part of tracer for hydrostatic head fluid (as lithium bromide).**
Magnesium - Mg	S	X			Retain	Constituent listed in WMA C and SST DQO.
Manganese – Mn	P (E, R, W)	X		X	Retain	Constituent listed in WMA C and SST DQO.
Mercury – Hg	P (A, E, U, W)	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Molybdenum - Mo	S	X			Retain	Constituent listed in WMA C and SST DQO.
Neodymium – Nd	S	X			Retain	Retain based on tank waste and self boiling tanks. The rare earths are naturally occurring in the vadose zone.
Nickel – Ni	P (E, U, W)	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Niobium – Nb	S	X			Eliminate	The rare earths are naturally occurring in the vadose zone.
Palladium – Pd	S	X			Eliminate	The rare earths are naturally occurring in the vadose zone.
Phosphorus - P	S	X			Retain	Constituent listed in WMA C and SST DQO.
Potassium - K	S	X		X	Retain	Constituent listed in WMA C and SST DQO.
Praseodymium – Pr	S	X			Eliminate	The rare earths are naturally occurring in the vadose zone.
Rhodium – Rh	S	X			Retain	Constituent listed in WMA C and SST DQO.
Rubidium – Rb	S	X			Eliminate	The rare earths are naturally occurring in the vadose zone.
Ruthenium – Ru	S	X			Eliminate	The rare earths are naturally occurring in the vadose zone.

Table 6. WMA A-AX Analyte Rationale

Constituent	Data Quality Objectives Report Phase 2 Characterization for Waste Management Area C RCRA Field Investigation/ Corrective Measures Study (RPP-RPT-38152, Rev 0)[a]	Single-Shell Tank Component Closure Data Quality Objectives (RPP-23403, Rev. 6)	Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area A-AX (DOE/RL-2009-70) and Hanford Atomic Energy Act Sitewide Groundwater Monitoring Plan (DOE/RL-2015-56, Rev 0)	Standard Best-Basis Inventory Constituents	Recommendation	Rationale for Decision
Samarium – Sm	S	X			Eliminate	The rare earths are naturally occurring in the vadose zone.
Selenium – Se	P (A, E, U, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Silicon – Si	S	X		X	**Retain**	**Retain based on BBI detections.** Silicon is part of the media being analyzed (sand, gravel and silt and clay).
Silver – Ag	P (A, E, U, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Sodium - Na	S	X		X	Retain	Constituent listed in WMA C and SST DQO.
Strontium – Sr	P (R)	X		X	Retain	Constituent listed in WMA C and SST DQO.
Sulfur – S	S	X			Retain	Constituent listed in WMA C and SST DQO.
Tantalum – Ta	S	X			Retain	Constituent listed in WMA C and SST DQO.
Tellurium – Te	S	X			Eliminate	The rare earths are naturally occurring in the vadose zone.
Thallium – Tl	P (E, U, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Thorium – Th	S	X			**Retain**	**Retain to review isotopic thorium.** The rare earths are naturally occurring in the vadose zone.
Tin – Sn	S	X			Retain	Constituent listed in WMA C and SST DQO.
Titanium – Ti	S	X			Eliminate	The rare earths are naturally occurring in the vadose zone.
Tungsten – W	S	X			Retain	Constituent listed in WMA C and SST DQO.
Uranium – U	P (E, R, W)	X		X	Retain	Constituent listed in WMA C and SST DQO.
Vanadium – V	P (E, U, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Yttrium – Y	S	X			Retain	Constituent listed in WMA C and SST DQO.
Zinc – Zn	P (E, U, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Zirconium – Zr	S	X		X	Retain	Constituent listed in WMA C and SST DQO.
Anions						
Bromide Br-	S	X			Retain	Constituent listed in WMA C and SST DQO.
Chloride – Cl-	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Fluoride – F-	P (U, W)	X		X	Retain	Constituent listed in WMA C and SST DQO.
Nitrate – NO3-	P (R, W)	X		X	Retain	Constituent listed in WMA C and SST DQO.
Nitrite – NO2-	P (R, W)	X		X	Retain	Constituent listed in WMA C and SST DQO.
Phosphate – PO4	S	X		X	Retain	Constituent listed in WMA C and SST DQO.
Sulfate – SO42-	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Sulfide – S2-	D[b, c]		X		Eliminate	Sulfides were not routinely used in Hanford Site processes. Limited use of sulfide may have occurred during the ferrocyanide processing of ^{137}Cs in the tanks. The other possible source of sulfides would be from the reduction of sulfates. However, this is unlikely in the high nitrate tank waste matrices. Soluble sulfide is not very stable and is easily oxidized by air. Any sulfide remaining in the waste is most likely present as insoluble metal sulfide. In addition, previous analyses of tank waste have not detected sulfides in the Hanford Site tanks.
Small Organic Acids						
Acetate – C2H3O2-	P (R)	X		X	Retain	Constituent listed in WMA C and SST DQO.
Formate – CHO2-	P (R)	X			Retain	Constituent listed in WMA C and SST DQO.
Glycolate – C2H3O3-	P (R)	X			Retain	Constituent listed in WMA C and SST DQO.
Oxalate – C2O42-	P (R)	X		X	Retain	Constituent listed in WMA C and SST DQO.
Cyanides						
Cyanide – CN-	P (A, U, W)	X	X		Retain	Constituent listed in WMA C and SST DQO.
Ferrocyanide – Fe(CN)64-	P (A, U, W)	X			Eliminate	No ferrocyanide waste in WMA A-AX tank waste.

Table 6. WMA A-AX Analyte Rationale

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Ammonium Ion						
Ammonium – NH4+	**P (W)**	**X**			**Retain**	**Constituent listed in WMA C and SST DQO.**
VOCs						WMA C, containing no self-boiling tanks, received much of the organic waste (OWW). Note that sampling for organics was discontinued at the WMA C as they were only detected a few times[b, c]. At WMA A-AX, containing self-boiling tanks, received less organic waste (OWW) than WMA C (Reference: HNF-3588, RPP-21854, HNF-4240). Additionally, total organic carbon, an overall indicator of organics, is not associated with Tanks A-104 and A-105 (BBI shows 0 kg for total organic carbon).
1,1,1-Trichloroethane	D[b, c]	X	X		Eliminate	
1,1,2,2-Tetrachloroethane	D[b, c]	X	X		Eliminate	
1,1,2,2-Tetrachloroethene	D[b, c]	X	X		Eliminate	
1,1,2-Trichloro-1,2,2-trifluoroethane	D[b, c]	X			Eliminate	
1,1,2-Trichloroethane	D[b, c]	X	X		Eliminate	
1,1,2-Trichloroethylene	D[b, c]	X	X		Eliminate	
1,1-Dichloroethene	D[b, c]	X	X		Eliminate	
1,2-Dichloroethane	D[b, c]	X	X		Eliminate	
2-Butanone (MEK)	D[b, c]	X	X		Eliminate	
2-Nitropropane	D[b, c]	X			Eliminate	
2-Pentanone	D[b, c]	X			Eliminate	
2-Propanone (Acetone)	D[b, c]	X	X		Eliminate	
4-Methyl-2-pentanone (MIBK)	D[b, c]	X	X		Eliminate	
Benzene	D[b, c]	X	X		Eliminate	
Carbon disulfide	D[b, c]	X	X		Eliminate	
Carbon tetrachloride	D[b, c]	X	X		Eliminate	
Chlorobenzene	D[b, c]	X	X		Eliminate	
Chloroethene (vinyl chloride)	D[b, c]	X	X		Eliminate	
Chloroform	D[b, c]	X	X		Eliminate	
Dichloromethane (methylene chloride)	D[b, c]	X	X		Eliminate	
Diethyl ether	D[b, c]	X			Eliminate	
Ethyl Acetate	D[b, c]	X			Eliminate	
Ethylbenzene	D[b, c]	X	X		Eliminate	
Isobutanol	D[b, c]	X	X		Eliminate	
Methanol	D[b, c]	X			Eliminate	
m-Xylene	D[b, c]	X	X		Eliminate	
n-Butyl alcohol (1-butanol)	D[b, c]	X			Eliminate	
o-Xylene	D[b, c]	X	X		Eliminate	
p-Xylene	D[b, c]	X	X		Eliminate	
Tetrahydrofuran	D[b, c]	X			Eliminate	
Toluene	D[b, c]	X	X		Eliminate	
trans-1,3-dichloropropene	D[b, c]	X	X		Eliminate	

