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

MEETING NUMBER: WMA-A-AX-DQO-2017-10
MEETING DATE: August 31, 2017
LOCATION: 3100 Port of Benton Blvd, Room 3C

ATTENDEES:

Mike Barnes (Ecology)	Scott Luke (WRPS)	Kim Schuyler (Freestone)
Joe Caggiano (Ecology)	Jeff Lyon (Ecology)	Marysia Skorska (Ecology)
Jan Bovier (DOE-ORP)	Julie Robertson (Freestone)	Cindy Tabor (WRPS)
Damon Deslistraty (Ecology)	Beth Rochette (Ecology)	

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 July 24, 2017, meeting had been placed in the Hanford Site Administrative Record and that the notes for the August 7, 2017 meeting were with Ecology for review through September 5, 2017.

DISCUSS ISSUES: Before the meeting, Ecology had reviewed information per ACTIONS 2017-08-07-03, 2017-08-07-04, and 2017-08-07-08 and provided feedback through various emails. Concerns raised in the emails and WRPS/DOE responses to the concerns were summarized by Ms. Tabor in Handout #1, which was discussed at the meeting.

- 1.a. Constituents/VOAs: Ecology staff members had raised a concern that the sampling equipment proposed for use at WMA A-AX focus area A-104/105 is not capable of adequately capturing volatile organic compounds (VOCs) for analysis. Ms. Tabor stated that the proposed equipment (described in the handout) is both capable of capturing VOCs and similar to protocol used elsewhere at Hanford and also across the country. The attendees discussed the possible use at A-104/105 of a field screening tool that has recently been deployed for 200-DV-1 Operable Unit sampling (**ACTION 2017-08-31-01**).

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Ms. Tabor stated that although the equipment is available for sampling, the program for sample management (handling and analysis) has not been used since 2010. As described in Handout #1, laboratory contract and personnel changes that have occurred in the interim will drive the preparation of new sample management procedures and training of new personnel; thus, it is unlikely that the VOC analysis program can be recreated in time to support VOC analysis of samples from the A-104/105 focus area (**ACTION 2017-08-31-02**; added note dated 8/31/2017 to **Agreement 8**). The attendees committed to continue working together to identify opportunities for VOC sampling at WMA A-AX (**ACTION 2017-08-31-03**).

- 1.b. Constituents/SVOAs: Before the meeting, Ecology had requested by email that tributyl phosphate and bis(2-ethylhexyl)phthalate analysis be performed at the Tanks A-104/105 focus area. Ms. Tabor stated that analysis of these two semivolatile organic compounds will be added to both Tables 6 and 8 (added note dated 8/31/2017 to **Agreement 8**).

- 1.c. Constituents/VOAs and SVOAs: The attendees discussed items 1.a and 1.b above further to clarify the resulting actions and agreements. Ms. Tabor proposed removing the color-coding that had previously appeared on Table 6, as it seemed to cause confusion, and Ecology agreed to the proposal (**ACTION 2017-08-31-04**).

- 1.d. Constituents/Dioxins and Furans: Before the meeting, Ecology had requested by email that analysis of dioxins and furans be performed on samples taken from the southern portion of A Farm. The constituents have been detected in groundwater assessment samples from the RCRA well network for WMA A-AX. The source is not yet known. Ms. Tabor stated that the upcoming draft DQO summary report will not call for analysis of dioxins and furans in vadose zone soil samples from the focus area at Tanks A-104/105 (**ACTION 2017-08-31-05**); however, she acknowledged that additional discussion between DOE-RL, DOE-ORP, and Ecology is needed about potential sources and the need to analyze WMA A-AX vadose zone soil samples for these constituents in the future (**ACTION 2017-08-31-06**).

- 2. DV-1: Ecology is receiving daily reports related to CHPRC borehole installation activities at 200-DV-1 Operable Unit locations. The reports indicate that VOCs are being detected in multiple boreholes in the 200 East and 200 West Areas. Data is preliminary at this time. Ms. Tabor is working with CHPRC to learn more about the findings and will provide issued reports to Ecology when they become available **ACTION 2017-08-31-07**).

- 3. Other Focus Areas (ACTION 2017-03-30-03): This will be identified as an open action in the draft DQO summary report.

- 4. Boundary (ACTIONS 2017-04-13-02 and 2017-08-07-09): These will be identified as open actions in the draft DQO summary report.

- 5. GPR (ACTION 2017-05-25-01): This will be identified as an open action in the draft DQO summary report.

- 6. WMA A-AX Decision Rule and Performance Criteria (ACTION 2017-08-07-05): During prior discussions, Ecology expressed concern about phrasing related to how data evaluation would be conducted (use of 95% UCL vs. maximum detected value). Additionally, in emails dated August 8

and August 9, 2017, Ecology expressed a concern about the need to evaluate individual constituents not only against acceptable values listed on Tables 8, 9, and 10, but also against their contribution to the sample hazard index and cancer risk level. The emails requested that Decision Rule #1 be rephrased to say, "For judgmental sampling, IF the maximum detected concentrations for individual constituents exceed acceptable levels identified in Tables 8, 9, or 10, OR the contaminant contributes 1% or greater to a sample hazard index of >1 or cancer risk of >1E-05, THEN the contaminant will be retained for further evaluation in the RFI/CMS." The emails also requested that the first bullet under Step 6 outputs for WMA A-AX be rewritten to state the following: "Quality control acceptance criteria for each constituent is identified in Tables 8, 9, and 10. Additionally, the criteria for sample hazard index and sample total cancer risk for samples with greater than or equal to two contaminants are 1 and 1E-05, respectively. For judgmental sampling, the maximum detected concentrations will initially be used for comparison to acceptable levels to identify constituents of potential concern."

Ms. Tabor acknowledged Ecology's continuing concern about the proposed language and said that WRPS would have to work together with DOE-ORP, DOE-RL, and CHPRC to address the concern. Due to the need to move forward with finalizing the draft DQO summary report, Ms. Tabor stated that the existing proposed text will be used in the draft document, but she also asked that an action be established and held open to discuss the matter further (**ACTION 2017-08-31-08**). Ms. Rochette stated that Ecology would prefer deletion of draft DQO summary report text related to ACTION 2017-08-07-05 until the matter is resolved. Ms. Rochette later suggested that the group review Decision Rules 2 and 4 from the WMA C Phase 2 DQO report to support future discussions.

