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# TRI-PARTY AGREEMENT

| Change Notice Number TPA-CN- 0748 | TPA CHANGE NOTICE FORM | Date: September 15, 2016 |
|---|---|---|
| Document Number, Title, and Revision: DOE/RL-2011-104, Rev. 0, Characterization Sampling and Analysis Plan for the 200-DV-1 Operable Unit | | Date Document Last Issued: January 2012 |
| Approved Change Notices Against this Document: TPA-CN-668, TPA-CN-724 | | |
| Originator: Mark Byrnes | | Phone: 509 373-3996 |

**Description of Change:**
This change notice for DOE/RL-2011-104 clarifies sample storage times and hold times as they apply to continuous sonic core sampling as well as correcting references within the document.

Michael Cline (DOE) and Dib Goswami/Rod Lobos (Ecology/EPA) agree that the proposed change modifies an approved workplan/document and will be processed in accordance with the Tri-Party Agreement Action Plan, Section 9.0, *Documentation and Records,* and not Chapter 12.0, *Changes to the Agreement*.

Changes include:

- Defining the sample storage times and hold times for continuous sonic core sampling in Section 3.2.5.
- Adding note "e" to Table 3-21 regarding sample storage times and hold times for continuous sonic core sampling.
- The reference to the COPC table in Section 2.1.4.8 needs to be revised to reference Table 1-2 versus Table 2-1.
- Table 3-2 needs to be revised to reference Table 1-2 versus Tables 2-1, 2-2, and 2-3. This global change affects Tables 3-3 through 3-18 and all associated Sample Location and Frequency descriptions in Section 3-1.

All deletions are indicated by ~~strikeout~~ and new text is indicated by double underline.
Copies of the pages affected by the changes are attached.

Note: Include affected page number(s): 2-6, 3-3, 3-6, 3-7, 3-10, 3-11, 3-14, 3-15, 3-18, 3-20, 3-22, 3-25, 3-27, 3-30, 3-31, 3-34, 3-35, 3-38, 3-39, 3-42, 3-43, 3-46, 3-47, 3-50, 3-51, 3-54, 3-55, 3-58, 3-59, 3-62, 3-63, 3-66, 3-67, 3-70, 3-76, and 3-77

**Justification and Impacts of Change:**

The original SAP (DOE-RL-2011-104) was written to support the use of hydraulic push technology to advance the boreholes and collect the required soil samples. When hydraulic push technology was not able to reach the required sampling depths, it was replaced by Becker-Hammer drilling followed by sonic drilling. Due to operational constraints of performing continuous core sampling during sonic drilling, the following changes to this SAP will be implemented:

Section 3.2.5, page 3-76, will now include text that states "The holding time clock will begin for the continuous core sampling when the laboratory opens the Lexan© sleeve to perform the lithology description and determine the sample collection intervals." Table 3-21, page 3-76, will have the following note "e". For continuous sonic core sampling, the holding time clock will begin when the laboratory opens the Lexan© sleeve to perform the lithology description and determine the sample collection intervals. While refrigeration of the sealed and intact soil cores contained within the Lexan© sleeve (capped at both ends) will prevent the loss of (or degradation of) the chemical analytes, the administrative goal will be to open the Lexan© sleeves within 120 days of the time the sleeves were capped at the drill site. However, some complicating factors (e.g., moderate to high radiation levels being encountered during drilling, boreholes needing to be re-drilled when total depth is not reached on first attempt, etc.) may require a small portion of the samples to be stored for up to 12 months in refrigeration/freezer units."

The project team determined that refrigeration/freezing of the sealed and intact soil cores contained within the Lexan© sleeve (capped at both ends) will prevent the loss of, or degradation of, the chemical analytes. No impacts to the analysis of the analytes are anticipated as a result of this change.

This approach is within the guidelines of DOE/RL-96-68, Rev. 4, *Hanford Analytical Services Quality Assurance Requirements Document Volume 2,* Section 4.4.73; the recommended guidance found in SW-846, Update V Revision 5, July 2014, *Test Methods for Evaluating Solid Waste, Physical/Chemical Method,* Sections 2.1, 3.3.4, and 4.1.2; EPA/600/R-05/124, *Sample Holding Time Reevaluation.*

Supporting information on hold times from SW-846 and EPA/600/R-05/124 is provided in the attachment.

**Approvals:**

| | | |
|---|---|---|
| DOE Project Manager | Date 10/12/16 | [X] Approved [ ] Disapproved |
| EPA Project Manager | Date 10/12/16 | [X] Approved [ ] Disapproved |
| Ecology Project Manager | Date 10/11/16 | [X] Approved [ ] Disapproved |

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#### *2.1.4.4 Comparability*

Comparability expresses the confidence with which one data set can be compared to another. Data comparability will be maintained by using standard procedures, uniform methods, and consistent units.

#### *2.1.4.5 Completeness*

Tables 2-1 and 2-2 identify the sample analytes, field parameters, and analytical performance requirements for samples collected under the scope of this SAP. The analytical data set will be considered 100 percent complete if all target analytes are reported for all samples identified for collection with no rejected data.

#### *2.1.4.6 Sensitivity*

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest. A measure of sensitivity is the detection limit.

#### *2.1.4.7 Method-Based Analysis*

All analyses being performed for total constituent determinations for COPCs against the requirements in Tables 2-1 and 2-2 will include a method-based analysis design. The laboratory will be directed to report all results for all constituents determined through multi-constituent analysis (e.g., IC, ICP, GEA, GC/MS) regardless of whether the reported constituents are designated COPCs. The analytical performance requirements will be applicable only to the COPCs. Poor QC related to non-COPC results would not result in any required corrective action by the laboratory except for the application of proper result qualification flags.

#### *2.1.4.8 Analytical Priority*

All of the COPCs listed in Table ~~2-1~~ 1-2 have been identified in Table 2-3 as either high priority, medium priority, or low priority. All of the COPCs will be analyzed in samples collected above 4.6 m (15 ft) depth. For samples collected below 4.6 m (15 ft) depth, the COPCs to be analyzed will be based on the available sample volume according to the highest to lowest priorities as defined in Table 2-3, if sample volume is insufficient to analyze for the entire list of COPCs. High-priority COPCs are critical for supporting waste site decisions and are required to be analyzed. Medium-priority COPCs are important for supporting waste site decisions and attempts will be made to collect at least every other planned sample. Low-priority COPCs are not critical for supporting waste site decisions and will be analyzed only if sufficient sample volumes are collected.

### 2.1.5 Special Training and Certification

A graded approach is used to ensure that workers receive a level of training commensurate with responsibilities and that complies with applicable DOE orders and government regulations. A job task analysis process is used to determine the type and level of training that personnel need to complete job tasks. The Field Team Lead, in coordination with line management, will ensure special training requirements for field personnel are met.

## 3.1 Sample Location and Frequency

This section provides the site-specific FSPs for individual waste sites in the 200-DV-1 OU. The approximate locations of planned and existing boreholes described in these FSPs are shown on figures for individual waste sites. The actual locations will be determined based on a field walkdown of current site conditions and ground penetrating radar surveys, as required, to avoid Hanford Site National Historic restrictions, roads, and other obstructions.

### 3.1.1 B Complex Area

Vadose zone characterization will be conducted at the following 200-DV-1 OU waste sites/groups in the B Complex Area: 216-B-7A&B Cribs; 216-B-8 Crib and Tile Field and 200-E-45 Health Instruments Shaft; 216-B-9 Crib and Tile Field; BX Trenches; and BY Cribs.

#### *3.1.1.1 216-B-7A&B Cribs*

The characterization planned for the 216-B-7A&B Cribs includes using DPT to push a drive point to refusal, attempting to reach at least to the CCU, and collecting samples using this same drive point. The location of the drive point is shown on Figure 3-1. The characterization location northeast of the 216-B-7A Crib (the direction that vadose zone strata dip) was selected to confirm the conceptual model that the vadose zone between approximately 15.2 m (50 ft) below ground surface (bgs) and the CCU is relatively uncontaminated, as shown by the existing data from the 216-B-7A Crib (DOE/RL-2002-42). Based on geophysical logging, the thickest zone of cesium-137 contamination is east of the 216-B-7A Crib at well 299-E33-58 (GJO-2002-343-TAR, *Hanford 200 Areas Spectral Gamma Baseline Characterization Report, 216-B-8 Crib and Adjacent Sites Waste Summary Report*).

The sampling intervals for the 216-B-7A&B Cribs were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. Samples will be collected at the base of the trench and at changes in lithology, as depicted on Figure 3-2. The samples will be analyzed for the COPCs presented in Tables ~~2-1, 2-2, and 2-3~~ 1-2, as indicated in the 216-B-7A&B Cribs Sampling Plan (Table 3-2).