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Trichlorofluoromethane	D[b, c]	X	X		Eliminate	
Xylenes	D[b, c]	X	X		Eliminate	
SVOCs						WMA C, containing no self-boiling tanks, received much of the organic waste (OWW). Note that sampling for organics was discontinued at the WMA C as they were only detected a few times. At WMA A-AX, containing self-boiling tanks, received less organic waste (OWW) than WMA C (Reference: HNF-3588, RPP-21854, HNF-4240). Additionally, total organic carbon, an overall indicator of organics, is not associated with Tanks A-104 and A-105 (BBI shows 0 kg for total organic carbon).
1,1-Biphenyl	S				Eliminate	
1,1-Dimethylhydrazine	S	X			Eliminate	
1,2,4-Trichlorobenzene	P (E, U, W)	X	X		Eliminate	
1,3-Dichlorobenzene	S	X			Eliminate	
1,4-Dichlorobenzene	S	X			Eliminate	
1,4-Dinitrobenzene	S	X			Eliminate	
2,4,5-Trichlorophenol	P (A, E, U)	X	X		Eliminate	
2,4,6-Trichlorophenol	P (E, U)	X	X		Eliminate	
2,4-Dinitrotoluene	P (A)	X	X		Eliminate	
2,6-Bis (tert-butyl)-4-methylphenol	P (A, W)	X			Eliminate	
2-Chlorophenol	P (U)	X	X		Eliminate	
2-Ethoxyethanol	P (A)	X			Eliminate	
2-Methylphenol (o-cresol)	P(A)	X	X		Eliminate	
2-sec-Butyl-4,6-dinitrophenol (Dinoseb)	S	X			Eliminate	
3-Methyl-2-butanone	S	X			Eliminate	
4-Methylphenol (p-cresol)	P (A)	X	X		Eliminate	
Acenaphthene	P (E, U)	X	X		Eliminate	
Acetophenone	S	X			Eliminate	
Benzo(a) anthracene	P (in D&D-30262)				Eliminate	
Benzo(a)pyrene	P (E, in D&D-30262)	X			Eliminate	
Benzo(b)fluoranthene	P (in D&D-30262)				Eliminate	
Benzo(k)fluoranthene	P (in D&D-30262)				Eliminate	
Bis(2-ethylhexyl)phthalate	P (in WMP-28945)				Eliminate	
Butylbenzylphthalate	P (U)	X	X		Eliminate	
Chrysene	P (in D&D-30262)				Eliminate	
Cresylic acid (cresol, mixed isomers) (Total Cresols)	P (A)	X			Eliminate	
Cyclohexanone	P (A, W)	X			Eliminate	
Dibenz(a,h)anthracene	P (in D&D-30262)	X			Eliminate	
Dibutyl phosphate	D[b, c]				Eliminate	
Di-n-butylphthalate	P (E, U)	X	X		Eliminate	
Di-n-octylphthalate	P (U)	X	X		Eliminate	
Ethylene glycol	D[b, c]				Eliminate	
Fluoranthene	P (U)	X	X		Eliminate	
Hexachlorobutadiene	P (A, W)	X	X		Eliminate	

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Hexachloroethane	P (A)	X	X		Eliminate	
Hexachloronaphtahlene	S	X			Eliminate	
Hexafluoroacetone	S	X			Eliminate	
Indeno (1,2,3-cd) pyrene	P (in D&D-30262)				Eliminate	
Isodrin	S	X			Eliminate	
m-Cresol (3-Methylphenol)	P (A)	X	X		Eliminate	
Methylhydrazine	S	X			Eliminate	
Monobutyl phosphate	D[b, c]				Eliminate	
N,N-Diphenylamine	S	X			Eliminate	
Naphthalene	P (U)	X	X		Eliminate	
Nitric acid, propyl ester	S	X			Eliminate	
Nitrobenzene	P (A, E, W)	X	X		Eliminate	
N-Nitrosodi-n-butylamine	S	X			Eliminate	
N-Nitroso-di-n-propylamine	P (U)	X	X		Eliminate	
N-Nitrosomethylethylamine	S	X			Eliminate	
N-Nitrosomorpholine	P (U)	X	X		Eliminate	
N-Nitroso-N, N-dimethylamine	S	X			Eliminate	
Octachloronaphthalene	S	X			Eliminate	
1,2-Dichlorobenzene (o-Dichlorobenzene)	P (A, W)	X	X		Eliminate	
o-Nitrophenol	P (U)	X	X		Eliminate	
p-Chloro-m-cresol (4-Chloro-3-methylphenol)	P (U)	X	X		Eliminate	
Pentachloronaphthalene	S	X			Eliminate	
Pentachloronitrobenzene (PCNB)	S	X			Eliminate	
Phenol	S	X			Eliminate	
p-Nitrochlorobenzene	S	X			Eliminate	
Pyrene	P (U)	X	X		Eliminate	
Pyridine	P (A, W)	X	X		Eliminate	
Tetrachloronaphthalene	S	X			Eliminate	
Toxaphene	S	X			Eliminate	
Tributyl phosphate	P (R, W)	X			Eliminate	Selected indicator organic for the occurrence of any organic contamination associated with tank waste[b].
Pesticides						
Aldrin	P	X			Retain	Constituent listed in WMA C and SST DQO.
Benzene hexachloride (including lindane) (Alpha, beta, gamma)	P	X			Retain	Constituent listed in WMA C and SST DQO.
Chlordane	P				Retain	Constituent listed in WMA C DQO.
DDT/DDD/DDE (total)	P				Retain	Constituent listed in WMA C DQO.
Dieldrin	P	X			Retain	Constituent listed in WMA C and SST DQO.
Endrin	P	X			Retain	Constituent listed in WMA C and SST DQO.
Heptachlor/heptachlor epoxide (total)	P				Retain	Constituent listed in WMA C DQO.
Hexachlorobenzene	P	X			Retain	Constituent listed in WMA C and SST DQO.
Pentachlorophenol	P	X			Retain	Constituent listed in WMA C and SST DQO.