- 7. Groundwater Information (ACTION 2017-08-07-01): Ms. Tabor provided text to Mr. Lyon intended to close this action from a previous meeting. Mr. Lyon reviewed and accepted the text, which will be added to the draft DQO summary report (**ACTION 2017-08-31-09**).

REVIEW OF UNRESOLVED (OR UPDATED) DQO PROCESS STEPS: Handouts #2 and #3 were provided to support the discussion. Ms. Robertson, Ms. Schuyler, and Ms. Tabor reviewed changes to the handouts that had been made since the August 7, 2017, meeting. The changes were shown in purple on the handouts.

- Background Information: Text was modified in Handout #2, Table 1 (Steps 1, 2, 3, 5, 6, and the footnote), to respond to a comment from Ms. Skorska.

- Step 2: The text at the end of the second bullet on page 4 of Handout #2, regarding evaluation of where waste may have passed through the soil, was modified to close ACTION 2017-08-07-02. Text in Table 3 of Handout #2 was also modified to close ACTION 2017-08-07-02.

- Step 3: Several minor changes were made to text in Handout #2, Table 4, "Type of Data" column, for clarification. PSQ #4 in Table 4 was modified to close ACTION 2017-08-07-02. Ms. Tabor will email Table 6 revisions made in response to various emails and discussions to Ms. Rochette, who will review and respond (**ACTION 2017-08-31-10**).

- Steps 5 and 6:
    - Ms. Tabor will email Table 8 revisions made in response to various emails and discussions to Ms. Rochette, who will review and respond (**ACTION 2017-08-31-11**). Ms. Rochette again

expressed concern that constituents in Table 8 need to be evaluated against hazard index and cumulative risk values as a part of the risk evaluation.
  - Tables 9 and 10 (Handout #3) footnotes were revised, and uranium-233 was added to both tables. Ecology had no concerns with the proposed changes.
  - The PSQ, estimation statement, and specifications of the estimator for PSQ#4 in Table 11 of Handout #2 was modified to close ACTION 2017-08-07-02. A footnote added to Table 4 is associated with minor clarifications made to Table 4.
  - Table 12, which was unchanged from the previous meeting, was accepted without comment (**Agreement 17** dated 08/31/2017).

- Step 7:
  - Two changes were made to Table 13 of Handout #2. A footnote was added to clarify the method for measuring the angles of the angled boreholes, and the location of proposed location #4 was updated from 241-A-104 to 241-A-105 to correct a typographical error.
  - On page 22 of Handout #2, text was added to clarify that pesticides and polychlorinated biphenyl analyses would be conducted only for shallow samples to support direct contact and ecological risk assessment. Ms. Rochette stated that these constituents had been identified in the groundwater and that, as a result, analyses for these constituents should be performed for deeper samples, too. Ms. Tabor stated that the existing text will be used in the draft DQO summary report, but she also asked that an action be established and held open to discuss the matter further (**ACTION 2017-08-31-12**).
  - On page 23 of Handout #2, text about drywell corrosion observations was revised to close ACTION 2017-08-07-06.

REVIEW AGREEMENTS AND ACTIONS: A summary of agreements and actions is provided in the tables below. At the 8/7/2017 meeting, the attendees recognized the need to correct the agreement list to reflect updates to older agreements at more recent meetings; the agreement list below incorporates those corrections. Seven actions were closed at this meeting, and 12 actions were opened.

DISCUSS PATH FORWARD: Ms. Tabor stated that WRPS intends to submit the draft DQO summary report to DOE-ORP at the end of September 2017, and to issue the final DQO summary report in January 2018. Development of the work plan/sampling analysis plan for the focus area around Tanks A-104/105 will begin in October 2017. The desire is to start field work in fiscal year 2018 and to begin borehole sampling in the summer of 2018. Borehole logging would occur before borehole sampling.

Jan B Bovier		10/5/2017
DOE Project Manager (print)	DOE Project Manager (signature)	Date
Jeffrey J. Lyon		10/5/2017
Ecology Project Manager (print)	Ecology Project Manager (signature)	Date

DATE	AGREEMENTS (3 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. **Step 1: 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.
05/25/2017;	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.
07/24/2017	**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;	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.
07/13/2017	**Note**: Scope was subsequently modified as described in Agreement 4.
08/07/2017	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.
08/31/2017	Table 1 (Approach) was revised to respond to an Ecology comment as shown in Handout #2 attached to the 08/31/2017 meeting notes.
05/25/2017;	7. **Step 2**: The parties agreed to the **Goal of the Study** as described in Handout #2 attached to the 05/25/2017 DQO meeting notes.
07/13/2017	**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).

DATE	AGREEMENTS (3 pages)
06/15/17; 08/07/2017 08/31/2017	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, semi-volatile organics, and hexavalent chromium. **Note**: Hexavalent chromium was added to the list as shown in the DQO meeting notes dated 08/07/2017. **Note**: (1) It was agreed that the A-104/105 focus area will not include VOC analysis. VOC analysis will be identified as "special study" instead of "eliminate" in Table 6. (2) For semi-volatiles, tributyl phosphate and bis(2-ethylhexyl)phthalate will be identified in Table 6 as "retain." These constituents will be added to Table 8, and analysis will be performed on samples from WMA A-AX and the focus area around Tanks A-104 and A-105.
06/15/2017 08/31/2017	9. **Step 3**: 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**. **Note**: Table 4 was subsequently modified as documented in Handout #2 of the DQO meeting notes dated 08/31/2017.
06/15/2017 07/13/2017 08/31/2017	10. **Step 7**: 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. **Note**: Text regarding surface sample duplicates was clarified as shown in the DQO meeting notes dated 07/13/2017. **Note**: Additional discussion is needed about text in Attachment #2 to the DQO meeting notes dated 08/31/2017 regarding depths at which PCBs and pesticides will be analyzed.
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; 08/31/2017	12. The parties agreed on the contents of **Step 2** as modified in the 07/13/17 meeting (Handout #2) and 08/31/2017 meeting (Handout #2).
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 (3 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.
07/24/2017; 08/07/2017; 08/31/2017	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**: Corrections and clarifications are described in the meeting notes dated 08/07/2017 and 08/31/2017.
07/24/2017	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).
08/31/2017	17. **Step 6**: The attendees accepted Table 12 as shown in Handout #2 of the 8/31/2017 meeting notes.