Table 3-2. 216-B-7A&B Cribs Sampling Plan

<table>
<tr><th rowspan="2">Sample Collection Methodology</th><th rowspan="2">Sample Location</th><th rowspan="2">Maximum Depth of Investigation</th><th rowspan="2">Sample Interval Depth (ft bgs)[a,d]</th><th rowspan="2">Analyte List</th><th colspan="2">Physical Properties</th></tr>
<tr><th>Sample Interval</th><th>Parameters</th></tr>
<tr><td>Direct push with sample barrel samples.</td><td>One direct push northeast of 216-B-7A.</td><td>Refusal, attempt to reach and sample the Cold Creek unit.</td><td>Sample barrel samples at depths:<br>14 – 16 ft bgs<br>22 – 24 ft bgs<br>36 – 38 ft bgs<br>100 – 102 ft bgs<br>163 – 165 ft bgs<br>216 – 218 ft bgs<br>224 – 226 ft bgs<br>235 – 237 ft bgs<br>Approximate depths only.</td><td>Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2.</td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="4">Approximate number of sample barrel samples</td><td colspan="3">8</td></tr>
<tr><td colspan="4">Approximate number of field quality-control samples[b]</td><td colspan="3">2</td></tr>
<tr><td colspan="4">Approximate number of physical-property samples</td><td colspan="3">0</td></tr>
<tr><td colspan="4">Approximate total number of soil samples collected</td><td colspan="3">10</td></tr>
<tr><td colspan="4">Approximate total number of soil samples analyzed[c]</td><td colspan="3">10</td></tr>
<tr><th colspan="4">Non-Sample Data Collection</th><th colspan="3">Maximum Depth of Investigation</th></tr>
<tr><td colspan="4">Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination.</td><td colspan="3">Surface to TD in new borehole (approximately 240 ft bgs).</td></tr>
</table>

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank (if possible and plausible).

c. Number of samples analyzed includes eight sample barrel samples, two field quality-control samples, and zero physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

N/A = not applicable

TD = total depth

#### *3.1.1.2 216-B-8 Crib and Tile Field and 200-E-45 Health Instrument Shaft*

The characterization planned for the 216-B-8 Crib and Tile Field and the 200-E-45 Health Instrument (HI) Shaft includes using DPT to push a drive point to refusal, attempting to reach the CCU, and collecting samples using this same drive point. The location of the drive point is shown on Figure 3-3. The location between the 216-B-8 Crib and the 200-E-45 HI Shaft was selected to focus the characterization on the zone of expected highest contamination and to address contaminant release from both waste sites.

The sampling intervals were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. The samples also will provide information on possible contamination released from the HI Shaft as a result of pump tests conducted following the 216-B-8 Crib operation (Section 2.1). Samples will be collected at depths corresponding to the bases of the two waste sites and at changes in lithology, as depicted on Figure 3-4. The samples will be analyzed for the COPCs presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2, as indicated in the 216-B-8 Crib and Tile FSP (Table 3-3).

Table 3-3. 216-B-8 Crib and Tile Field Sampling Plan

<table>
<tr><th rowspan="2">Sample Collection Methodology</th><th rowspan="2">Sample Location</th><th rowspan="2">Maximum Depth of Investigation</th><th rowspan="2">Sample Interval Depth (ft bgs)[a,d]</th><th rowspan="2">Analyte List</th><th colspan="2">Physical Properties</th></tr>
<tr><th>Sample Interval</th><th>Parameters</th></tr>
<tr><td>Direct push with sample barrel samples.</td><td>One direct push between 216-B-8 Crib and 200-E-45 HI Shaft.</td><td>Refusal, attempt to reach and sample the Cold Creek unit.</td><td>Sample barrel sample at depths:<br>4 – 6 ft bgs<br>23 – 25 ft bgs<br>34 – 36 ft bgs<br>49 – 51 ft bgs<br>144 – 146 ft bgs<br>206 – 208 ft bgs<br>Approximate depths only.</td><td>Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2.</td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="4">Approximate number of sample barrel samples</td><td colspan="3">6</td></tr>
<tr><td colspan="4">Approximate number of field quality-control samples[b]</td><td colspan="3">2</td></tr>
<tr><td colspan="4">Approximate number of physical-property samples</td><td colspan="3">0</td></tr>
<tr><td colspan="4">Approximate total number of soil samples collected</td><td colspan="3">8</td></tr>
<tr><td colspan="4">Approximate total number of soil samples analyzed[c]</td><td colspan="3">8</td></tr>
<tr><th colspan="4">Non-Sample Data Collection</th><th colspan="3">Maximum Depth of Investigation</th></tr>
<tr><td colspan="4">Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination.</td><td colspan="3">Surface to TD in new borehole (approximately 210 ft bgs).</td></tr>
</table>

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank (if possible and plausible).

c. Number of samples analyzed includes six sample barrel samples, two field quality-control samples, and zero physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

N/A = not applicable

TD = total depth

#### *3.1.1.3 216-B-9 Crib and Tile Field*

The characterization planned for the 216-B-9 Crib and Tile Field includes using DPT to push two drive points to refusal, attempting to reach the CCU and collecting samples using these same drive points. The locations of the drive points are shown on Figure 3-5. The locations were selected to focus the characterization on the zones of expected deepest contamination and to address contaminant release from both the crib and the tile field. The deepest contamination recognized on any of the scintillation probe profiles was 43 m (141 ft) bgs at well 299-E28-57 (GJO-2002-358-TAC, *Hanford 200 Area Spectral Gamma Baseline Characterization Project, 216-B-5 Injection Well and 216-B-9 Crib and Tile Field Waste Site Summary Report*, page 32). However, waste liquids may have migrated deeper than 45.7 m (150 ft) if corroded well 299-E28-53 provided a preferential pathway.

The sampling intervals were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment and in the deep vadose zone that may be a source to groundwater. Samples will be collected at depths corresponding to the bases of the crib and tile field, and at changes in lithology, as depicted on Figure 3-6. The samples will be analyzed for the COPCs presented in Tables 2-1, 2-2, and 2-3 1-2, as indicated in the 216-B-9 Crib and Tile FSP (Table 3-4).

Table 3-4. 216-B-9 Crib and Tile Field Sampling Plan

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a,d] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Two direct pushes with sample barrel samples. | One direct push near well 299-E28-57 and one near well 299-E28-53; the location for sampling will be based on geophysical logging. | Refusal, attempt to reach and sample the Cold Creek unit. | Sample barrel at depth:<br>13 – 15 ft bgs<br>52 – 54 ft bgs<br>100 – 102 ft bgs<br>160 – 162 ft bgs<br>214 – 216 ft bgs<br>243 – 245 ft bgs<br>248 – 250 ft bgs<br>Approximate depths only. | Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2. | N/A | N/A |
| Approximate number of sample barrel samples | | | | 14 | | |
| Approximate number of field quality-control samples[b] | | | | 4 | | |
| Approximate number of physical-property samples | | | | 0 | | |
| Approximate total number of soil samples collected | | | | 18 | | |
| Approximate total number of soil samples analyzed[c] | | | | 18 | | |
| **Non-Sample Data Collection** | | | | **Maximum Depth of Investigation** | | |
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | | | | Surface to TD in each new borehole (approximately 250 ft bgs). | | |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank (if possible and plausible).

c. Number of samples analyzed includes fourteen sample barrel samples, four field quality-control samples, and zero physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

N/A = not applicable

TD = total depth

#### *3.1.1.4 BX Trenches (216-B-37 Trench and 216-B-42 Trench)*

The characterization planned for the 216-B-37 Trench includes using DPT to push a drive point to refusal, attempting to reach the CCU, and collecting samples using this same drive point. The location of the drive point is shown on Figure 3-7. The 216-B-37 Trench was selected for characterization because it received the largest disposal volume of all the BX Trenches. The location at the east end of the 216-B-37 Trench was selected to focus the characterization on the zone of expected highest and deepest contamination, based on the results of the previous characterization at the 216-B-38 Trench (DOE/RL-2002-42).

The sampling intervals for the 216-B-37 Trench were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. Samples will be collected at the base of the trench and at changes in lithology, as depicted on Figure 3-8. The samples will be analyzed for the COPCs presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2, as indicated in the 216-B-37 Trench Sampling Plan (Table 3-5).

The characterization planned for the 216-B-42 Trench includes drilling a borehole to groundwater, and collecting samples and geophysical logs using this same borehole. The location of the borehole is shown on Figure 3-7. The 216-B-42 Trench was selected for characterization because it received a higher inventory of technetium-99 than the other BX Trenches. Drilling will ensure that the vertical extent of the technetium-99 contamination in the subsurface at this location is characterized. The location at the east end of the 216-B-42 Trench was selected to focus the characterization on the zone of expected highest contamination, based on the results of the previous characterization at the 216-B-38 Trench (DOE/RL-2002-42). The drilling and logging efforts are planned to reduce the uncertainty associated with the differences in waste streams between the 216-B-42 Trench and the other BX Trenches located within geographical proximity.

The sampling intervals for the 216-B-42 Trench were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. Split-spoon samples will be collected at the base of the trench and at changes in lithology, as depicted on Figure 3-9. The split-spoon samples will be analyzed for analytes presented in Table~~s~~ 2-1, 2-2, and 2-31, as indicated in the 216-B-42 Trench Sampling Plan (Table 3-6). Grab samples will be collected at 3.0 m (10 ft) intervals throughout the borehole, starting at 10.7 m (35 ft) bgs. Selected grab samples may be analyzed for mobile COPCs as determined by the field geologist and technical lead, using characterization data such as geophysical logs, lithology (geologist logs), and split-spoon sample analytical results, consistent with the field sampling strategy (Section 3.2.3). Groundwater samples or other opportunistic samples may be collected if requested to support integration with other Central Plateau activities.