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GRO/DRO						
Gasoline-Range Organics	D[b, c]				Eliminate	
Diesel-Range Organics	D[b, c]				Eliminate	
PCBs						
Aroclors (1016, 1221, 1232, 1242, 1248, 1254, 1260)	P	X	X		Retain	Constituent listed in WMA C and SST DQO.
Congeners	D[b, c]				Eliminate	
Other						
TOC (total organic carbon)				X	Add	
Radionuclides						
Americium-241	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Antimony-125	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Carbon-14	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Cesium-137	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Cobalt-60	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Curium-242	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Curium-243	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Curium-244	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Europium-152	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Europium-154	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Europium-155	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Iodine-129	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Neptunium-237	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Nickel-63	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Plutonium-238	P			X	Retain	Constituent listed in WMA C DQO.
Plutonium-239	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Plutonium-240	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Plutonium-241	P		X	X	Retain Estimated from Pu 238 and Pu 239/240	Constituent listed in WMA C DQO.
Radium-226	S		X	X	**Retain**	**Retain based on BBI detections.** TPA-CN-668 removed Radium-226 and 228 from DV-1 SAP. ---Potassium 40, radium 226, radium 228, thorium 228, thorium 230, and thorium 232 are naturally occurring background radionuclides identified by consensus of Tri Party managers as not directly related to Hanford Operations or processes in the Central Plateau.
Selenium-79	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Strontium-90	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.

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Technetium-99	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Thorium-228	P	X			Eliminate	TPA-CN-668 removed Radium-226 and 228 from DV-1 SAP. Potassium 40, radium 226, radium 228, thorium 228, thorium 230, and thorium 232 are naturally occurring background radionuclides identified by consensus of Tri Party managers as not directly related to Hanford Operations or processes in the Central Plateau.
Thorium-230	P	X			Eliminate	TPA-CN-668 removed Radium-226 and 228 from DV-1 SAP. Potassium 40, radium 226, radium 228, thorium 228, thorium 230, and thorium 232 are naturally occurring background radionuclides identified by consensus of Tri Party managers as not directly related to Hanford Operations or processes in the Central Plateau.
Thorium-232	P	X		X	**Retain**	**Retain based on BBI detections.** TPA-CN-668 removed Radium-226 and 228 from DV-1 SAP. Potassium 40, radium 226, radium 228, thorium 228, thorium 230, and thorium 232 are naturally occurring background radionuclides identified by consensus of Tri Party managers as not directly related to Hanford Operations or processes in the Central Plateau.
Tin-126	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Tritium	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Uranium-233	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Uranium-234	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Uranium-235	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Uranium-236	P	X		X	Retain	Constituent listed in WMA C and SST DQO.
Uranium-238	P	X	X	X	Retain	Constituent listed in WMA C and SST DQO.
Physical Properties						
Soil density	X	X			Retain	Physical property listed in WMA C and SST DQO.
pH	X	X			Retain	Physical property listed in WMA C and SST DQO.
Percent solids					Retain	Performed at WMA C, not identified in DQO.
Percent water	X	X			Retain	Physical property listed in WMA C and SST DQO.
Specific conductance					Retain	Performed at WMA C, not identified in DQO.
Particle size distribution					Retain	Particle size distribution will be performed by the laboratory if sample volume is sufficient.
Porosity					Eliminate	Additional physical properties will be considered for focus areas where sufficient sample volumes can be collected.
Total alkalinity					Eliminate	Additional physical properties will be considered for focus areas where sufficient sample volumes can be collected.
Redox potential					Eliminate	Additional physical properties will be considered for focus areas where sufficient sample volumes can be collected.
Total inorganic carbon					Eliminate	Additional physical properties will be considered for focus areas where sufficient sample volumes can be collected.

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Physical Property Evaluations						
Hydraulic properties					Eliminate	Additional physical properties will be considered for focus areas where sufficient sample volumes can be collected.
Iron content and iron association					Eliminate	Additional physical properties will be considered for focus areas where sufficient sample volumes can be collected.
Mineral phase identification					Eliminate	Additional physical properties will be considered for focus areas where sufficient sample volumes can be collected.
Leaching characteristics					Eliminate	Additional physical properties will be considered for focus areas where sufficient sample volumes can be collected.
Sequential extraction					Eliminate	Additional physical properties will be considered for focus areas where sufficient sample volumes can be collected.

Detected both Shallow and Deep at WMA C (RPP-RPT-58339, Rev. 0, Phase 2 RCRA Facility Investigation Report for Waste Management Area C)
Detected Shallow at WMA C (RPP-RPT-58339, Rev. 0, Phase 2 RCRA Facility Investigation Report for Waste Management Area C)
Detected Deep at WMA C (RPP-RPT-58339, Rev. 0, Phase 2 RCRA Facility Investigation Report for Waste Management Area C)

Note:
a. P=Primary and S=Secondary as defined in RPP-PLAN-38777, Rev.3, Sampling and Analyis Plan for Phase 2 Characterization of Vadose Zone Soil in Waste Management Area C.
Discontinued (D) constituents were documented in RPP-PLAN-38777, Rev.3. Letters inside the parenthetical identify that reason why a constituent was categorized as primary per RPP-RPT-38152, Rev 0: A = Part A constituent, E= Ecological risk assessment, R = Risk assessment constituent, U = UHC (underlying hazardous constituent), and W = constituent in PNNL-12040, Regulatory Data Quality Objectives Supporting Tank Waste Remediation System Privitization Project, WMP-28945, Data Quality Objective Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process, and D&D-30262, Data Quality Objectives Summary Report for the 200-IS-1 Operable Unit Pipelines and Appurtenances.
b. 11-TPD-020, 2011, "Organic Analyses Optimization for Waste Management Area (WMA) C," Office of River Protection, U.S. Department of Energy, Richland, Washington, March 23.
c. 11-NWP-053, 2011, "Re: Organic Analyses Optimization for Waste Management Area (WMA) C," State of Washington Department of Ecology, Richland, Washington, June 1.