ACTIONS (3 pages)			
Action No.	**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. Retain as open item for draft DQO summary report.
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. Retain as open item for draft DQO summary report.
2017-05-25-01	Tabor	Evaluate borehole placement/configuration after getting updated GPR results.	Open. On hold until conduct GPR study. Retain as open item for draft DQO summary report.
2017-08-07-01	Tabor	Develop draft DQO summary report text about where groundwater info will be provided to share with DOE then Ecology.	Closed at 8/31/17 meeting.
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.	Closed at 8/31/17 meeting. Tables 4 and 11 were also revised accordingly.
2017-08-07-03	Rochette	Review proposed changes to Table 8 of Handout #2 by August 21, 2017.	Closed at 8/31/17 meeting.

ACTIONS (3 pages)			
Action No.	**Actionee**	**Description**	**Status**
2017-08-07-04	Rochette	Review proposed text changes on pages 18 and 19 of Handout #1 related to use of 95% UCL.	Closed at 8/31/17 meeting.
2017-08-07-05	Tabor	Provide Ecology WMA Phase 2 language regarding use of 95% UCL.	Proposed text not accepted by Ecology. Retain as open item for draft DQO summary report.
2017-08-07-06	Childress	Clarify what is meant by "evaluated" on page 23 of Handout #1.	Closed at 8/31/17 meeting.
2017-08-07-07	Lyon	Ecology will meet to discuss need for VOA/SVOA analysis at the A-104/105 focus area.	Closed at 8/31/17 meeting.
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.	Closed at 8/31/17 meeting.
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.	Open. Retain as open item for draft DQO summary report.
2017-08-31-01	Tabor	ORP/WRPS will look into using a VOC field screening tool at A-104/105.	New. Retain as open item for draft DQO summary report.
2017-08-31-02	Tabor	Pull text from page 1 of 8/31/17 Handout #1 into DQO report ("Similar WMA C analyses...requirements of new laboratory contractors.").	New.
2017-08-31-03	Bovier/Lyon	Ecology, DOE-ORP, and WRPS will continue discussions on where at WMA A-AX to perform a VOC study and what VOCs to analyze.	New. Retain as open item for draft DQO summary report.
2017-08-31-04	Tabor	Remove color coding from Table 6 to reduce confusion.	New.
2017-08-31-05	Tabor	Add justification for not doing dioxin/furan sampling at the A-104/105 focus area to the draft DQO summary report and to the DQO meeting handout.	New.
2017-08-31-06	Bovier/ Hildebrand/ Lyon	Ecology, DOE-ORP, and WRPS will continue discussions regarding the need to analyze WMA A-AX vadose zone soil samples for dioxins and furans.	New. Retain as open item for draft DQO summary report.
2017-08-31-07	Tabor	When they become available, provide issued reports to Ecology with information about VOCs found in 200-DV-1 Operable Unit boreholes.	New. Retain as open item for draft DQO summary report.

ACTIONS (3 pages)			
Action No.	**Actionee**	**Description**	**Status**
2017-08-31-08	Bovier/ Hildebrand/ Lyon	Ecology, DOE-ORP, and WRPS will continue discussions about WMA A-AX Decision Rule and Performance Criteria text on data evaluation (e.g., use of 95% UCL).	New. Retain as open item for draft DQO summary report.
2017-08-31-09	Tabor	Text about groundwater information was presented to Ecology at the 8/31/17 meeting and was accepted. Incorporate the text into draft DQO summary report.	New.
2017-08-31-10	Tabor/Rochette	Ms. Tabor will email Table 6 revisions to Ms. Rochette, who will review and respond.	New.
2017-08-31-11	Tabor/Rochette	Ms. Tabor will email Table 8 revisions to Ms. Rochette, who will review and respond.	New.
2017-08-31-12	Bovier/Lyon	Ecology, DOE-ORP, and WRPS will continue discussions about performing pesticide and PCB analyses on samples taken below 15 ft bgs.	New. Retain as open item for draft DQO summary report.

Handout #1
WMA A-AX Vadose Zone Issues

WMA A-AX Vadose Zone DQO Issues

1. **Constituents:**
   a. **VOAs**

Beth
Email 8/17/17, 5:30 pm:
Mike, our chemist, has stated that the sampling tools cannot collect VOAs. Therefore, we cannot get VOA data. So for both the DQO document and the SAP, please include text describing the sampling equipment that will be used in coring, including a clear explanation for why sampling volatile organic analytes (VOAs) is not possible with the equipment. We consider these contaminants of potential concern as they have been found in groundwater throughout PO-1. Also, see previous emails regarding lines of evidence for including organics.

Joe C to Harold, Email 8/17/2017, 9:01 am:
For the A-AX DQO, we are having discussions regarding VOAs and SVOAs in the vadose zone. Can these be sampled for in narrow diameter push holes to assure that any such gases are captured for analysis? There seems to be opinions here that sampling can only be done in larger diameter holes. I know that soil gas sampling was done with shallow pushes at the SWL by John Evans (and others) at PNNL, but I don't know the specifics of how the sampling was done. So, is this possible in either A or AX tank farm?

Cindy
Email 8/22/17, 8:23 am (below is a summary):
The proposed sampling tools are fully capable of collecting soil for VOAs and were, in fact, used successfully for that purpose during the WMA C investigation. The proposed sampling method will use direct push using a drive barrel with stainless steel liners. The liners are removed from the barrel at the sampling location and are immediately capped and sealed. While no soil sampling method is absolute for VOAs, because loss may occur during the transfer to the sampling container and in the lab, we believe that the method proposed at WMA A-AX (and used at WMA C) is an excellent method for collecting soil at depth for VOAs and SVOAs, akin to split spoon sampling.