Table 3-5. 216-B-37 Trench Sampling Plan

<table>
<tr><th rowspan="2">Sample Collection Methodology</th><th rowspan="2">Sample Location</th><th rowspan="2">Maximum Depth of Investigation</th><th rowspan="2">Sample Interval Depth (ft bgs)[a,d]</th><th rowspan="2">Analyte List</th><th colspan="2">Physical Properties</th></tr>
<tr><th>Sample Interval</th><th>Parameters</th></tr>
<tr><td>Direct push with sample barrel samples.</td><td>One direct push at eastern end of 216-B-37 Trench.</td><td>Refusal, attempt to reach and sample the Cold Creek unit.</td><td>Sample barrel sample at depths:<br>13 – 15 ft bgs<br>42 – 44 ft bgs<br>98 – 100 ft bgs<br>149 – 151 ft bgs<br>206 – 208 ft bgs<br>220 – 222 ft bgs<br>Approximate depths only.</td><td>Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2.</td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="4">Approximate number of sample barrel samples</td><td colspan="3">6</td></tr>
<tr><td colspan="4">Approximate number of field quality-control samples[b]</td><td colspan="3">2</td></tr>
<tr><td colspan="4">Approximate number of physical-property samples</td><td colspan="3">0</td></tr>
<tr><td colspan="4">Approximate total number of soil samples collected</td><td colspan="3">8</td></tr>
<tr><td colspan="4">Approximate total number of soil samples analyzed[c]</td><td colspan="3">8</td></tr>
<tr><th colspan="4">Non-Sample Data Collection</th><th colspan="3">Maximum Depth of Investigation</th></tr>
<tr><td colspan="4">Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination.</td><td colspan="3">Surface to TD in new borehole (approximately 225 ft bgs).</td></tr>
</table>

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank (if possible and plausible).

c. Number of samples analyzed includes six sample barrel samples, two field quality-control samples, and zero physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

N/A = not applicable

TD = total depth

Table 3-6. 216-B-42 Trench Sampling Plan

| **Sample Collection Methodology** | **Sample Location** | **Maximum Depth of Investigation** | **Sample Interval Depth (ft bgs)[a,d]** | **Analyte List** | **Physical Properties** | |
|---|---|---|---|---|---|---|
| | | | | | **Sample Interval** | **Parameters** |
| Borehole to groundwater with split-spoon samples. | One deep borehole near eastern end of trench. | To groundwater (approximately 275 ft bgs). | Split-spoon sample at depths:<br>10 – 12 ft bgs<br>18 – 20 ft bgs<br>24 – 26 ft bgs<br>55 – 57 ft bgs<br>67 – 69 ft bgs<br>98 – 100 ft bgs<br>168 – 170 ft bgs<br>186 – 188 ft bgs<br>230 – 232 ft bgs<br>272 – 274 ft bgs<br>Approximate depths only.<br>Grab samples at 10 ft intervals throughout borehole, starting at 35 ft bgs. | Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2. | One sample at each change in lithology or fine-grained intervals (same as split-spoon sample intervals, between 15-200 ft bgs), as indicated on Figure 3-9. | pH,<br>bulk density,<br>moisture,<br>particle size distribution. |
| Approximate number of split-spoon samples | | | | | 10 | |
| Approximate number of field quality-control samples[b] | | | | | 2 | |
| Approximate number of physical-property samples | | | | | 7 | |
| Approximate number of grab samples | | | | | 24 | |
| Approximate total number of soil samples collected | | | | | 43 | |
| Approximate total number of soil samples analyzed[c] | | | | | 19 | |
| **Non-Sample Data Collection** | | | | | **Maximum Depth of Investigation** | |
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | | | | | Surface to TD in new borehole (approximately 275 ft bgs). | |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank.

c. Number of samples analyzed includes ten split-spoon samples, two field quality-control samples, and seven physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

TD = total depth

on Figure 3-11. The samples at the northeast corner of the 216-B-46 Crib and in the center of the BY Cribs will be analyzed for analytes presented in Tables 2-1, 2-2, and 2-3, as indicated in the BY Cribs Sampling Plan A (Table 3-7A). The samples to the northeast and northwest of the BY Cribs will be analyzed for the COPCs presented in Tables 2-1, 2-2, and 2-3 1-2, as indicated in the BY Cribs Sampling Plan B (Table 3-7B).

Surface geophysical exploration data were collected at the BY Cribs in 2007 (RPP-34690, *Surface Geophysical Exploration of the B, BX, and BY Tank Farm at the Hanford Site*). The existing data will be evaluated during Phase I to determine if application of recent advances in geophysical data interpretation, using the existing data set, would significantly refine the CSM of the lateral distribution of mobile contaminants. If not, a new surface geophysical survey may be conducted using the deep electrodes that will be installed at the four Phase I drive point locations.

Following completion of the Phase I characterization, the results will be evaluated and the preliminary conceptual model will be updated. DOE-RL and Ecology will then concur on the need for and scope of any Phase II target characterization activities.

Table 3-7A. BY Cribs Sampling Plan A

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a,d] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Two direct pushes with sample barrel samples. | One direct push at the northeast corner of the 216-B-46 Crib and one between the 216-B-45 and 216-B-49 Cribs (locations 1 and 3 on Figure 3-10). | Refusal, attempt to reach and sample the Cold Creek unit. | Sample barrel at depths:<br>8 – 10 ft bgs<br>18 – 20 ft bgs<br>42 – 44 ft bgs<br>64 – 66 ft bgs<br>84 – 86 ft bgs<br>110 – 112 ft bgs<br>130 – 132 ft bgs<br>157 – 159 ft bgs<br>188 – 190 ft bgs<br>195 – 197 ft bgs<br>Approximate depths only; actual sample depths will be based on geophysical logging. | Analytes for shallowest three sample intervals are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2.<br>Analytes for deepest seven sample intervals are mobile contaminants technetium-99, uranium, nitrate, and cyanide. | N/A | N/A |
| Approximate number of sample barrel samples | | | | 20 | | |
| Approximate number of field quality-control samples[b] | | | | 4 | | |
| Approximate number of physical-property samples | | | | 0 | | |
| Approximate total number of soil samples collected | | | | 24 | | |
| Approximate total number of soil samples analyzed[c] | | | | 24 | | |
| **Non-Sample Data Collection** | | | | **Maximum Depth of Investigation** | | |
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | | | | Surface to TD in each new borehole (approximately 200 ft bgs). | | |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank (if possible and plausible).

c. Number of samples analyzed includes twenty sample barrel samples, four field quality-control samples, and zero physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

N/A = not applicable

TD = total depth

### 3.1.2 T Complex Area

Vadose zone characterization will be conducted at the following 200-DV-1 OU waste sites/groups in the T Complex Area: 216-T-3 Reverse Well; 216-T-5 Trench; 216-T-6 Cribs; 216-T-7 Tile Field; T Trenches; 216-T-18 Crib; 216-T-19 Crib and Tile Field; and TX Trenches.

#### *3.1.2.1 216-T-3 Injection/Reverse Well*

The characterization planned for the 216-T-3 Injection/Reverse Well includes drilling a borehole to groundwater and collecting samples and geophysical logs using this same borehole. The location of the borehole is shown on Figure 3-12. The location was selected to be as close as possible to the 216-T-3 Reverse Well to focus on the waste released from this injection/reverse well. Drilling will ensure that the vertical extent of contamination in the subsurface at this location is characterized.

The sampling intervals for the 216-T-3 Reverse Well were selected to reduce the uncertainty associated with the nature and extent of contamination in the deep vadose zone that may be a source to groundwater. The sample intervals also were selected to evaluate (1) the extent of contamination released through the perforations in the well (from 32.3 m [106 ft] bgs to total depth (TD) of 62.8 m [206 ft] bgs), (2) whether shallow waste migrated from another source, and (3) whether possible leaks to the vadose zone occurred at casing changes. Because the perforations in the 216-T-3 Reverse Well begin at 31.85 m (104.5 ft) bgs, contamination release from the 216-T-3 waste site is unlikely in the upper 4.6 m (15 ft) of the subsurface and no samples are planned for the shallow vadose zone.

Samples will be collected at the top and bottom of the perforated zone in the well and at changes in lithology, as depicted on Figure 3-13. The split-spoon samples will be analyzed for the COPCs presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2, as indicated in the 216-T-3 Reverse Well Sampling Plan (Table 3-8). Selected grab samples may be analyzed for mobile COPCs as determined by the field geologist and technical lead using characterization data such as geophysical logs, lithology (geologist logs), and split-spoon sample analytical results, consistent with the field sampling strategy (Section 3.2.3). Groundwater samples or other opportunistic samples may be collected if requested to support integration with other Central Plateau activities.