Table 8. Analytical Performance Requirements for Chemical Constituents

Constituent	CAS Number	Acceptable Level (mg/kg)[a]					Hanford Site Background[g] (mg/kg)	Primary Method[p]	Alternative Method[p]	Detection Limit (mg/kg)	Quality Control Acceptance Criteria[l, j]		
											Accuracy		Precision
		Direct Contact, WAC 173-340-740 Method B Unrestricted RBL[b]	Direct Contact, WAC 173-340-745 Method C Industrial RBL[c]	Outdoor Worker RBL[d]	Ecological Protection[e] ≤15 ft	Groundwater Protection[f]					Laboratory Control Sample Recovery (%)	Spike Recovery (%)	Relative Percent Difference
Metals													
Aluminum	7429-90-5	8.00E+04	3.50E+06	1.30E+06	1.18E+04[k]	4.80E+05	1.18E+04	6010 ICP/AES (acid)	6020 ICP/MS (acid)	2.75	80-120	75-125	≤30
Antimony	7440-36-0	32	1,400	519	92	5.4	130	6020 ICP/MS (acid)	6010 ICP/AES (acid)	0.13[q]	80-120	75-125	≤30
Arsenic	7440-38-2	0.67	87.5	20[l]	127	0.034	20	6020 ICP/MS (acid)	6010 ICP/AES (acid)	0.2	80-120	75-125	≤30
Barium	7440-39-3	1.60E+04	7.00E+05	2.59E+05	358	1,648	132	6010 ICP/AES (acid)	6020 ICP/MS (acid)	10.2	80-120	75-125	≤30
Beryllium	7440-41-7	160	7,000	259.5	10	63.2	1.51	6010 ICP/AES (acid)	6020 ICP/MS (acid)	0.5	80-120	75-125	≤30
Bismuth	7440-69-9	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	25.8	80-120	75-125	≤30
Boron	7440-42-8	1.60E+04	7.00E+05	2.60E+05	28.6	205	3.89	6010 ICP/AES (acid)	6020 ICP/MS (acid)	6	80-120	75-125	≤30
Cadmium	7440-43-9	80	3,500	1,110	9.8	0.69	0.563	6020 ICP/MS (acid)	6010 ICP/AES (acid)	0.02	80-120	75-125	≤30
Calcium	7440-70-2	—	—	—	—	—	1.72E+04	6010 ICP/AES (acid)	6020 ICP/MS (acid)	6.25	80-120	75-125	≤30
Cerium	7440-45-1	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	10.5	80-120	75-125	≤30
Chromium	7440-47-3	1.20E+05	5.25E+06	1.95E+06	109	2,000	18.5	6010 ICP/AES (acid)	6020 ICP/MS (acid)	0.15	80-120	75-125	≤30
Hexavalent chromium[m]	18540-29-9	240	1.05E+04	3,893	109	0.192	—	7196A	—	0.09[m]	80-120	75-125	≤30
Cobalt	7440-48-4	24	1,050	389	15.7	4.3	15.7	6020 ICP/MS (acid)	6010 ICP/AES (acid)	2	80-120	75-125	≤30
Copper	7440-50-8	3,200	1.40E+05	5.19E+04	58	284	22	6010 ICP/AES (acid)	6020 ICP/MS (acid)	1	80-120	75-125	≤30
Iron	7439-89-6	5.60E+04	2.45E+06	9.08E+05	—	5,645	3.26E+04	6010 ICP/AES (acid)	6020 ICP/MS (acid)	5	80-120	75-125	≤30
Lanthanum	7439-91-0	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	2.75	80-120	75-125	≤30
Lead	7439-92-1	250[n]	1,000[n]	—	156	3,000	10.2	6010 ICP/AES (acid)	6020 ICP/MS (acid)	5	80-120	75-125	≤30
Lithium	7439-93-2	160	7,000	2,596	2	192	13.3	6010 ICP/AES (acid)	6020 ICP/MS (acid)	0.9	80-120	75-125	≤30
Magnesium	7439-95-4	—	—	—	—	—	7,060	6010 ICP/AES (acid)	6020 ICP/MS (acid)	26	80-120	75-125	≤30
Manganese	7439-96-5	1.12E+04	4.90E+05	1.80E+05	1,260	501	512	6010 ICP/AES (acid)	6020 ICP/MS (acid)	1	80-120	75-125	≤30
Mercury	7439-97-6	24	1,050	389	0.3	2.1	0	7471 Cold vapor atomic absorption (acid)	6020 ICP/MS (acid)	0.01	80-120	75-125	≤30

Table 8. Analytical Performance Requirements for Chemical Constituents

Constituent	CAS Number	Acceptable Level (mg/kg)[a]					Hanford Site Background[g] (mg/kg)	Primary Method[p]	Alternative Method[p]	Detection Limit (mg/kg)	Quality Control Acceptance Criteria[i,j]		
											Accuracy		Precision
		Direct Contact, WAC 173-340-740 Method B Unrestricted RBL[b]	Direct Contact, WAC 173-340-745 Method C Industrial RBL[c]	Outdoor Worker RBL[d]	Ecological Protection[e] ≤15 ft	Groundwater Protection[f]					Laboratory Control Sample Recovery (%)	Spike Recovery (%)	Relative Percent Difference
Molybdenum	7439-98-7	400	1.75E+04	6,489	2	32	0	6010 ICP/AES (acid)	6020 ICP/MS (acid)	0.47[q]	80-120	75-125	≤30
Neodymium	7440-00-8	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	5	80-120	75-125	≤30
Nickel	7440-02-0	1,600	7.00E+04	2.59E+04	38	130	19	6020 ICP/MS (acid)	6010 ICP/AES (acid)	3	80-120	75-125	≤30
Phosphorus	7723-14-0	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	10	80-120	75-125	≤30
Potassium	7440-09-7	—	—	—	—	—	2,150	6010 ICP/AES (acid)	6020 ICP/MS (acid)	157	80-120	75-125	≤30
Rhodium	7440-16-6	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	26	80-120	75-125	≤30
Selenium	7782-49-2	400	1.75E+04	6,489	1.4	5.2	1	6020 ICP/MS (acid)	6010 ICP/AES (acid)	0.02[r]	80-120	75-125	≤30
Silicon	7440-21-3	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	5	80-120	75-125	≤30
Silver	7440-22-4	400	1.75E+04	6,489	3	14	0.17	6020 ICP/MS (acid)	6010 ICP/AES (acid)	6.00E-04[r]	80-120	75-125	≤30
Sodium	7440-23-5	—	—	—	—	—	690	6010 ICP/AES (acid)	6020 ICP/MS (acid)	22	80-120	75-125	≤30
Strontium	7440-24-6	4.80E+04	2.10E+06	7.79E+05	4,228	6,758	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	1	80-120	75-125	≤30
Sulfur	7704-34-9	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	11	80-120	75-125	≤30
Tantalum	7440-25-7	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	26	80-120	75-125	≤30
Thallium	7440-28-0	0.8	35	—	0.5	0.71	0.185	6020 ICP/MS (acid)	6010 ICP/AES (acid)	4.00E-04[r]	80-120	75-125	≤30
Thorium	7440-29-1	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	5	80-120	75-125	≤30
Tin	7440-31-5	4.80E+04	2.10E+06	7.79E+05	84	4.80E+04	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	6	80-120	75-125	≤30
Tungsten	7440-33-7	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	43	80-120	75-125	≤30
Uranium	7440-61-1	240	1.05E+04	3,892	22	3.21[k]	3.21	6020 ICP/MS (acid)	6010 ICP/AES (acid)	0.5[h]	80-120	75-125	≤30
Vanadium	7440-62-2	400	1.75E+04	6,488	43.2	1,600	85.1	6020 ICP/MS (acid)	6010 ICP/AES (acid)	6.00E-03[r]	80-120	75-125	≤30
Yttrium	7440-65-5	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	1	80-120	75-125	≤30