That said, we must acknowledge that there are significant challenges to conducting volatile organic compound (VOC) analyses on vadose zone soil samples from focus area Tanks A-104/105 during FY 2018, when sample collection is planned. Similar WMA C analyses were last conducted around 2010, and laboratory contract and personnel changes have resulted in a loss of expertise related to sample management and analysis. Procedures for handling and analyzing the samples will have to be recreated to meet the requirements of new laboratory contractors. It is unlikely that the VOC analysis program can be recreated in time to support VOC analysis of samples from the Tanks A-104/105 focus area. In recognition of these challenges, we propose identifying VOAs in Table 6 as "Special Study" rather than "Eliminate and recommend that VOAs be evaluated at a different focus area to be investigated at a later date. Using information shared by Mike Barnes, WRPS is developing recommendations on potential areas to evaluate for VOAs, and these recommendations will be shared with Ecology.

Action: Instead of being identified as "Eliminate" in Table 6, VOAs will be identified as "Special Study". Ecology, DOE-ORP, and WRPS will continue discussions on where to perform a study and what VOCs to analyze (also refer to c. below). This item will be identified in Appendix A as an Open Item. Note that the focus area of Tanks A-104 and A-105 will not include VOAs.

b. SVOAs

Beth:

Email 8/17/17, 5:30 pm:

We would like TBP and bis(2-ethylhexyl)phthalate analyzed in the samples taken throughout A and AX. TBP was a significant component of PUREX waste, and bis(2-ethylhexyl)phthalate has been found in groundwater associated the PUREX cribs and elsewhere in PO-1. It may also be a source of ecological risk in the shallow zone (as in WMA C).

Beth:

Email 8/21/17, 2:55 pm

4. At WMA C, bis(2-ethylhexyl)phthalate appears to be an ecological risk in the shallow samples at WMA C according to the baseline risk assessment.
5. I have looked at the leak assessment document for A-AX (RPP-ENV-37956) and found that tributyl phosphate was found in process condensate; there was an A farm off-gas ventilation release as early as 1957, which could have had TBP and other organics.

DOE-ORP Response:

DOE-ORP agrees to analyzing for tributyl phosphate and bis(2-ethylhexyl)phthalate at WMA A-AX. They will be identified in Table 6 as "Retain". These constituents will be added to Table 8 and analysis will be performed on samples from WMA A-AX and the focus area around Tanks A-104 and A-105.

The following information is regarding bis(2-ethylhexyl)phthalate being a risk issue at WMA C:
The exposure point concentrations (EPC) for bis-2-ethylhexyl phthalate exceeds the Tier 2 screening level at 3 exposure areas (EAs). However, as part of the Scientific Management Decision Point (SMDP), bis-2-ethylhexyl phthalate was eliminated from further evaluation.

RPP-RPT-58329, Revision 2, *Baseline Risk Assessment for Waste Management Area C,* Section 4.6.2: *Bis (2-ethylhexyl) phthalate – The EPCs (4.03 mg/kg, 1.84 mg/kg and 2.3 mg/kg) at EA F plus G, EA L1 plus L2 and EA P, respectively are greater than the corresponding Tier 2 screening value (0.17 mg/kg, California Quail). Hence, the HQs (23.7, 10.8 and 13.5) are significantly greater than 1. It should be noted that two of the most elevated concentrations (7.2 mg/kg and 2.8 mg/kg) at EA F plus G were detected at 15 and 11 ft bgs, respectively. Both of those samples are below the Hanford bioactive zone of 10 ft. The reporting limits for those sample results are 0.58 mg/kg. For EA L1 plus L2, the EPC is equal to the sample result of one detected sample (with "J" qualifier). The reporting limit for that sample is 0.57 mg/kg. For EA P, only 2 samples were detected with "J" qualifiers. Their reporting limits are 0.57 and 0.59 mg/kg, respectively. That means, for all cases, the reporting limits for all detected sample results are greater than Tier 2 screening value. In addition, according to Table 3-1 of CHPRC-01311, the confidence limit for the screening value is low and is not recommended for use if another value with greater confidence is available. Tier 2 LOAEL-based screening values with moderate confidence established by the authors are available for the site-specific receptors red-tailed hawk and badger (1.2 mg/kg and 204 mg/kg, respectively). The EPC for the entire site (WMA C) is 1.17 mg/kg, which equates to an HQ Accordingly, bis (2-ethylhexyl) phthalate is not proposed for retention or further ecological evaluation at WMA C.*

Action: Tributyl phosphate and bis(2-ethylhexyl)phthalate will be identified in Table 6 as "Retain". These constituents will be added to Table 8 and analysis will be performed on WMA A-AX samples and those samples collected from the focus area around Tanks A-104 and A-105.

c. **VOAs and SVOAs**

Beth:

Email 8/21/17, 2:55 pm

3. Various organics (SVOCs and VOCs) have been detected in shallow and deep samples at WMA C. These were included in the handouts at the A-AX DQO meeting on the constituent list, and they are highlighted in pink and blue. The assumption that these are common laboratory contaminants is weak, given the variety of detected VOCs and their prior use at Hanford.
6. There were numerous pipeline leaks, some from which process condensate was released, starting in 1959. Releases also occurred from jumper pits, diversion boxes, pipeline encasement, filters at the 702-A building, filter building, and stack. This tells me that, while the tanks might have boiled and lost any organics in the waste to the air through boiling, there were various other sources besides boiling tanks that could have released organics to the vadose zone, perhaps through the ground surface or at the depth of pipelines and ancillary equipment. VOCs and a number of SVOCs have low Kds, and would be mobile in the subsurface if they were released with liquids.
7. The spectral gamma logs from 3 feet below the surface in A farm show waste was released across essentially the entire surface of the farm. This suggests that plenty of waste was not inside the tanks where boiling occurred, but outside on the soil surface where it would have been subjected to mobilizing fluids including precipitation.

DOE-ORP Response:

Common laboratory contaminants was given as an example with respect to the organics highlighted in Table 6. The constituents were highlighted to show what was detected or above background in WMA C for reference purposes.

The following provides information on how organics were sampled and detected at specific locations in WMA C.

Per RPP-PLAN-3877, Revision 2A, *Sampling and Analysis Plan for Phase 2 Characterization of Vadose Zone Soil in the Waste Management Area C*:

> "Five of the twenty-seven sites identified for characterization have been selected to evaluate potential for organic contamination."