Table 3-8. 216-T-3 Injection/Reverse Well Sampling Plan

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a,d] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Borehole to groundwater with split-spoon samples. | One borehole adjacent to the 216-T-3 Well. | To groundwater (approximately 274 ft bgs). | Split-spoon sample at depths:<br>19 – 21 ft bgs<br>60 – 62 ft bgs<br>106 – 108 ft bgs<br>115 – 117 ft bgs<br>120 – 122 ft bgs<br>138 – 140 ft bgs<br>170 – 172 ft bgs<br>200 – 202 ft bgs<br>228 – 230 ft bgs<br>250 – 252 ft bgs<br>Approximate depths only.<br>Grab samples at 10 ft intervals throughout borehole. | Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2. | One sample at each change in lithology within the 216-T-3 perforated zone (between 98 and 206 ft bgs), as shown on Figure 3-13. | pH,<br>bulk density,<br>moisture,<br>particle size distribution. |

| | |
|---|---|
| Approximate number of split-spoon samples | 10 |
| Approximate number of field quality-control samples[b] | 2 |
| Approximate number of physical-property samples | 6 |
| Approximate number of grab samples | 27 |
| Approximate total number of soil samples collected | 45 |
| Approximate total number of soil samples analyzed[c] | 18 |

| Non-Sample Data Collection | Maximum Depth of Investigation |
|---|---|
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | Surface to TD in new borehole (approximately 275 ft bgs). |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank.

c. Number of samples analyzed includes ten split-spoon samples, two field quality-control samples, and six physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

TD = total depth

#### *3.1.2.2 216-T-5 Trench*

The characterization planned for the 216-T-5 Trench includes using DPT to push three drive points to refusal, attempting to reach the CCU, with geophysical logging of two of the drive points and sample collection at the third (twin) drive point. The locations of the drive points are shown on Figure 3-14. The locations were selected to characterize both ends of the trench to reduce uncertainty regarding the location of the discharge point. The third drive point will twin the logged drive point at the northeastern location and will be sampled because shallow boreholes drilled there in 1985 encountered contamination.

The sampling intervals were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. Samples will be collected at the depth corresponding to the base of the trench and at changes in lithology, as depicted on Figure 3-15. The samples will be analyzed for the COPCs presented in Tables 2-1, 2-2, and 2-3 1-2, as indicated in the 216-T-5 Trench Sampling Plan (Table 3-9).

Table 3-9. 216-T-5 Trench Sampling Plan

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a,d] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Three direct pushes, one (twin) with sample barrel samples. | One near northeastern edge of the 216-T-5 Trench and one in southern portion; northeastern location will be sampled. | Refusal, attempt to reach and sample the Cold Creek unit. | Sample barrel sample at depths:<br>13 – 15 ft bgs<br>37 – 39 ft bgs<br>39 – 41 ft bgs<br>59 – 61 ft bgs<br>76 – 78 ft bgs<br>93 – 95 ft bgs<br>Approximate depths only; actual sample depths will be based on geophysical logging. | Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2. | N/A | N/A |

| | |
|---|---|
| Approximate number of sample barrel samples | 6 |
| Approximate number of field quality-control samples[b] | 1 |
| Approximate number of physical-property samples | 0 |
| Approximate total number of soil samples collected | 7 |
| Approximate total number of soil samples analyzed[c] | 7 |
| **Non-Sample Data Collection** | **Maximum Depth of Investigation** |
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | Surface to TD in each new borehole (approximately 100 ft bgs). |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank (if possible and plausible).

c. Number of samples analyzed includes six sample barrel samples, one field quality-control sample, and zero physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

N/A = not applicable

TD = total depth

#### *3.1.2.3 216-T-6 Cribs*

The characterization planned for the 216-T-6 Cribs includes using DPT to push three drive points to refusal, attempting to reach the CCU, with geophysical logging at two of the drive points and sample collection at the third (twin) drive point. The locations of the drive points are shown on Figure 3-16. The locations were selected to address contaminant release from both cribs. The twin drive point east of the eastern crib (crib #1) will be sampled because the liquid wastes were discharged to the eastern crib, which was designed to overflow to the western crib (crib #2).

The sampling intervals were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. Samples will be collected at the depth corresponding to the base of the crib and at changes in lithology, as depicted on Figure 3-17. The samples will be analyzed for the COPCs presented in Tables 2-1, 2-2, and 2-3 1-2, as indicated in the 216-T-6 Cribs Sampling Plan (Table 3-10).

Table 3-10. 216-T-6 Cribs Sampling Plan

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a,d] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Three direct pushes, one (twin) with sample barrel samples. | One east of the eastern 216-T-6 Crib (crib #1) and one east of the western 216-T-6 crib (crib #2); the location east of the eastern 216-T-6 Crib (crib #1) will be sampled.<br>The direct push locations will be as close as feasible to the crib but outside of the crib footprint.[e] | Refusal, attempt to reach and sample the Cold Creek unit. | Sample barrel sample at depths:<br>8 – 10 ft bgs<br>22 – 24 ft bgs<br>38 – 40 ft bgs<br>45 – 47 ft bgs<br>78 – 80 ft bgs<br>101 – 103 ft bgs<br>103 – 105 ft bgs<br>Approximate depths only; actual sample depths will be based on geophysical logging. | Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2. | N/A | N/A |
| Approximate number of sample barrel samples | | | | 7 | | |
| Approximate number of field quality-control samples[b] | | | | 2 | | |
| Approximate number of physical-property samples | | | | 0 | | |
| Approximate total number of soil samples collected | | | | 9 | | |
| Approximate total number of soil samples analyzed[c] | | | | 9 | | |
| **Non-Sample Data Collection** | | | | **Maximum Depth of Investigation** | | |
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | | | | Surface to TD in each new borehole (approximately 105 ft bgs). | | |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank (if possible and plausible).

c. Number of samples analyzed includes seven sample barrel samples, two field quality-control samples, and zero physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

e. The crib was constructed using wooden timbers and presents a cave-in potential. For safety purposes, the borehole will be outside of the wood construction footprint.

bgs = below ground surface

N/A = not applicable

TD = total depth

#### *3.1.2.4 200-W-52 Crib and 216-T-7 Tile Field*

The characterization planned for the 216-T-7 Tile Field includes drilling a borehole to groundwater and collecting samples and geophysical logs using this same borehole. The location of the borehole is shown on Figure 3-18. The location of the borehole was selected to be near the central distribution pipe and as close to the influent end of the tile field as possible without entering WMA T. Drilling will ensure that the vertical extent of contamination in the subsurface at this location is characterized.

The sampling intervals for the 216-T-7 Tile Field were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. Samples will be collected at the base of the tile field and at changes in lithology, as depicted on Figure 3-19. The split-spoon samples will be analyzed for the COPCs presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2, as indicated in the 216-T-7 Tile FSP (Table 3-11). Selected grab samples may be analyzed for mobile COPCs as determined by the field geologist and technical lead, using characterization data such as geophysical logs, lithology (geologist logs), and split-spoon sample analytical results, consistent with the field sampling strategy (Section 3.2.3). Groundwater samples or other opportunistic samples may be collected if requested to support integration with other Central Plateau activities.

Waste from the 216-T-32 Crib appears to have migrated southwest and to have commingled with waste discharged to the 200-W-52 Crib and 216-T-7 Tile Field. The 200-W-52 Crib and 216-T-7 Tile Field received a larger volume of waste and inventory of contaminants than the 216-T-32 Crib. Although geophysical logging of the existing boreholes has been completed at the 216-T-32 Crib and shows no contamination below the CCU, soil samples for chemical analysis have not been collected. The analytical data from the new borehole drilled to groundwater at the 216-T-7 Tile Field will be evaluated to identify the potential need for a borehole with soil samples at the 216-T-32 Crib. Based on this evaluation, and pending the opportunity to cost effectively access the 216-T-32 Crib within the T Tank Farm fence, a characterization borehole at the 216-T-32 Crib will be considered by the Tri-Parties.

Table 3-11. 216-T-7 Tile Field Sampling Plan

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a,d] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Borehole to groundwater with split-spoon samples. | One deep borehole near eastern end of tile field (immediately west of the tank farm fence). | To groundwater (approximately 225 ft bgs). | Split-spoon sample at depths:<br>13 – 15 ft bgs<br>25 – 27 ft bgs<br>39 – 41 ft bgs<br>48 – 50 ft bgs<br>78 – 80 ft bgs<br>85 – 87 ft bgs<br>97 – 99 ft bgs<br>112 – 114 ft bgs<br>119 – 121 ft bgs<br>128 – 130 ft bgs<br>221 – 223 ft bgs<br>Approximate depths only.<br>Grab samples at 10 ft intervals throughout borehole. | Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2. | One sample at each change in lithology or other fine-grained intervals (same as split-spoon sample intervals between 45 and 130 ft bgs), as shown on Figure 3-19. | pH, bulk density, moisture, particle size distribution. |

| | |
|---|---|
| Approximate number of split-spoon samples | 11 |
| Approximate number of field quality-control samples[b] | 2 |
| Approximate number of physical-property samples | 7 |
| Approximate number of grab samples | 22 |
| Approximate total number of soil samples collected | 42 |
| Approximate total number of soil samples analyzed[c] | 20 |
| **Non-Sample Data Collection** | **Maximum Depth of Investigation** |
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | Surface to TD in new borehole (approximately 225 ft bgs). |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank.

c. Number of samples analyzed includes eleven split-spoon samples, two field quality-control samples, and seven physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

TD = total depth

#### *3.1.2.5 T Trenches (216-T-14 Trench and 216-T-15 Trench)*

The characterization planned for the 216-T-14 Trench and the 216-T-15 Trench includes using DPT to push four drive points to refusal, attempting to reach the CCU, with geophysical logging of three drive points and sample collection at the fourth (twin) drive point. The locations of the drive points are shown on Figure 3-20. Among the four T Trenches, the 216-T-15 Trench received the largest volume of waste liquid and the largest inventory of contaminants. The 216-T-14 Trench received the highest pore volume because it has a shorter length than the other three trenches. It is likely that the discharge points for the trenches were at their southern ends. Drive point locations were selected at both the southern and northern ends of the centerline of the 216-T-15 Trench to reduce uncertainty regarding the location of the discharge point. The twin drive point at the southern end of the 216-T-15 Trench will be sampled because it is most likely to be at the location where the highest volume and largest inventory was discharged.