Table 8. Analytical Performance Requirements for Chemical Constituents

Constituent	CAS Number	Acceptable Level (mg/kg)[a]					Hanford Site Background[g] (mg/kg)	Primary Method[p]	Alternative Method[p]	Detection Limit (mg/kg)	Quality Control Acceptance Criteria[i,j]		
											Accuracy		Precision
		Direct Contact, WAC 173-340-740 Method B Unrestricted RBL[b]	Direct Contact, WAC 173-340-745 Method C Industrial RBL[c]	Outdoor Worker RBL[d]	Ecological Protection[e] ≤15 ft	Groundwater Protection[f]					Laboratory Control Sample Recovery (%)	Spike Recovery (%)	Relative Percent Difference
Zinc	7440-66-6	2.40E+04	1.05E+06	3.89E+05	621	5,971	67.8	6010 ICP/AES (acid)	6020 ICP/MS (acid)	1	80-120	75-125	≤30
Zirconium	7440-67-7	—	—	—	—	—	—	6010 ICP/AES (acid)	6020 ICP/MS (acid)	1	80-120	75-125	≤30
Ammonium Ion													
Ammonia/ammonium	7664-41-7	—	—	—	—	—	9	300.7 IC (distillation)	—	1	80-120	75-125	≤30
Cyanides													
Cyanide (total)	57-12-5	48	2,100	180	2.07E+04	0.97	—	9014 Spectrophotometric (distillation)	9012 Colorimetric	0.5	80-120	75-125	≤30
Anions													
Chloride	16887-00-6	—	—	—	—	1,000	100	9056 IC (water)	—	0.3	80-120	75-125	≤30
Fluoride	16984-48-8	4,800	2.10E+05	7.79E+04	845	2,884	2.81	9056 IC (water)	—	2.81[q]	80-120	75-125	≤30
~~Nitrate~~	~~14797-55-8~~	~~5.68E+05~~	~~2.49E+07~~	~~9.21E+06~~	—	~~180~~	~~52~~	~~9056 IC (water)~~	—	~~2.5[n]~~	~~80-120~~	~~75-125~~	~~≤30~~
~~Nitrite~~	~~14797-65-0~~	~~2.40E+04~~	~~1.05E+06~~	~~4.28E+05~~	—	~~13~~	—	~~9056 IC (water)~~	—	~~2.5[n]~~	~~80-120~~	~~75-125~~	~~≤30~~
Nitrogen in Nitrate	NO3-N	1.28E+05	5.60E+06	2.08E+06	27[o]	4.00E+01	—	9056 IC (water)	—	2.5[n]	80-120	75-125	≤30
Nitrogen in Nitrite	NO2-N	8.00E+03	3.50E+05	1.30E+05	27[o]	4.00E+00	—	9056 IC (water)	—	2.5[n]	80-120	75-125	≤30
Phosphate	14265-44-2	—	—	—	—	—	0.785	9056 IC (water)	—	0.785[q]	80-120	75-125	≤30
Sulfate	14808-79-8	—	—	—	—	1,000	237	9056 IC (water)	—	2.7	80-120	75-125	≤30
Bromide	24959-67-9	—	—	—	—	—	—	9056 IC (water)	—	1	80-120	75-125	≤30
Small Organic Acids													
Acetate	71-50-1	—	—	—	—	—	—	9056 IC (water)	—	4.50	80-120	75-125	≤30
Formate	64-18-6	—	—	—	—	—	—	9056 IC (water)	—	10.0	80-120	75-125	≤30
Glycolate	666-14-8	—	—	—	—	—	—	9056 IC (water)	—	3.80	80-120	75-125	≤30
Oxalate	338-70-5	—	—	—	—	—	—	9056 IC (water)	—	2.00	80-120	75-125	≤30

Table 8. Analytical Performance Requirements for Chemical Constituents

Constituent	CAS Number	Acceptable Level (mg/kg)[a]					Hanford Site Background[g] (mg/kg)	Primary Method[p]	Alternative Method[p]	Detection Limit (mg/kg)	Quality Control Acceptance Criteria[k,j]		
											Accuracy		Precision
		Direct Contact, WAC 173-340-740 Method B Unrestricted RBL[b]	Direct Contact, WAC 173-340-745 Method C Industrial RBL[c]	Outdoor Worker RBL[d]	Ecological Protection[e] ≤15 ft	Groundwater Protection[f]					Laboratory Control Sample Recovery (%)	Spike Recovery (%)	Relative Percent Difference
Pesticides													
Aldrin	309-00-2	0.06	7.72	0.17	0.01	2.52E-03	—	8081 GC/ECD	8270 GC/MS	0.01	70-130	70-130	≤30
Benzene hexachloride (including lindane) (Alpha, beta, gamma)	58-89-9	0.91	119.32	2.83	6	2.47E-03	—	8081 GC/ECD	8270 GC/MS	0.60	70-130	70-130	≤30
alpha-Benzene hexachloride	319-84-6	0.16	20.83	0.41	6	5.44E-04	—	8081 GC/ECD	8270 GC/MS	—	70-130	70-130	≤30
beta-1,2,3,4,5,6-Hexachlorocyclohexane (beta-Benzene hexachloride)	319-85-7	0.56	72.92	1.40	0.06	2.28E-03	—	8081 GC/ECD	8270 GC/MS	—	70-130	70-130	≤30
gamma-Benzene hexachloride (Lindane)	58-89-9	0.91	119.32	2.80	6	2.47E-03	—	8081 GC/ECD	8270 GC/MS	0.60	70-130	70-130	≤30
Chlordane	57-74-9	2.86	375	8.02	1	0.26	—	8081 GC/ECD	8270 GC/MS	0.10	70-130	70-130	≤30
DDT/DDD/DDE (total)	50-29-3 (DDT) 72-54-8 (DDD) 72-55-9 (DDE)	—	—	—	0.75	—	—	8081 GC/ECD	8270 GC/MS	0.075	70-130	70-130	≤30
2,4'-DDD	72-54-8	4.17	546.88	11	0.75	0.34	—	8081 GC/ECD	8270 GC/MS	0.075	70-130	70-130	≤30
2,4'-DDE	72-55-9	2.94	386.03	10	0.75	0.45	—	8081 GC/ECD	8270 GC/MS	0.075	70-130	70-130	≤30
2,4'-DDT	50-29-3	2.94	386.03	9.5	0.75	3.49	—	8081 GC/ECD	8270 GC/MS	0.075	70-130	70-130	≤30
Dieldrin	60-57-1	0.06	8.2	273.6	1.40E-04	2.82E-03	—	8081 GC/ECD	8270 GC/MS	0.007	70-130	70-130	≤30
Endrin	72-20-8	24.0	1050	2.83	0.2	4.40E-01	—	8081 GC/ECD	8270 GC/MS	0.02	70-130	70-130	≤30
Heptachlor/heptachlor epoxide (total)	1024-57-3	0.22	29.17	0.34	0.4	3.79E-03	—	8081 GC/ECD	8270 GC/MS	0.04	70-130	70-130	≤30
Heptachlor	76-44-8	0.22	29.17	0.34	0.4	0.004	—	8081 GC/ECD	8270 GC/MS	0.04	70-130	70-130	≤30
Heptachlor epoxide	1024-57-3	—	—	—	0.4	—	—	8081 GC/ECD	8270 GC/MS	0.04	70-130	70-130	≤30
Hexachlorobenzene	118-74-1	0.63	82.03	1.42	17	8.77E-02	—	8081 GC/ECD	8270 GC/MS	1.70	70-130	70-130	≤30
Pentachlorophenol	87-86-5	2.50	328.13	4.41	3	3.47E-03	—	8081 GC/ECD	8270 GC/MS	0.30	70-130	70-130	≤30
PCBs													
Aroclor 1016	12674-11-2	5.60	245	29.7	1.80	1.07	—	8082 GC/ECD	—	0.02	70-130	70-130	≤30
Aroclor 1221	11104-28-2	0.5	65.6	0.76	1.50	0.00	—	8082 GC/ECD	—	0.02	70-130	70-130	≤30
Aroclor 1232	11141-16-5	0.5	65.6	0.59	1.40	0.00	—	8082 GC/ECD	—	0.02	70-130	70-130	≤30
Aroclor 1242	53469-21-9	0.5	65.6	0.97	1.50	0.07	—	8082 GC/ECD	—	0.02	70-130	70-130	≤30
Aroclor 1248	12672-29-6	0.5	65.6	0.98	0.33	0.07	—	8082 GC/ECD	—	0.02	70-130	70-130	≤30
Aroclor 1254	11097-69-1	0.5	65.6	1.02	1.50	0.11	—	8082 GC/ECD	—	0.02	70-130	70-130	≤30
Aroclor 1260	11096-82-5	0.5	65.6	1.08	1.50	0.72	—	8082 GC/ECD	—	0.02	70-130	70-130	≤30
Physical Properties													
Soil Density	—	—	—	—	—	—	—	Gravimetric	—	—	—	—	≤30
pH	—	—	—	—	—	—	—	9040C		—	± 0.1 pH units	—	—
Percent solids	—	—	—	—	—	—	—	Gravimetric	—	—	80-120	—	—
Percent water	—	—	—	—	—	—	—	Gravimetric		—	80-120	—	≤30
Specific conductance	—	—	—	—	—	—	—	9050A	—	—	—	—	—