Summary in RPP-RPT-58339, Revision 0, *Phase 2 RCRA Facility Investigation for Waste Management Area C* identifies:

> "Specifically, five sites were identified in the original work plan and SAP for organic analysis, three locations associated with UPR-200-E-81 (Site P) and two locations associated with Tank C-103 (Site L). Additional sites sampled for the full suites of organic constituents include Sites E, F, G, H, I, R, and U. Analytical results obtained from a total of 14 soil investigation locations (including the five at Sites L and P) were evaluated to determine whether to optimize the investigation at the remaining sites.
>
> Tributyl phosphate, the selected indicator for the potential occurrence of organic contamination associated with tank waste, was not identified in any of the samples. A letter (Letter 11-TPD-020, "Organic Analyses Optimization for Waste Management Area [WMA] C") from DOE was sent on March 29, 2011 to Ecology requesting the removal of the following from WMA C sample analysis:
>
> - VOCs
> - Ethylene glycol
> - Monobutyl and dibutyl phosphate

- Polychloride biphenyl (PCB) congeners
- Gasoline range organics (GRO)
- Diesel range organics (DRO).

In addition, the SST closure DQO (RPP-23403) was modified to remove sulfide as a constituent associated with tank waste; therefore, discontinuing analysis for sulfide was also requested. Analysis of samples for PCB aroclors, pesticides, and SVOCs would continue without change.

An approval letter (11-NWP-053, "Re: Organic Analyses Optimization for Waste Management Area [WMA] C" from Ecology was received on June 1, 2011, confirming the removal of VOCs, ethylene glycol, monobutyl and dibutyl phosphates, PCB congeners, GRO, DRO, and sulfide from the analyte list for WMA C Phase 2 samples. This letter acknowledged the changes were implemented for the slant push at WMA C Tank C-104 (Site J [C8100]). Soil samples for (Site J [C8100], Site A [C8102], Site B [C8104], and Site C [C8106]) were analyzed for a reduced suite of organic analytes, focusing on constituents of highest concern. In effect, samples collected under Revision 2A of the SAP were analyzed with the changes set forth in letter 11-NWP-053 implemented."

For WMA C - as identified in Letter 11-TPD-020 (Attachment 1): "Tributyl phosphate, the selected indicator organic for the occurrence of any organic contamination associated with the tank waste, was not identified in any of the samples. ..While organic constituents were detected in a number of samples, many are associated with common laboratory contaminants or corresponding detection in the blanks." Ecology's response (11-NWP-053, Attachment 2) identified: "We agree with the recommended changes for organic analyses..." and also identified: "We further strongly encourage that all parties begin to discuss area of further optimization."

It is recommended that highlighting in Table 6 be removed as it does not present a clear picture is considered a constituent of potential concern (COPC) in WMA C. Additionally, DOE would like to recommend a similar approach to evaluating the collection of organics to what was performed at WMA C and recommend areas to conduct this evaluation should be discussed.

Additionally, we agree that there is surficial contamination in WMA A-AX as evident by spectral gamma logs. This was also the case in WMA C; however, no organics were identified as a COPC. It has also been identified that soil temperatures in WMA A-AX have been elevated due to the self-boiling tanks in the farm.

Action: Highlighting in Table 6 will be removed. Instead of being identified as "Eliminate" in Table 6, VOAs will be identified as "Special Study". Ecology, DOE-ORP, and WRPS will continue discussions on where to perform a study and what VOCs to analyze. This item will be identified in Appendix A as an Open Item. Tributyl phosphate and bis(2-ethylhexyl)phthalate will be identified in Table 6 as "Retain". These constituents will be added to Table 8 and analysis will be performed on WMA A-AX samples and those samples collected from the focus area around Tanks A-104 and A-105.

d. <u>Dioxins and Furans</u>

Beth:

Email 8/17/17, 5:30 pm:

Well 299-E25-236 had detects for some dioxins and furans on 12/12/2012 (samples B2N336 and B2N3C6). This appears to be the only date when dioxins and furans were analyzed in groundwater

samples in this area. The lab code in the PO-1 data was TAKN, and the code for the sample owners was PNLGW. Unless a facility has been identified as a source for this, we request analysis of dioxins and furans in samples taken from the southern portion of A farm. We realize that this is not the current focus area for the RI, so there is time to look into any information that might be available to tie the dioxins and furans to a facility other than A farm. For now, we would like any DQO and SAP for A-AX to include these contaminants on the list of contaminants of potential concern for the southern portion of A farm.

DOE-RL: Dioxins and furans are included in the current WMA A/AX groundwater assessment plan (DOE/RL-2015-49, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area A-AX*) for the entire RCRA well network. Dioxin and furans are required under RCRA groundwater assessment under Appendix 5 of Ecology Publication No. 97-407, unless there is sufficient documentation for exclusion. Detections of dioxins and furans have been identified within the groundwater assessment samples, and the detection will be evaluated and addressed in the future groundwater assessment first determination report. The detection limits and cleanup values are extremely low and it is common to have detections in the field blanks and other data validation concerns.

DOE-ORP Response:
At this point, DOE-ORP recommends that dioxins and furans not be added to Table 8 until the investigation has been completed and there is further discussion of dioxin and furan analysis being performed in the southern portion of A Farm. An Open Action Item for this issue will be documented in the Appendix A of the DQO. Dioxins and furans will not be analyzed in the focus area around Tanks A-104 and A-105. DOE-RL will need to be involved with the discussion regarding the addition of these constituents, as the potential source would be within their operable unit.

Action: Further discussion will occur after the data is evaluated and documented. Appendix A will identify that dioxin and furan groundwater data are being evaluated and that this issue is an Open Action Item. Note that dioxins and furans will not be analyzed in the focus area around Tanks A-104 and A-105.

2. <u>DV-1</u>

Beth:
Email 8/21/17, 2:55 pm

2. VOCs were detected recently in the field at measureable quantities from a deep borehole during DV-1 drilling activities.

Joe C to Cindy, Email 8/17/17, 10:11 am
In that presentation (DV-1/EA-1 – Phil Burke), they talked about soil sampling, but nothing about results that I could see. Are any of those soil sampling results available yet? In particular, I'm interested in seeing results for dangerous waste, especially organics. Any documents released yet?

DOE-ORP Response: DV-1 has been contacted for information.