The sampling intervals were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. Samples will be collected at the depth corresponding to the base of the trench and at changes in lithology, as depicted on Figure 3-21. The samples will be analyzed for the COPCs presented in Tabl~~es 2-1, 2-2, and 2-3~~ 1-2, as indicated in the 216-T-15 Trench Sampling Plan (Table 3-12).

Table 3-12. 216-T-14 Trench and 216-T-15 Trench Sampling Plan

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a,d] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Four direct pushes, one (twin) with sample barrel samples. | One near southern end of the 216-T-15 Trench, one near northern end of the 216-T-15 Trench, and one near the southern end of the 216-T-14 Trench; the southern 216-T-15 Trench location will be sampled. | Refusal, attempt to reach and sample the Cold Creek unit. | Sample barrel sample at depths:<br>8 – 10 ft bgs<br>34 – 36 ft bgs<br>71 – 73 ft bgs<br>98 – 100 ft bgs<br>103 – 105 ft bgs<br>Approximate depths only; actual sample depths will be based on geophysical logging. | Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2. | N/A | N/A |
| Approximate number of sample barrel samples | | | | 5 | | |
| Approximate number of field quality-control samples[b] | | | | 1 | | |
| Approximate number of physical-property samples | | | | 0 | | |
| Approximate total number of soil samples collected | | | | 6 | | |
| Approximate total number of soil samples analyzed[c] | | | | 6 | | |
| **Non-Sample Data Collection** | | | | **Maximum Depth of Investigation** | | |
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | | | | Surface to TD in each new borehole (approximately 105 ft bgs). | | |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank (if possible and plausible).

c. Number of samples analyzed includes five sample barrel samples, one field quality-control sample, and zero physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

N/A = not applicable

TD = total depth

#### *3.1.2.6 216-T-18 Crib*

The characterization planned for the 216-T-18 Crib includes using DPT to push one drive point to refusal, attempting to reach at least to 30.5 m (100 ft) bgs. The location of the drive point is shown on Figure 3-22. The drive point location was selected near the center of the 216-T-18 Crib, based on the historical description of the waste site location near well 299-W11-11 (HW-31442, *Removal of Cesium from Uranium Recovery Process Wastes*, p. 28).

In 2008, three drive points were installed at the 216-T-18 Crib and logged in accordance with DOE/RL-2007-02 (C6410, C6411, and C6412 in Figure 3-22). The results of the geophysical logging at the three push boreholes is summarized in the geophysical log data report (HGLP-LDR-309, *Geophysical Investigation Report Small Diameter Logging Results 200-TW-1 Operable Unit Site Characterization*). The logging was performed in these small diameter direct-push boreholes using the small diameter logging systems (SDLS), which are configured to operate inside steel casing with a minimum inner diameter of 4.4 cm (1.75 in.). Bismuth germanate, neutron moisture, and passive neutron logs were run in all three boreholes in the 216-T-18 Crib. Using the SDLS, the detection level for plutonium is at or near 100 nCi/g. There were no apparent detections of plutonium in any of the boreholes. Because of the relatively high detection level for plutonium using the SDLS in the small diameter boreholes, an additional drive point will be pushed at this waste site and sampled for laboratory analyses.

The sampling intervals were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. Samples will be collected at the depth corresponding to the base of the trench and at changes in lithology, as depicted in Figure 3-23. The samples will be analyzed for the COPCs presented in Table 1-2, as indicated in the 216-T-18 Crib Sampling Plan (Table 3-13).

Table 3-13. 216-T-18 Crib Sampling Plan

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a,d] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Direct push with sample barrel samples. | One direct push in center of 216-T-18 Crib. | Refusal, attempt to reach 100 ft bgs. | Sample barrel at depths:<br>13 – 15 ft bgs<br>28 – 30 ft bgs<br>60 – 62 ft bgs<br>70 – 72 ft bgs<br>85 – 87 ft bgs<br>98 – 100 ft bgs<br>Approximate depths only. | Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2. | N/A | N/A |

| | |
|---|---|
| Approximate number of sample barrel samples | 6 |
| Approximate number of field quality-control samples[b] | 2 |
| Approximate number of physical-property samples | 0 |
| Approximate total number of soil samples collected | 8 |
| Approximate total number of soil samples analyzed[c] | 8 |
| **Non-Sample Data Collection** | **Maximum Depth of Investigation** |
| N/A | Surface to TD in new borehole (approximately 100 ft bgs). |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank (if possible and plausible).

c. Number of samples analyzed includes six sample barrel samples, two field quality-control samples, and zero physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

N/A = not applicable

TD = total depth

#### *3.1.2.7 216-T-19 Crib and Tile Field*

The characterization planned for the 216-T-19 Crib and Tile Field includes drilling a borehole to groundwater and collecting samples and geophysical logs using this same borehole. Figure 3-24 shows the location of the borehole. The location was selected at the point of discharge to the tile field, near the overflow from the crib, where the highest volume of waste was disposed. Drilling will ensure that the vertical extent of contamination in the subsurface at this location is characterized.

The sampling intervals for the 216-T-19 Crib and Tile Field were selected to reduce the uncertainty associated with the nature and extent of contamination in the deep vadose zone that may be a source to groundwater. Because waste entered the 216-T-19 Crib and Tile Field at approximately 7.0 m (23 ft) bgs, contamination is not anticipated for the upper 4.6 m (15 ft) bgs of the vadose zone and no samples are planned for this interval. Samples will be collected at the bottom of the tile field and at changes in lithology, as depicted on Figure 3-25. The split-spoon samples will be analyzed for the COPCs presented in Tables 2-1, 2-2, and 2-3 1-2, as indicated in the 216-T-19 Crib and Tile FSP (Table 3-14). Selected grab samples may be analyzed for mobile COPCs as determined by the field geologist and technical lead, using characterization data such as geophysical logs, lithology (geologist logs), and split-spoon sample analytical results, consistent with the field sampling strategy (Section 3.2.3). Groundwater samples or other opportunistic samples may be collected if requested to support integration with other Central Plateau activities.

Table 3-14. 216-T-19 Crib and Tile Field Sampling Plan

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a,d] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Borehole to groundwater with split-spoon samples. | One deep borehole near connection between crib and tile field. | To groundwater (approximately 229 ft). | Split-spoon sample at depths:<br>27 – 29 ft bgs<br>39 – 41 ft bgs<br>42 – 44 ft bgs<br>58 – 60 ft bgs<br>92 – 94 ft bgs<br>99 – 101 ft bgs<br>118 – 120 ft bgs<br>168 – 170 ft bgs<br>216 – 218 ft bgs<br>Approximate depths only.<br>Grab samples at 10 ft intervals throughout borehole. | Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2. | One sample at each change in lithology or fine-grained interval (same as split-spoon sample intervals between 35 - 200 ft bgs), as shown on Figure 3-25. | pH,<br>bulk density,<br>moisture,<br>particle size distribution. |

| | |
|---|---|
| Approximate number of split-spoon samples | 9 |
| Approximate number of field quality-control samples[b] | 2 |
| Approximate number of physical-property samples | 7 |
| Approximate number of grab samples | 23 |
| Approximate total number of soil samples collected | 41 |
| Approximate total number of soil samples analyzed[c] | 18 |
| **Non-Sample Data Collection** | **Maximum Depth of Investigation** |
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | Surface to TD in new borehole (approximately 230 ft bgs). |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank. Trip blanks will accompany samples collected for volatile organic analysis, as needed. Full trip blanks and field transfer blanks will accompany samples collected for volatile organic analysis, as needed.

c. Number of samples analyzed includes nine split-spoon samples, two field quality-control samples, and seven physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

TD = total depth

#### *3.1.2.8 TX Trenches (216-T-23 Trench and 216-T-25 Trench)*

The characterization planned for the TX Trenches includes using DPT to push three drive points to refusal, attempting to reach the CCU, with geophysical logging of two drive points and sample collection at the third drive point. The locations of the drive points are shown on Figure 3-26. One location will be at the eastern end of the 216-T-25 Trench. The basis for selecting this location is that among the five TX Trenches, the 216-T-25 Trench received the largest volume of waste liquid and the largest inventory of contaminants. It is likely that the discharge points for the trenches were at their eastern ends. The second location is at the eastern end of the 216-T-23 Trench. The basis for selecting this location is that geophysical logging suggests that the contamination is deepest at the 216-T-23 Trench. The drive point for collecting samples will be at the location of the deepest contamination, based on the geophysical logging of the first two drive points.

The sampling intervals were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. Samples will be collected at the depth corresponding to the base of the trench and at changes in lithology, as depicted on Figure 3-27. The samples will be analyzed for the COPCs presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2, as indicated in the 216-T-23 Trench and 216-T-25 Trench Sampling Plan (Table 3-15).