Table 8. Analytical Performance Requirements for Chemical Constituents

Constituent	CAS Number	Acceptable Level (mg/kg)[a]					Hanford Site Background[g] (mg/kg)	Primary Method[p]	Alternative Method[p]	Detection Limit (mg/kg)	Quality Control Acceptance Criteria[i,j]		
											Accuracy		Precision
		Direct Contact, WAC 173-340-740 Method B Unrestricted RBL[b]	Direct Contact, WAC 173-340-745 Method C Industrial RBL[c]	Outdoor Worker RBL[d]	Ecological Protection[e] ≤15 ft	Groundwater Protection[f]					Laboratory Control Sample Recovery (%)	Spike Recovery (%)	Relative Percent Difference
Particle size distribution[l]	—	—	—	—	—	—	—	ASTM D 422/ ASTM D 6913	—	—	—	—	—
Porosity	—	—	—	—	—	—	—	—	—	—	—	—	—
Total alkalinity	—	—	—	—	—	—	—	—	—	—	—	—	—
Redox potential	—	—	—	—	—	—	—	—	—	—	—	—	—
Total inorganic carbon	—	—	—	—	—	—	—	—	—	—	—	—	—
Physical Property Evaluations													
Hydraulic properties	—	—	—	—	—	—	—	—	—	—	—	—	—
Iron content and iron association	—	—	—	—	—	—	—	—	—	—	—	—	—
Mineral phase identification	—	—	—	—	—	—	—	—	—	—	—	—	—
Leaching characteristics	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequential extraction	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 8. Analytical Performance Requirements for Chemical Constituents

Constituent	CAS Number	Acceptable Level (mg/kg)[a]					Hanford Site Background[g] (mg/kg)	Primary Method[p]	Alternative Method[p]	Detection Limit (mg/kg)	Quality Control Acceptance Criteria[i, j]		
											Accuracy		Precision
		Direct Contact, WAC 173-340-740 Method B Unrestricted RBL[b]	Direct Contact, WAC 173-340-745 Method C Industrial RBL[c]	Outdoor Worker RBL[d]	Ecological Protection[e] ≤15 ft	Groundwater Protection[f]					Laboratory Control Sample Recovery (%)	Spike Recovery (%)	Relative Percent Difference

a. The preliminary screening level (from the data quality objective process) is the risk-based value used to determine appropriate analytical requirements (e.g., detection limits). Remedial action levels will be proposed in the corrective measure study, and will guide remediation of the sites.

b. The unrestricted direct contact risk-based level is based on an excess lifetime cancer risk of 1 in 1,000,000 or hazard quotient of 1.0. ECF-HANFORD-10-0444, Revision 3, *Documentation of Standard Method B Soil Cleanup Levels for Unrestricted Land Use.*

c. The industrial direct contact risk-based level is based on an excess lifetime cancer risk of 1 in 100,000 or hazard quotient of 1.0. ECF-HANFORD-10-0453, Revision 2, *Calculation of Standard Method C Direct Contact Soil Cleanup Levels for Industrial Land Use for the 100 Areas and 300 Area Remedial Investigation/Feasibility Study Report*.

d. The outdoor worker risk-based level used to determine analytical performance requirements is based on an excess lifetime cancer risk of 1 in 1,000,000 or hazard quotient of 1. ECF-HANFORD-16-0134, *Calculation of Soil Nonradiological Preliminary Remediation Goals for the Outdoor Worker Scenario*.

e. CHPRC-01311, *Tier 2 Risk-Based Soil Concentrations Protective of Ecological Receptors at the Hanford Site*; CHPRC-00784, *Tier 1 Risk-Based Soil Concentrations Protective of Ecological Receptors at the Hanford Site*; ECF-HANFORD-11-0158, *Tier 2 Terrestrial Plant and Invertebrate Preliminary Remediation Goals (PRGs) for Nonradionuclides for Use at the Hanford Site*.

f. ECF-HANFORD-10-0442, *Calculation of Nonradiological Soil Concentrations Protective of Groundwater Using the Fixed Parameter 3 Phase Equilibrium Partitioning Equation for the 100 Areas and 300 Area*.

g. DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*; ECF-HANFORD-11-0038, *Soil Background for Interim Use at the Hanford Site*.

h. Uranium result will be calculated using isotopic uranium analysis results.

i. Laboratory quality acceptance requirements are based on RPP-23403, RPP-RPT-38152, and WHL-MP-1011, "~~ATL~~ Quality Assurance Project Plan for 222-S Laboratory."

j. QC failures will be brought to the immediate attention of the Primary Laboratory Contact, discussed in the report narrative, and associated result(s) qualified appropriately in the data package. Note that if there are QC failures associated with secondary analytes, reanalysis will not be required.

k. The actual value is less than its background level. Hence, it was set equal to the background concentration.

l. The outdoor worker risk-based level for arsenic is equal to the site background concentration.

m. Prior to performing this analysis, a preparation method will need to be developed; therefore, detection limit may need to be modified.

n. The acceptable level of lead is the Method A industrial land use soil cleanup level from Table 745-1 of WAC 173-340-745(3).

o. The values for nitrate and nitrite are calculated for nitrogen in nitrate plus nitrite.

p. Equivalent methods may be used by the laboratory with prior approval by the Primary Laboratory Contact and Project Manager.

q. Detection limit listed is Hanford background value. The laboratory shall attempt to achieve a detection limit less than Hanford background.

r. Detection limit may be less than can be reported by current analytical methodology. The laboratory shall report results to the lowest achievable detection limit while maintaining quality standards.