Action: Provide information from DV-1 when it becomes available.

3. Other Focus Areas

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.

Action: Will be identified in Appendix A as an Open Item.

4. Boundary

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.
2017-08-07-09	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.	Open.

Action: Will be identified in Appendix A as an Open Item.

5. GPR

2017-05-25-01	Tabor	Evaluate borehole placement/configuration after getting updated GPR results.	Open. On hold until conduct GPR study.

Action: Will be identified in Appendix A as an Open Item.

6. WMA A-AX decision rule and performance criteria

2017-08-07-05	Tabor	Provide Ecology WMA Phase 2 language regarding use of 95% UCL.	In progress/Open

Beth
Email 8/9/17, 2:09 pm (8/8/17, 4:00 pm)
Damon pointed that the highlighted text below should read "greater than or equal to two contaminants". Hopefully it will not be difficult to make that modification.

I've had a chance to check the revised Decision Rule 1 and the first bullet for Step 6 outputs. I request that they be reworded to the following:
Decision Rule 1: "For judgmental sampling, IF the maximum detected concentrations for individual constituents exceed acceptable levels identified in Tables 8, 9, or 10, OR the contaminant contributes

1% or greater to a sample hazard index of > 1 or cancer risk of > 1E-05, THEN the contaminant will be retained for further evaluation ~~will be performed during~~ in the RFI/CMS."

First bullet under Step 6 outputs:
"Quality control acceptance criteria for each constituent is identified in Tables 8, 9 and 10. Additionally, the criteria for sample hazard index and sample total cancer risk for samples with greater than two contaminants are 1 and 1E-05, respectively. For judgmental sampling, the maximum detected concentrations will initially be used for comparison to acceptable levels to identify constituents of potential concern."

I had to add in the hazard index and total cancer risk limits because these are promulgated criteria in WAC 173-340 (section -708 and other sections).
The specification of judgmental sampling is necessary because it is an instance in which the use of a 95% UCL is hard to defend. When statistical sampling is done, we require a 95% UCL.
In general, because of this, I don't recommend judgmental sampling. I realize the rest of the team has chosen this approach. Therefore, the wording has to specify the type of sampling so that we are not in violation of WAC 173-340-740(7)(d).

DOE-ORP Response:
DOE-ORP has asked for DOE-RL to provide input on this issue as they provide integration oversight on risk assessment processes. Discussion with Ecology on this matter will need to continue to ensure that standardized language is developed which will meet regulatory requirements. It is anticipated that the language that is developed will be used in similar SST vadose zone DQOs. Note that WMA C Phase 2 DQO language referenced 95% UCL in a decision rule. At this point, DOE-ORP recommends that the below decision rule be included in the WMA A-AX DQO and that an Open Action Item for this issue be documented in the Appendix A of the DQO.

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.

Action: WMA A-AX DQO will use the above decision rule, and Appendix A will identify that this decision rule is under discussion (Open Action Item).

7. Groundwater Information

2017-08-07-01	Tabor	Develop draft DQO summary report text about where groundwater info will be provided to share with DOE then Ecology.	In progress.

DOE-ORP Response:
The following text will be included in Section 1 of the DQO
"Although the groundwater beneath WMA A-AX will not be investigated under the WMA A-AX DQO process, information about the groundwater will be needed to fully understand the nature and extent of contamination associated with WMA A-AX. The groundwater potentially impacted by WMA A-AX is being investigated under the Hanford Site 200-PO-1 and 200-BP-5 Operable Units. It is anticipated that information from the remedial investigation report(s) associated with these groundwater operable units will be incorporated into the WMA A-AX RCRA Facility Investigation (RFI) Report in a manner similar to how groundwater information about the groundwater beneath WMA C was incorporated into the WMA C Phase 2 RFI Report.

It is DOE's intent to provide a brief summary in the WMA A-AX RFI Report about groundwater monitoring results for constituents of interest. For each constituent of interest, groundwater-related information will be provided: 1) if the constituent is a groundwater COPC and 2) if upgradient sources are believed to have contributed to contamination in the groundwater under WMA A-AX. Depictions of groundwater plumes will be provided in the WMA A-AX RFI Report along with general information on the wells in the WMA A-AX area (e.g., construction diagrams, screen intervals). Additionally, information about impacts to groundwater from contamination in the vadose zone will be provided."

Action: The above text will be added to Section 1 of the WMA A-AX DQO.

Attachment 1

INCOMING CORRESPONDENCE COVERSHEET

Author	Addressee	Correspondence No.
T. W. Fletcher/ORP	J. J. Lyon/DOEC	11-TPD-020

Subject: ORGANIC ANALYSES OPTIMIZATION FOR WASTE MANAGEMENT AREA (WMA) C

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Assignee:	**None**
Received:	March 23, 2011
Due Date:	**None**

U.S. Department of Energy
Office of River Protection
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

11-TPD-020

MAR 2 3 2011

Mr. Jeffrey Lyon
Tank Waste Storage Project Manager
Nuclear Waste Program
State of Washington
Department of Ecology
3100 Port of Benton Blvd
Richland, Washington 99352

Dear Mr. Lyon:

ORGANIC ANALYSES OPTIMIZATION FOR WASTE MANAGEMENT AREA (WMA) C

References:
1. *Phase 2 RCRA Facility Investigation/Corrective Measures Study Work Plan for Waste Management Area C*, RPP-PLAN-39114, Revision 1," dated March 29, 2010.
2. *Sampling and Analysis Plan for Phase 2 Characterization of Vadose Zone Soil in Waste Management Area C*, RPP-PLAN-3877, Revision 2, dated October 06, 2010.

The U.S. Department of Energy, Office of River Protection (ORP) is performing soil sampling and analysis in WMA C to support a Phase 2 RCRA Facility Investigation Report. In accordance with Section 3.5.2 of RPP-PLAN-39114, Rev. 1A (Reference 1) and Section 4.1.1 of RPP-PLAN-38777, Rev. 2 (Reference 2), the suite of organic analytes has been reviewed and optimization is warranted. Five sites were identified in RPP-PLAN-39114 for organic analysis, three locations associated with Unplanned Release (UPR) 81 (Site P) and two locations associated with Single Shell Tank (SST) C-103 (Site L). Additional sites sampled for the full suites of organic constituents also include Sites E, F, G, H, I, R and U. Tributyl phosphate, the selected indicator organic for the occurrence of any organic contamination associated with tank waste, was not identified in any of the samples.