Table 3-15. 216-T-23 Trench and 216-T-25 Trench Sampling Plan

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a,d] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Three direct pushes, one with sample barrel samples. | One direct push at the eastern end of the 216-T-23 Trench and one at the eastern end of the 216-T-25 Trench, with geophysical logging at both; the location for sampling will be based on geophysical logging. | Refusal, attempt to reach and sample the Cold Creek unit. | Sample barrel at depths:<br>12 – 14 ft bgs<br>32 – 34 ft bgs<br>48 – 50 ft bgs<br>76 – 78 ft bgs<br>88 – 90 ft bgs<br>103 – 105 ft bgs<br>113 – 115 ft bgs<br>Approximate depths only; actual sample depths will be based on geophysical logging. | Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2. | N/A | N/A |

| | |
|---|---|
| Approximate number of sample barrel samples | 7 |
| Approximate number of field quality-control samples[b] | 2 |
| Approximate number of physical-property samples | 0 |
| Approximate total number of soil samples collected | 9 |
| Approximate total number of soil samples analyzed[c] | 9 |
| **Non-Sample Data Collection** | **Maximum Depth of Investigation** |
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | Surface to TD in each new borehole (approximately 115 ft bgs). |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank (if possible and plausible).

c. Number of samples analyzed includes seven sample barrel samples, two field quality-control samples, and zero physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

N/A = not applicable

TD = total depth

### 3.1.3 S Complex Area

Vadose zone characterization will be conducted at the following 200-DV-1 OU waste sites/groups in the S Complex Area: 216-S-9 Crib; 216-S-13 Crib; and 216-S-21 Crib.

#### *3.1.3.1 216-S-9 Crib*

The characterization planned for the 216-S-9 Crib includes using DPT to push one drive point to refusal, attempting to reach the CCU, with sample collection using the same drive point. The location of the drive point is shown on Figure 3-28. This location was selected to be near the influent (southern) end of the crib and near the leak of contaminated liquid waste discovered in 1969 at the junction of the pipelines to the 216-S-9 Crib (pipeline 200-W-139-PL) and the 216-S-23 Crib (pipeline 200-W-141-PL) (unplanned release UPR-200-W-108).

The sampling intervals were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. Samples will be collected at the depth corresponding to the base of the crib and at changes in lithology, as depicted on Figure 3-29. The samples will be analyzed for the COPCs presented in Tables 2-1, 2-2, and 2-3 1-2, as indicated in the 216-S-9 Crib Sampling Plan (Table 3-16).

Well 299-W22-95 is planned to be drilled at the northern end of the crib in support of groundwater remediation. Geophysical logging of this well will provide additional characterization for the 216-S-9 Crib.

Table 3-16. 216-S-9 Crib Sampling Plan

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a,d] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Direct push with sample barrel samples. | One direct push at southern end of 216-S-9 Crib. | Refusal, attempt to reach and sample the Cold Creek unit. | Sample barrel at depths:<br>13 – 15 ft bgs<br>28 – 30 ft bgs<br>60 – 62 ft bgs<br>80 – 82 ft bgs<br>99 – 101 ft bgs<br>118 – 120 ft bgs<br>132 – 134 ft bgs<br>Approximate depths only. | Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2. | N/A | N/A |
| Approximate number of sample barrel samples | | | | 7 | | |
| Approximate number of field quality-control samples[b] | | | | 2 | | |
| Approximate number of physical-property samples | | | | 0 | | |
| Approximate total number of soil samples collected | | | | 9 | | |
| Approximate total number of soil samples analyzed[c] | | | | 9 | | |
| **Non-Sample Data Collection** | | | | **Maximum Depth of Investigation** | | |
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | | | | Surface to TD in new borehole (approximately 140 ft bgs). | | |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank (if possible and plausible).

c. Number of samples analyzed includes seven sample barrel samples, two field quality-control samples, and zero physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

bgs = below ground surface

N/A = not applicable

TD = total depth

#### *3.1.3.2 216-S-13 Crib*

The characterization planned for the 216-S-13 Crib includes drilling a borehole to groundwater and collecting samples and geophysical logs using this same borehole. The location of the borehole is shown on Figure 3-30. The location was selected at the influent side of the crib to address the zone of expected highest contamination. Drilling will ensure that the vertical extent of contamination in the subsurface at this location is characterized.

The sampling intervals for the 216-S-13 Crib were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. The samples also are planned to reduce the uncertainty associated with differences in the chromium inventory between the current Soil Inventory Model (SIM) and historical estimates (e.g., DOE/RL-91-60, *S Plant Aggregate Area Management Study Report*). Samples will be collected at the bottom of the crib and at changes in lithology, as depicted on Figure 3-31. The split-spoon samples will be analyzed for the COPCs presented in Tables 2-1, 2-2, and 2-3 1-2, as indicated in the 216-S-13 Crib Sampling Plan (Table 3-17). Selected grab samples may be analyzed for mobile COPCs as determined by the field geologist and technical lead, using characterization data such as geophysical logs, lithology (geologist logs), and split-spoon sample analytical results, consistent with the field sampling strategy (Section 3.2.3). Groundwater samples or other opportunistic samples may be collected if requested to support integration with other Central Plateau activities.

Table 3-17. 216-S-13 Crib Sampling Plan

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a,d] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Borehole to groundwater with split-spoon samples. | One deep borehole as close as feasible to the crib, but outside of the crib footprint.[e] | To groundwater (approximately 245 ft). | Split-spoon sample at depths:<br>13 – 15 ft bgs<br>29 – 31 ft bgs<br>33 – 35 ft bgs<br>75 – 77 ft bgs<br>98 – 100 ft bgs<br>124 – 126 ft bgs<br>158 – 160 ft bgs<br>172 – 174 ft bgs<br>193 – 195ft bgs<br>217 – 219 ft bgs<br>243 – 245 ft bgs<br>Approximate depths only.<br>Grab samples at 10 ft intervals throughout borehole. | Analytes are presented in Tables~~ 2-1, 2-2, and 2-3~~ 1-2. | One sample at each change in lithology or fine-grained interval (same as split-spoon sample intervals below 32 ft bgs), as indicated in Figure 3-31. | pH,<br>bulk density,<br>moisture,<br>particle size distribution. |

| | |
|---|---|
| Approximate number of split-spoon samples | 11 |
| Approximate number of field quality-control samples[b] | 3 |
| Approximate number of physical-property samples | 6 |
| Approximate number of grab samples | 24 |
| Approximate total number of soil samples collected | 44 |
| Approximate total number of soil samples analyzed[c] | 20 |

| Non-Sample Data Collection | Maximum Depth of Investigation |
|---|---|
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | Surface to TD in new borehole (approximately 245 ft bgs). |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank. Full trip blanks and field transfer blanks will accompany samples collected for volatile organic analysis, as needed.

c. Number of samples analyzed includes eleven split-spoon samples, three field quality-control samples, and six physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

e. The crib was constructed using wooden timbers and presents a cave-in potential. For safety purposes, the borehole will be outside of the wood construction footprint.

bgs = below ground surface

TD = total depth

### *3.1.3.3 216-S-21 Crib*

The characterization planned for the 216-S-21 Crib includes using DPT to push one drive point to refusal, attempting to reach the CCU, with sample collection using the same drive point. The location of the drive point is shown on Figure 3-32. The location was selected at the influent side of the crib to address the zone of expected highest contamination.

The sampling intervals were selected to reduce the uncertainty associated with the nature and extent of contamination in the shallow vadose zone above 4.6 m (15 ft) bgs that may pose a risk to human health and the environment, and in the deep vadose zone that may be a source to groundwater. Samples will be collected at the depth corresponding to the base of the crib and at changes in lithology, as depicted on Figure 3-33. The samples will be analyzed for COPCs presented in Tables 2-1, 2-2, and 2-3 1-2, as indicated in the 216-S-21 Crib Sampling Plan (Table 3-18). The 13.1 to 13.7 m (43 to 45 ft) depth interval will address a zone of high moisture shown in a geophysical log from well 299-W23-63 in December 2006. The 25.9 to 26.8 m (85 to 88 ft) interval will address possible mobile contaminants present in a fine-grained, silt layer.

Table 3-18. 216-S-21 Crib Sampling Plan

| Sample Collection Methodology | Sample Location | Maximum Depth of Investigation | Sample Interval Depth (ft bgs)[a] | Analyte List | Physical Properties | |
|---|---|---|---|---|---|---|
| | | | | | Sample Interval | Parameters |
| Direct push with sample barrel samples. | One location as close as feasible to the crib but outside of the crib footprint.[e] | Refusal, attempt to reach and sample the Cold Creek unit. | Sample barrel at depths:<br>13 – 15 ft bgs<br>33 – 35 ft bgs<br>43 – 45 ft bgs<br>85 – 87 ft bgs<br>98 – 100 ft bgs<br>112 – 114 ft bgs<br>119 – 121 ft bgs<br>Approximate depths only. | Analytes are presented in Table~~s 2-1, 2-2, and 2-3~~ 1-2. | N/A | N/A |

| | |
|---|---|
| Approximate number of sample barrel samples | 7 |
| Approximate number of field quality-control samples[b] | 2 |
| Approximate number of physical-property samples | 0 |
| Approximate total number of soil samples collected | 9 |
| Approximate total number of soil samples analyzed[c] | 9 |
| **Non-Sample Data Collection** | **Maximum Depth of Investigation** |
| Downhole gamma-spectroscopy log and neutron moisture log. Passive neutron log may be collected on a case-by-case basis if gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. | Surface to TD in new borehole (approximately 125 ft bgs). |

a. Actual sampling depths may vary depending on the amount of backfill/overburden used in interim-stabilization activities at the waste site, field screening results, and varying subsurface conditions, consistent with the field sampling strategy (Section 3.2.3).

b. One duplicate, one split (optional), and one equipment blank (if possible and plausible).

c. Number of samples analyzed includes seven sample barrel samples, two field quality-control samples, and zero physical-property samples.

d. To convert feet to meters, multiply by 0.3048.

e. The crib was constructed using wooden timbers and presents a cave-in potential. For safety purposes, the borehole will be outside of the wood construction footprint.

bgs = below ground surface

N/A = not applicable

TD = total depth

### 3.2.4 Geophysical Logging

The drilled boreholes will be geophysically logged with the high-resolution, spectral gamma-ray logging system to determine the vertical distribution and concentration of gamma-emitting radionuclides. Soil moisture will be determined using a neutron logging tool. Passive neutron logs may be collected on a case-by-case basis if the gamma-spectroscopy log and/or process history indicates the likely presence of plutonium contamination. The boreholes will be logged before the casing is telescoped and before the borehole is decommissioned. The starting point for logging will be recorded; this is usually at the ground surface or the top of the casing. Boreholes will be decommissioned with DOE-RL and EPA approval, in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," after geophysical logging and all sampling are completed.