s. The acceptable level of lead is the Method A unrestricted land use soil cleanup level from Table 740-1 of WAC 173-340-900.

t. Particle size distribution will be performed by the laboratory if sample volume is sufficient. Note that 222-S will need to develop protocol to perform test.

u. Detection limits are associated with nitrate (CAS number 14797-55-8) and nitrite (CAS number 14797-65-0)

AES = atomic emission spectroscopy
DDD = Dichlorodiphenyldichloroethane
DDE = Dichlorodiphenyldichloroethylene
DDT = Dichlorodiphenyltrichloroethane
CAS = Chemical abstract number
ECD = electron capture detector
GC = gas chromatography
IC = ion chromatography
ICP = inductively coupled plasma
MS = mass spectroscopy
RBL = risk-based level

Table 9. Analytical Performance Requirements for Radiological Constituents - Shallow Soil Samples (up to 15 ft below ground surface)

Constituent	CAS Number	Acceptable Level (pCi/g)[a]		Hanford Site Background[d] (pCi/g)	Primary Method[i]	Alternative Method[j]	Detection Limit (pCi/g)	Quality Control Acceptance Criteria[e,f]		
								Accuracy		Precision
		Outdoor Worker RBL[b]	Ecological Protection[c]					Laboratory Control Sample Recovery (%)	Spike Recovery (%)	Relative Percent Difference
Americium-241	14596-10-2	613	4,840	—	Alpha energy analysis (acid)	ICP/MS (acid)	1	80-120	—	≤30
Antimony-125	14234-35-6	—	—	—	Gamma energy analysis (direct)	—	0.3	80-120	—	≤30
Carbon-14	14762-75-5	5.70E+05	32	—	Liquid scintillation (acid)	—	1	80-120	75-125	≤30
Cesium-137	10045-97-3	10.8	924	1.05	Gamma energy analysis (direct)	—	0.1	80-120	—	≤30
Cobalt-60	10198-40-0	5.7	805	8.42E-03	Gamma energy analysis (direct)	—	0.01[g,h]	80-120	—	≤30
Curium-242	15510-73-3	—	—	—	Alpha energy analysis (acid)	ICP/MS (acid)	1	NA	—	NA
Curium-243/244	CM-243/244	64	—	—	Alpha energy analysis (acid)	ICP/MS (acid)	1	NA	—	NA
Europium-152	14683-23-9	6.8	1,740	—	Gamma energy analysis (direct)	—	0.1[g]	NA	—	≤30
Europium-154	15585-10-1	8.2	1,610	3.34E-02	Gamma energy analysis (direct)	—	0.03[g,h]	NA	—	≤30
Europium-155	14391-16-3	603	3.34E+04	5.39E-02	Gamma energy analysis (direct)	—	0.05[g,h]	NA	—	≤30
Iodine-129	15046-84-1	1,568	—	—	Low energy gamma counting	ICP/MS (acid)	2	80-120	—	≤30
Neptunium-237	13994-20-2	24	7,880	—	ICP/MS (acid)	Alpha energy analysis (acid)	3.80E-02	80-120	75-125	≤30
Nickel-63	13981-37-8	6.00E+05	—	—	Liquid scintillation (acid)	—	30	80-120	—	≤30
Plutonium-238	13981-16-3	3,438	5,980	3.78E-03	Alpha energy analysis (acid)	ICP/MS (acid)	1	NA	—	≤30
Plutonium-239/240	Pu-239/240	2,971	6,270	2.48E-02	Alpha energy analysis (acid)	ICP/MS (acid)	0.03[g,h]	80-120	—	≤30
Plutonium-241	14119-32-5	2.03E+04	—	—	Liquid scintillation (acid)	Est. from Pu-238 and Pu239/240	1.65E+04	80-120	75-125	≤30

Table 9. Analytical Performance Requirements for Radiological Constituents - Shallow Soil Samples (up to 15 ft below ground surface)

Constituent	CAS Number	Acceptable Level (pCi/g)[a]		Hanford Site Background[d] (pCi/g)	Primary Method[j]	Alternative Method[j]	Detection Limit (pCi/g)	Quality Control Acceptance Criteria[e,f]		
								Accuracy		Precision
		Outdoor Worker RBL[b]	Ecological Protection[c]					Laboratory Control Sample Recovery (%)	Spike Recovery (%)	Relative Percent Difference
Radium-226	13982-63-3	—	58.3	0.82	Gamma energy analysis (direct)	—	—	80-120	75-125	≤30
Selenium-79	15758-45-9	5.68E+04	—	—	Liquid scintillation (acid)	—	10	—	—	≤30
Strontium-89/90[i] (Total)	10098-97-2	1190	91	0.18	Beta GPC	—	0.18	80-120	75-125	≤30
Tin-126	15832-50-5	—	—	—	ICP/MS (acid)	—	400	80-120	75-125	≤30
Technetium-99	14133-76-7	1.17E+05	5,360	—	ICP/MS (acid)	Liquid scintillation (acid)	1	80-120	75-125	≤30
Thorium-232	7440-29-1	—	—	1.32	ICP/MS (acid)	—	4.40E-05	80-120	75-125	≤30
Tritium	10028-17-8	1.26E+04	420	—	Liquid scintillation (acid)	—	30	80-120	75-125	≤30
Uranium-233/234[k]	U-233/234	2,201	6,370	1.1	ICP/MS (acid)	—	3.75E-02	—	—	≤30
Uranium-235	15117-96-1	36	4,360	0.11	ICP/MS (acid)	—	4.32E-05	80-120	75-125	≤30
Uranium-236	13982-70-2	—	—	—	ICP/MS (acid)	—	5.18E-04	—	—	≤30
Uranium-238	7440-61-1	170	5,150	1.06	ICP/MS (acid)	—	4.37E-04	80-120	75-125	≤30

a. The preliminary screening level (from the data quality objective process) is the risk-based value used to determine appropriate analytical requirements (e.g., detection limits). Remedial action levels will be proposed in the corrective measure study, and will guide remediation of the sites.

b. The outdoor worker risk-based level used to determine analytical performance requirements is based on an excess lifetime cancer risk of 1 in 10,000. ECF-HANFORD-16-0133, Revision 0, *Calculation of Soil Radiological Preliminary Remedial Goals for the Outdoor Worker Scenario*.

c. CHPRC-00784, *Tier 1 Risk-Based Soil Concentrations Protective of Ecological Receptors at the Hanford Site*.

d. DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*.

e. Laboratory quality acceptance requirements are based on RPP-23403, RPP-RPT-38152, and WHL-MP-1011, "~~ATL~~ Quality Assurance Project Plan for 222-S Laboratory."

f. Quality control failures will be brought to the immediate attention of the Primary Laboratory Contact, discussed in the report narrative, and associated result(s) qualified appropriately in the data package. Note that if there are quality control failures associated with secondary analytes, reanalysis will not be required.

g. Detection limit listed is Hanford background value. The laboratory shall attempt to achieve a detection limit less than Hanford background.

h. Detection limit may be less than can be reported by current analytical methodology. The laboratory shall report results to the lowest achievable detection limit while maintaining quality standards.

i. Based on half-live, Strontium-89 is not present in Hanford wastes; therefore, Strontium-89/90 is equivalent to Strontium-90.

j. Equivalent methods may be used by the laboratory with prior approval by the Primary Laboratory Contact and Project Manager.

k. Value is for Uranium-234.