While organic constituents were detected in a number of samples, many are associated with common laboratory contaminants or corresponding detections in the blanks. Available organic data was presented at the monthly WMA C meeting in October 2010 and at the January 2011 Performance Assessment meeting. Additional data was provided to the State of Washington Department of Ecology on February 9, 2011. Based on review of this data and the process defined in the work plan, the list of analytical constituents for WMA C should be optimized to focus on the constituents of highest concern.

In particular, technetium-99 and cyanide have been targeted for improved detection limits, quality control, and further investigations, as required. Additionally, the optimization of organics will make sample volume available to perform the remaining constituents with full quality control and allow for re-analyses, where necessary.

It is proposed that the organic analyses be optimized by eliminating the following methods for the remainder of the WMA C sampling activities:

- Volatile organics (VOC)
- Ethylene glycol
- Monobutyl and dibutyl phosphate
- PCB congeners
- Gasoline range organics (GRO)
- Diesel range organics (DRO)

It is also suggested that the following organics continue to be analyzed in WMA C:

- Semi-volatile organics (SVOC), including tributyl phosphate
- PCB Aroclors
- Pesticides

In addition to the organic constituents discussed above, it is recommended that sulfide be omitted from the list of chemicals of potential concern. The single-shell tank closure data quality objectives was modified to remove sulfide as a constituent associated with tank waste; therefore, sampling for sulfide in WMA C soils should also be discontinued.

It is recommended these changes be made effective for the fiscal year 2011 sampling activities in WMA C. If you agree with these recommended changes to the work plan (RPP-PLAN-39114 and sampling and analyses plan, please respond with your concurrence within 30 days of this request.

If you have further questions, please contact me or your staff may contact Mr. Robert W. Lober, Tank Farm Programs and Projects Division at (509) 373-7949.

Sincerely,

Thomas W. Fletcher, Acting Assistant Manager
Tank Farms Project

TPD:RWL

cc: See Distribution List (Page 3)

cc:
Administrative Record
Environmental Portal
WRPS Correspondence

Attachment 2

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
3100 Port of Benton Blvd • Richland, WA 99354 • (509) 372-7950
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

June 1, 2011 11-NWP-053

Mr. Robert Lober
Office of River Protection
United States Department of Energy
P.O. Box 450, MSIN: H6-60
Richland, Washington 99352

Re: Organic Analyses Optimization for Waste Management Area (WMA) C

Dear Mr. Lober:

This letter is in response to your letter regarding organic analyses optimization for WMA C. We strongly agree with the need to optimize and focus on the constituents of highest concern. The State of Washington Environmental Accreditation Department conducted an on-site visit to ATL 222-S Laboratory on April 13 and 14, 2011. A member of my staff accompanied this visit. The team was favorably impressed with the analytical and technical capability of the laboratory team, responsiveness of the staff, attention to detail, and focus on quality control issues. The team made a number of recommendations to the laboratory that can be utilized in achieving this optimization.

My staff has reviewed the analytical data, associated quality control, and supporting documentation. We agree with your proposal to eliminate sampling and analyses for the six methods defined in your letter, elimination of sulfide as an analyte, and retention of the three methods. We authorize you to implement these directions immediately and acknowledge that these requirements were used for the slant push at WMA tank C-104. We further strongly encourage that all parties begin to discuss areas of further optimization. These areas include:

- The inorganic and organic analyte list
- A greater utilization and reliance on electronic records
- A review of the data requirements and needs for this project

We feel that in evaluating the data needs, we can reduce the time and effort necessary to produce the data package that will support the requirements of M-045-81. We agree with the recommended changes for organic analyses and their incorporation into the work plan (RPP-PLAN-39114) and the sampling and analyses plan (RPP-PLAN-38777). We would like to begin discussions as soon as possible.

If you have any further questions or clarifications, please contact me at 509-372-7914.

Sincerely,

Jeffery J. Lyon
Tank Waste Storage Project Manager
Nuclear Waste Program

mb/dbm
cc: see next page

Reference: Letter 11-TPD-020, dated March 23, 2011, from T. W. Fletcher, USDOE-ORP, to Jeffrey Lyon, Ecology, *Organic Analyses Optimization for Waste Management Area (WMA) C*

cc: Dennis Faulk, EPA
Stuart Harris, CTUIR
Gabriel Bohnee, NPT
Russell Jim, YN
Susan Leckband, HAB
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Handout #2
Data Quality Objectives Process Summary

WMA A-AX DATA QUALITY OBJECTIVES (DQO) PROCESS SUMMARY

Revised Hand Out

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.

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, risk-informed retrieval process, 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, risk-informed retrieval process, 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, risk-informed retrieval process, 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, risk-informed retrieval process, 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, risk-informed retrieval process, 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, risk-informed retrieval process, 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 needed on (1) naturally occurring vadose zone soil constituents that could potentially be altered by contact with tank waste and (2) tank waste constituents that may remain in soil at detectable levels after the bulk of the waste has passed through portions of the soil. These data could provide information about where tank waste may have passed through portions of the soil.

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 portions of the WMA A-AX vadose zone soil?	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 those portions of the soil. 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 those portions of the soil.
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 and Physical properties (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?	• Technical evaluation: Physical properties (e.g., bulk density, pH, and 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?	• Technical Evaluation: Leaching characteristics of tank waste based on batch and column leaching tests • Technical Evaluation: Sequential extraction to estimate the labile fraction (readily leachable fraction) of constituents • Technical Evaluation: Mineral phase identification within the tank waste residuals • Technical Evaluation: 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 portions of the WMA A-AX vadose zone soil?	Fate and transport inputs: • Technical Evaluation: Mineralogical changes due to waste-sediment interaction and mineral phase identification • Chemical and Radiological - Pore water and sediment tests (sequential extraction such as water extraction, bicarbonate extraction, acetic acid extraction, oxalic acid extraction, and total digestion) • Technical Evaluation: 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.