The direct-push boreholes will be geophysically logged using either a slim-hole spectral gamma-ray logging system or a gross gamma logging system. Soil moisture will be determined using a neutron logging tool. Passive neutron logs may be collected on a case-by-case basis if the gamma log and/or process history indicates the likely presence of plutonium contamination.

### 3.2.5 Sample Collection and Preservation

Sample collection under this SAP will be performed in accordance with site sampling procedures. Sample preservation, containers, and holding times are presented in Table 3-21. The holding time clock will begin for the continuous core sampling when the laboratory opens the Lexan© sleeve to perform the lithology description and determine the sample collection intervals.

Table 3-21. Sample Preservation, Container, and Holding-Time Guidelines

| Analytes* | Matrix | Bottle | | Amount[a,b] | | Preservation | Packing Requirements | Holding Time[d,e] |
|---|---|---|---|---|---|---|---|---|
| | | Number | Type | Minimum | Optimal | | | |
| **Radionuclides** | | | | | | | | |
| Americium-241 | Soil | 1 | G/P | 8 g | 20 g | None | None | 6 months |
| Cesium-137 | Soil | 1 | G/P | 60 g | 500 g | None | None | 6 months |
| Europium-154 | Soil | | | | | | | |
| Neptunium-237 | Soil | 1 | G/P | 8 g | 20 g | None | None | 6 months |
| Plutonium-239/240 | Soil | 1 | G/P | 8 g | 20 g | None | None | 6 months |
| Strontium-90 | Soil | 1 | G/P | 5 g | 10 g | None | None | 6 months |
| Technetium-99 | Soil | 1 | G/P | 18 g | 30 g | None | None | 6 months |
| Uranium-238 | Soil | 1 | G/P | 5 g | 10 g | None | None | 6 months |
| **Chemicals** | | | | | | | | |
| IC anions – EPA Method 300.0 | Soil | 1 | G/P | 30 g | 60 g | Cool 4°C | Cool 4°C | 28 days/ 48 hours[c] |
| Metals by ICP, ICP/MS | Soil | 1 | G/P | 10 g | 20 g | Cool 4°C | Cool 4°C | 6 months |

Table 3-21. Sample Preservation, Container, and Holding-Time Guidelines

| Analytes* | Matrix | Bottle | | Amount[a,b] | | Preservation | Packing Requirements | Holding Time[d,e] |
|---|---|---|---|---|---|---|---|---|
| | | Number | Type | Minimum | Optimal | | | |
| Hexavalent chromium – Method 7196 | Soil | 1 | aG | 60 g | 120 g | Cool 4°C | Cool 4°C | 30 days |
| Mercury – Method 7471 – (CVAA) | Soil | 1 | G | 2 g | 5 g | Cool 4°C ± 2°C | Cool 4°C | 28 days |
| Total cyanide – 9010 | Soil | 1 | G | 10 g | 20 g | Cool 4°C | Cool 4°C | 14 days |
| SVOA – Method 8270A | Soil | 1 | aG | 120 g | 250 g | Cool 4°C | Cool 4°C | 14/40 days[d] |
| VOA – low level – Method 5035A/8260 | Soil | 5 | aG | 5 g | | Freeze -7°C to -20°C | Freeze -7°C to -20°C | 14 days |
| VOA – high level – Method 5035A/8260 | Soil | 3 | aG | 5 g | | Cool 4°C | Cool 4°C | 14 days |

Notes:

*4-digit EPA methods are found in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, as amended. EPA Method 300.0 is found in EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*.

a. Optimal sample amounts, which may be adjusted downward to accommodate the possibility of retrieval of a small amount of sample. Minimum sample size includes material needed for laboratory batch QC.

b. Mixed soil samples (co-located subsamples that are homogenized to ensure that the minimum sample amount requirements are met) may be obtained and submitted to the analytical laboratory for analyses for specific analytes.

c. The EPA Method 300.0 nitrate, nitrite, and phosphate holding time is 48 hours after sample extraction preparation. The holding time of 28 days applies to all other anions quantified by EPA Method 300.0.

d. The first number shown is the number of days to extract and the second number is the number of days to analyze the extract.

e. For continuous sonic core sampling, the holding time clock will begin when the laboratory opens the Lexan© sleeve to perform the lithology description and determine the sample collection intervals. While refrigeration of the sealed and intact soil cores contained within the Lexan© sleeve (capped at both ends) will prevent the loss of (or degradation of) the chemical analytes, the administrative goal will be to open the Lexan© sleeves within 120 days of the time the sleeves were capped at the drill site. However, some complicating factors (e.g., moderate to high radiation levels being encountered during drilling, boreholes needing to be re-drilled when total depth is not reached on first attempt, etc.) may require a small portion of the samples to be stored up to 12 months in refrigeration/freezer units.

aG = amber glass

CVAA = cold vapor atomic absorption

EPA = U.S. Environmental Protection Agency

G = glass

IC = ion chromatography

ICP = inductively coupled plasma

ICP/MS = inductively coupled plasma/mass spectrometry

P = plastic

SVOA = semivolatile organic analyte

VOA = volatile organic analyte

# Attachment to TPA-CN-0748

This attachment provides excerpts from EPA's Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846, Hanford Analytical Services Quality Assurance Requirements Document Volumes 1 through 4 (HASQARD) and a white paper summarizing the applicability of EPA's Sample Holding Time Reevaluation, 2005 Report.

**CHAPTER TWO OF SW-846 - CHOOSING THE CORRECT PROCEDURE**

2.1 Guidance Regarding Flexibility Inherent to SW-846 Methods and the Precedence of SW-846 Quality Control Criteria

Section 2.1, 4th paragraph, 1st and 2nd sentence, page TWO-2
"The performance data included in the SW-846 methods are not intended to be used as absolute QC acceptance criteria for method performance. The data are intended to be guidance, by providing typical method performance in typical matrices, to assist the analyst in selection of the appropriate method for the intended application."

2.2.6 Sample preservation and holding times
Section 2.2.6, 1st paragraph, 1st sentence, page TWO-5
"Table 2-40 provides information regarding recommended sample preservation techniques, sample holding times, and other information."

Section 2.2.6, 1st paragraph, 6th sentence, page TWO-6
"However, regarding the information in Table 2-40, a longer holding time may be appropriate if it can be demonstrated that reported concentrations are not adversely affected from preservation, storage and analyses performed outside the recommended holding times."

**CHAPTER THREE OF SW-846 - INORGANIC ANALYTES**

3.3.4 Sample Handling and Preservation

Section 3.3.4, 1st paragraph, second sentence, Page THREE-6
"Sample holding times, recommended collection volumes or masses and recommended digestion volumes, and preservatives are listed in Table 3-2."
The table included the following information (Page THREE-19 and THREE-20) for; Metals except Hg and $Cr^{6+}$ solids a holding time of 6 months, Hexavalent chromium (solid matrix) a holding time of 30 days to extraction 7 days from extraction to analysis, for Mercury (solid matrix a holding time of 28 days, and for Cyanide (solid matrix) a holding time 14 days

The Holding Time column has this as a footnote: "A longer holding time may be appropriate if it can be demonstrated[1] that the reported analyte concentrations are not adversely affected by preservation, storage and analysis performed outside the recommended holding times."

**CHAPTER FOUR OF SW-846 CHAPTER - ORGANIC ANALYTES**

1st paragraph of Chapter, page FOUR-1
"Prior to employing the methods in this chapter, analysts are advised to consult the disclaimer statement at the front of this manual and the information in Chapter Two for guidance on the allowed flexibility in the choice of apparatus, reagents, and supplies. In addition, unless specified in a regulation, the use of SW846 methods is not mandatory in response to Federal testing requirements. The information contained in this chapter is provided by EPA as guidance to be used by the analyst and the regulated community in making judgments necessary to meet the data quality objectives (DQOs) or needs for the intended use of the data."