CAS = Chemical Abstracts Service

GPC = Gas proportional counting

GEA = Gamma energy analysis

ICP = inductively coupled plasma

MS = mass spectroscopy

RBL = risk-based level

Table 10. Analytical Performance Requirements Radiological Constituents - Deep Soil Samples (greater than 15 ft below ground surface)

Constituent	CAS Number	Acceptable Level (pCi/g)[a]		Hanford Site Background[d] (pCi/g)	Primary Method[k]	Alternative Method[k]	Detection Limit (pCi/g)	Quality Control Acceptance Criteria[e,f]		
								Accuracy		Precision
		Construction Worker RBL[b]	Ecological Protection[c]					Laboratory Control Sample Recovery (%)	Spike Recovery (%)	Relative Percent Difference
Americium-241	14596-10-2	2.20E+04	4,840	—	Alpha energy analysis (acid)	ICP/MS (acid)	1	80-120	NA	≤30
Antimony-125	14234-35-6	—	—	—	Gamma energy analysis (direct)	—	0.3	80-120	NA	≤30
Carbon-14	14762-75-5	4.80E+06	32	—	Liquid scintillation (acid)	—	1	80-120	75-125	≤30
Cesium-137	10045-97-3	1,550	924	1.05	Gamma energy analysis (direct)	—	0.1	80-120	NA	≤30
Cobalt-60	10198-40-0	334	805	8.42E-03	Gamma energy analysis (direct)	—	0.01[g,h]	80-120	NA	≤30
Curium-242	15510-73-3	—	—	—	Alpha energy analysis (acid)	ICP/MS (acid)	1	—	NA	NA
Curium-243/244	CM-243/244	7,582	—	—	Alpha energy analysis (acid)	ICP/MS (acid)	1	—	NA	NA
Europium-152	14683-23-9	739	1,740	—	Gamma energy analysis (direct)	—	0.1[g]	—	NA	≤30
Europium-154	15585-10-1	691	1,610	3.34E-02	Gamma energy analysis (direct)	—	0.03[g,h]	—	NA	≤30
Europium-155	14391-16-3	3.24E+04	3.34E+04	5.39E-02	Gamma energy analysis (direct)	—	0.05[g,h]	—	NA	≤30
Iodine-129	15046-84-1	1.21E+05	—	—	Low energy gamma counting	ICP/MS (acid)	2	80-120%	NA	≤30
Neptunium-237	13994-20-2	4,193	7,880	—	ICP/MS (acid)	Alpha energy analysis (acid)	3.80E-02	80-120%	75-125	≤30
Nickel-63	13981-37-8	2.86E+07	—	—	Liquid scintillation (acid)	—	30	80-120%	NA	≤30
Plutonium-238	13981-16-3	2.98E+04	5,980	3.78E-03	Alpha energy analysis (acid)	ICP/MS (acid)	1	—	NA	≤30
Plutonium-239/240	Pu-239/240	2.80E+04	6,270	2.48E-02	Alpha energy analysis (acid)	ICP/MS (acid)	0.03[g,h]	80-120%	NA	≤30
Plutonium-241	14119-32-5	1.03E+06	—	—	Liquid scintillation (acid)	Est. from Pu-238 and Pu239/240	1.65E+04	80-120%	75-125	≤30
Radium-226	13982-63-3	—	58.3	0.82	GEA	—	—	80-120	75-125	≤30
Selenium-79	15758-45-9	3.20E+06	—	—	Liquid scintillation (acid)	—	10	—	NA	≤30
Strontium-89/90 (Total)[j]	10098-97-2	1.21E+05	91	0.18	Beta GPC	—	0.18	80-120	75-125	≤30
Tin-126	15832-50-5	—	—	—	ICP/MS (acid)	—	400	80-120	75-125	≤30

Table 10. Analytical Performance Requirements Radiological Constituents - Deep Soil Samples (greater than 15 ft below ground surface)

Constituent	CAS Number	Acceptable Level (pCi/g)[a]		Hanford Site Background[d] (pCi/g)	Primary Method[k]	Alternative Method[k]	Detection Limit (pCi/g)	Quality Control Acceptance Criteria[e,f]		
								Accuracy		Precision
		Construction Worker RBL[b]	Ecological Protection[c]					Laboratory Control Sample Recovery (%)	Spike Recovery (%)	Relative Percent Difference
Technetium-99	14133-76-7	5.80E+06	5,360	—	ICP/MS (acid)	Liquid scintillation (acid)	1	80-120	75-125	≤30
Thorium-232	7440-29-1	—	—	1.32	ICP/MS (acid)	—	4.40E-05	80-120	75-125	≤30
Tritium	10028-17-8	3.26E+05	420	—	Liquid scintillation (acid)	—	30	80-120	75-125	≤30
Uranium-233/234[i]	U-233/234	5.51E+04	6,370	1.1	ICP/MS (acid)	—	3.75E-02	—	NA	≤30
Uranium-235	15117-96-1	5,984	4,360	0.11	ICP/MS (acid)	—	4.32E-05	80-120	75-125	≤30
Uranium-236	13982-70-2	—	—	—	ICP/MS (acid)	—	5.18E-04	—	—	≤30
Uranium-238	7440-61-1	2.11E+04	5,150	1.06	ICP/MS (acid)	—	4.37E-04	80-120	75-125	≤30

a. The preliminary screening level (from the data quality objective process) is the risk-based value used to determine appropriate analytical requirements (e.g., detection limits). Remedial action levels will be proposed in the corrective measure study, and will guide remediation of the sites.

b. The construction worker risk-based level used to determine analytical performance requirements is based on an excess lifetime cancer risk of 1 in 10,000. ECF-HANFORD-16-0132, Revision 0, *Calculation of Soil Radiological Preliminary Remedial Goals for the Construction Worker Scenario*.

c. CHPRC-00784, *Tier 1 Risk-Based Soil Concentrations Protective of Ecological Receptors at the Hanford Site*.

d. DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*.

e. Laboratory quality acceptance requirements are based on RPP-23403, RPP-RPT-38152, and WHL-MP-1011, "~~ATL~~ Quality Assurance Project Plan for 222-S Laboratory."

f. Quality control failures will be brought to the immediate attention of the Primary Laboratory Contact, discussed in the report narrative, and associated result(s) qualified appropriately in the data package. Note that if there are quality control failures associated with secondary analytes, reanalysis will not be required.

g. Detection limit listed is Hanford background value. The laboratory shall attempt to achieve a detection limit less than Hanford background.

h. Detection limit may be less than can be reported by current analytical methodology. The laboratory shall report results to the lowest achievable detection limit while maintaining quality standards.

i. Value is for Uranium-234.

j. Based on half-live, Strontium-89 is not present in Hanford wastes; therefore, Strontium-89/90 is equivalent to Strontium-90.

k. Equivalent methods may be used by the laboratory with prior approval by the Primary Laboratory Contact and Project Manager.

CAS = Chemical Abstracts Service
GPC = Gas proportional counting
GEA = Gamma energy analysis
ICP = inductively coupled plasma
MS = mass spectroscopy
RBL = risk-based level