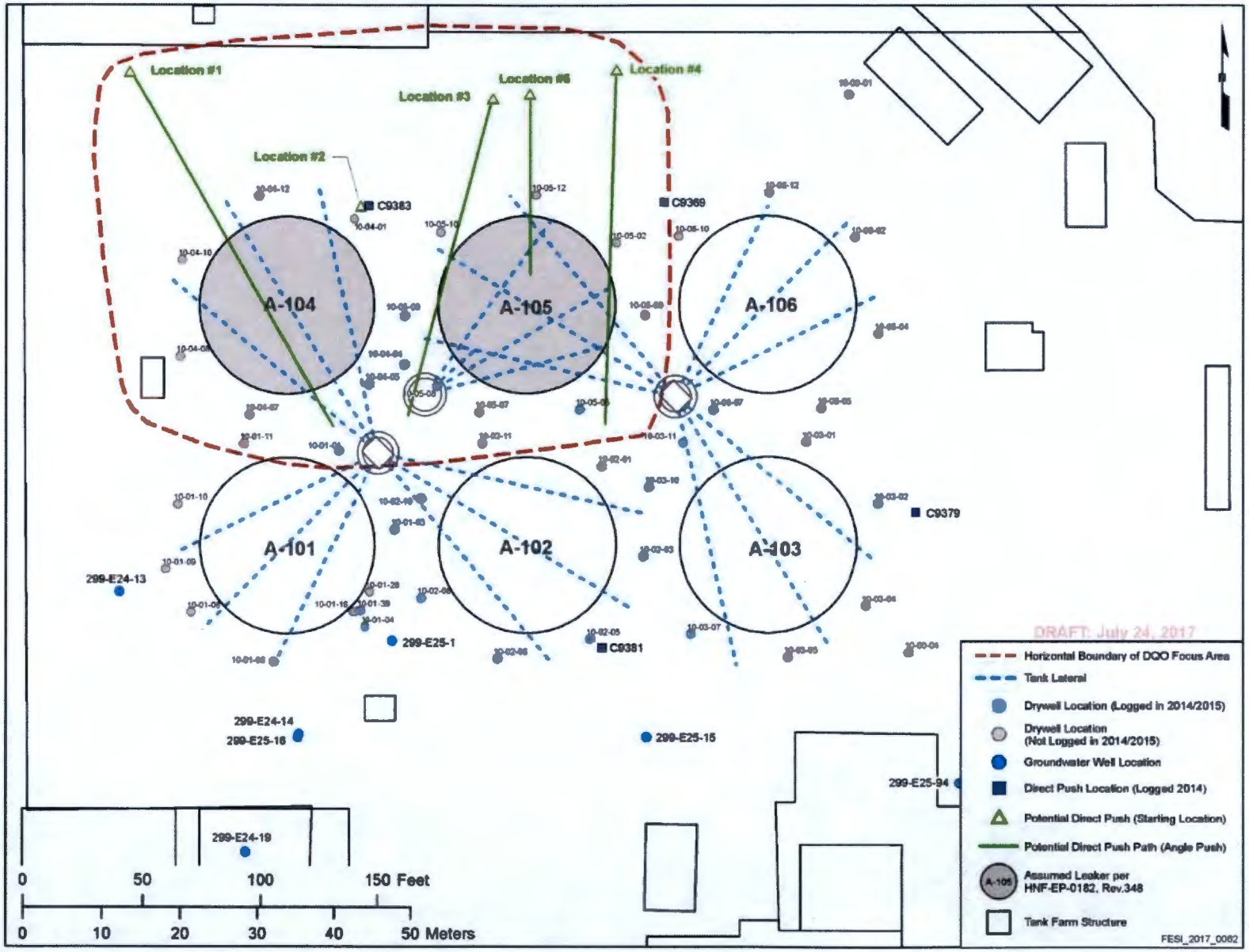
Smallest decision unit

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[1]		
	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 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 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 portions of the WMA A-AX vadose zone soil?	**#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 those portions of the soil. 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 those portions of the soil.	**#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 portions of the soil. **#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 portions of the soil.

[1] Data types to address PSQs are identified in Table 4. Data collected to address PSQ #1 will also be used to address PSQs #2, #3, and #4.

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**[1] 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**[1] 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-105 (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**[1] 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*
[1] Angle is defined as degrees from vertical (i.e., 90 degrees minus dip).			

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. Pesticides and PCBs are not associated with tank waste generation and storage; however, the samples will provide initial data for direct contact or ecological risk. Direct exposure and ecological risk-based levels (RBL) are only applicable in the top 15 ft of soil. Therefore, samples will only be collected in the near-surface zone (i.e., in the top 15 ft).
- 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 three 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). Documentation has been reviewed and it is thought that these drywell can be logged; however, they will be evaluated during the field investigation to determine if they can be logged (e.g., via field and/or camera inspection).

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 #3
Data Quality Objectives Process Summary Tables 9 and 10

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
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
Radium-226	13982-63-3	—	58.3	0.82	Gamma energy analysis (direct)	—	0.2	80-120	75-125	≤30
Selenium-79	15758-45-9	5.68E+04	—	—	Liquid scintillation (acid)	—	10	—	—	≤30
Strontium-90	10098-97-2	1190	91	0.18	Beta GPC	—	0.18[g,h]	80-120	75-125	≤30
Tin-126	15832-50-5	—	—	—	ICP/MS (acid)	—	400	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
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	13968-55-3	—	—	—	ICP/MS (acid)	—	0.174	—	—	≤30
Uranium-234	13966-29-5	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, "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-life, 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	—	0.2	80-120	75-125	≤30
Selenium-79	15758-45-9	3.20E+06	—	—	Liquid scintillation (acid)	—	10	—	NA	≤30
Strontium-90	10098-97-2	1.21E+05	91	0.18	Beta GPC	—	0.18[g,h]	80-120	75-125	≤30
Tin-126	15832-50-5	—	—	—	ICP/MS (acid)	—	400	80-120	75-125	≤30
Technetium-99	14133-76-7	5.80E+06	5,360	—	ICP/MS (acid)	Liquid scintillation (acid)	1	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
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	13968-55-3	—	—	—	ICP/MS (acid)	—	0.174	—	—	≤30
Uranium-234	13966-29-5	5.51E+04	6,370	1.1	ICP/MS (acid)	—	3.75E-02	—	—	≤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, "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