4.1.2 Sample Handling and Preservation: General Considerations

Section 4.1.2, 1st paragraph, 1st sentence, page FOUR-1
"The following sections deal separately with volatile organic chemicals (VOCs) and semivolatile organic chemicals (SVOCs). Refer to Chapter Two and Table 41 of this section for recommended sample containers, sample preservation, and holding time information"

Section 4.1.2, 2nd paragraph, 1st - 3rd sentences, page FOUR-1
"The preservation and holding time information presented in Table 4-1 does not represent EPA requirements, but rather is intended solely as guidance. Selection of preservation techniques and applicable holding times should be based on all available information, including the properties of the analytes of interest for the project, their anticipated concentration levels, the composition of the sample matrix itself, and the stated project specific DQOs. A shorter holding time may be appropriate if the analytes of interest are reactive (e.g., 2-chloroethyl vinyl ether, acrylamide) or the sample matrix is complex (e.g., wastewater)."

**DOE/RL-96-68, HASQARD VOLUMES 1 THROUGH 4**

Volume 1, Appendix A Glossary, page Vol.1: A-5 "Holding Time – Many analytes require adherence to holding time requirements. Regulatory holding time begins at sample collection. Some regulatory holding times include collection through final analysis; others segregate the time between collection through preparation, and preparation through analysis."

Volume 2, 4.4.7.3 Holding Times and Turn-Around Times, 4th bullet in section, page Vol. 2: 4-13
"• Recommended sample holding times guidelines are provided in Appendix A. These represent the maximum generally accepted lengths of time where, under the specified preservation conditions, significant loss of analytes, or degradation of analytes is not expected to occur. Unless there is reason to believe that unique circumstances could accelerate or delay the loss or degradation of analytes in a given set of samples, the holding times in Appendix A should not be deviated from. A project team may determine the applicability of holding times based on sampling and analysis constraints, data use, or other technical criteria. These determinations shall be documented in the applicable DQO document, SAP, or in project records.

Volume 2, 4.4.7.3 Holding Times and Turn-Around Times, 2nd paragraph, page Vol. 2: 4-13
"The consequences and impacts of missed holding times on data quality shall be taken into account in the sample collection planning process (Section 2.0), and actual missed holding times should be discussed or otherwise noted in the analytical data package or analytical report from the laboratory."

Volume 2, 4.4.8 Holding Times for Highly-Radioactive Samples, page Vol. 2: 4-13
"Short holding times (i.e., on the order of 24 hours to one to two weeks) required for some analyses may not be achievable for highly-radioactive samples because of the increased time required to handle high radiation samples with remote handlers in hot cells. The increased logistics required to survey, transport, and screen highly-radioactive samples before analysis may also contribute to missed holding times."

Note: CHPRC experienced this with borehole C9549 Cores 1 and 2.

**Sample Holding Time Reevaluation, EPA/600/R-05/124, October 2005**

3.1.4 Cr(VI) Holding Time for Extraction and Extract Stability – Conclusions, page 29 1st Paragraph
"The purpose of this study was to investigate if the extractable Cr(VI) concentration in soils/sediments was effected by the holding time prior to extraction according to SW-846 Method 3060A procedures. Of the six soils studied, five exhibited no or limited influence of holding time prior to extraction for the 224 days of this study regardless of the holding condition (4°C or -20°)."

Section 4 Conclusions
Page 95 2nd Paragraph
"The sixth Cr(VI) contaminated soil exhibited poor recovery (<5%) of the matrix spikes from the outset of the study."

PNNL personal communication, 2016: Thus, results of this sixth sample were determined to be impacted by other factors and it was reasonable to base the conclusions only on the other 5 samples.

Page 97 2nd Paragraph
"Extractable metal concentrations were not affected significantly by a holding time of up to 392 days or by air drying of the soils. Only one pooled data set exhibited a CV>20%, which is the current SW-846 precision metric for hot acid extraction of metals. However, CV>20% was found to be the result of one holding time data set that was well outside the Day 0 mean. The remaining data sets exhibited fairly tight CVs across time ranging from 5.6 to 15.8%. The CV data suggests that no chemically significant change in concentration occurred during the holding time sequence and the pooled data exhibited no clear cut difference between moist or dry sample handling."

**Project Team Conclusion**

CHPRC and PNNL drafted a "white paper" titled "Options for Hold Times As It Applies to 200-DV-1 Continuous-Core Soil Samples and Attenuation/Transport Study". The "white paper" was based on a review of the EPA guidance that suggested site specific hold times can be established if it can be demonstrated that sample degradation will not occur and the EPA Study of the hold-time effect for metals and redox –sensitive constituents. The review concluded that sample degradation is not expected for the 200-DV-1 samples during the storage and hold times established for the project.

**References**

DOE/RL-96-68**,** September 2014 *Hanford Analytical Services Quality Assurance Requirements Document Volumes 1 through 4*:

Volume 1: Administrative Requirements
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL1-04.pdf
Volume 2: Sampling and Technical Requirements
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL2-04.pdf
Volume 3: Field Analytical Technical Requirements
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL3-04.pdf
Volume 4: Laboratory Technical Requirements
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL4-04.pdf

EPA, October 2005, *Sample Holding Time Reevaluation*, EPA/600/R-05/124, Prepared by Battelle Memorial Institute, Pacific Northwest Division
http://nepis.epa.gov/Exe/ZyPDF.cgi/P10096LN.PDF?Dockey=P10096LN.PDF

EPA, July 2014, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, SW-846 Update V Revision 8. https://www.epa.gov/hw-sw846

White Paper *"Approach for Hold Times As It Applies to 200-DV-1 Continuous-Core Soil Samples and Attenuation/Transport Study",* September 7, 2016, PNNL and CHPRC.

**APPROACH FOR HOLD TIMES AS IT APPLIES TO 200-DV-1 CONTINUOUS-CORE SOIL SAMPLES AND ATTENUATION/TRANSPORT STUDY**

September 7, 2016

A White Paper by PNNL and CHPRC

Due to the unique drilling operations and sampling methods required to support ongoing 200-DV-1 characterization sampling, this white paper was prepared to provide the information needed to support a decision on how long samples may be held in storage prior to analysis, and when the hold time clock starts. Details on the 200-DV-1 sampling operations are outlined in the *Characterization Sampling and Analysis Plan for the 200-DV-1 OU* (hereafter 200-DV-1 SAP) (DOE/RL-2011-104 Rev. 1).

Analyses for the 200-DV-1 operable unit (OU) identified in Table 3-21 of the 200-DV-1 SAP are targeted at characterizing the contaminant distribution. Additional analyses will also be conducted to identify and quantify processes that affect contaminant attenuation and transport. These additional analyses evaluate contaminant mobility using several types of methods. Interpretation of the attenuation and transport results will consider the biogeochemical conditions in the sample. The 200-DV-1 samples are continuous-core samples collected in one- to five-foot Lexan liners that are sealed (capped and taped) at the drill site, stored on ice, and delivered to refrigerated storage within 24 hours of collection. The 200-DV-1 OU sonic drilling process is continuous, therefore the duration from the time the first sample is collected until the time samples can be delivered to the laboratory is approximately 17 days based on the drilling crews working 4 days per week.

The unique operating constraints for 200-DV-1 OU requires an acceptable and technically defensible approach be developed for hold times which includes the establishment of a maximum duration of refrigerated storage for the sealed cores prior to opening. The process CHPRC is implementing is described below.

The approach being implemented assumes the hold time clock begins when a sealed sample liner is opened to extract sample material. Prior to opening, soil sample liners are stored at a temperature less than or equal to 4°C for up to 12 months with an administrative goal of initiating analyses within 120 days. This sample handling approach is based on the data being used to determine contaminant distribution in the deep vadose zone and to study attenuation/transport for assessing contaminant behavior. These data are not for direct exposure calculations in a risk assessment or for waste designation purposes. Furthermore, EPA’s guidance suggested that site specific hold times can be established if it can be demonstrated that sample degradation will not occur. An EPA study of the hold-time effect for metals and redox-sensitive constituents was reviewed and used to provide evidence that sample degradation is not expected for the 200-DV-1 samples during the storage and hold times established for the project.

The EPA study results demonstrated that concentrations of extractable metals and redox-sensitive constituents (represented by hexavalent chromium in the study) are not significantly affected or degraded by sample storage for the time period specified for the 200-DV-1 sample storage (EPA/600/R-05/124, *Sample Holding Time Reevaluation*). Concentrations of anions and other biogeochemical analytes are also not expected to be significantly affected based on results for the redox-sensitive analyte hexavalent chromium in EPA/600-R-05/124.

The technical basis for this approach is the information provided in the EPA document, *Sample Holding Time Reevaluation* (EPA/600/R-05/124). This document included an assessment of hold (storage) time prior to acid extraction and analysis of metals and for alkaline extraction and analysis for hexavalent chromium, both for sediment samples. The following quotes from EPA/600/R-05/124 describe the methods and conclusions of the study. For the metals study, "samples were digested using the acid-leachable digestion detailed in SW-846 Method 3051-Microwave Assisted Acid Digestion of Sediments, Sludges, Soils, and Oils. Digestates were analyzed via SW-846 Method 6020-Inductively Coupled Plasma-Mass Spectrometry." The report summarized conclusions for the metals portion of the study as follows. "Extractable metal concentrations were not affected significantly by a holding time of up to 392 days or by air drying of the soils. Only one pooled data set exhibited a coefficient of variation (CV) >20%, which is the current SW-846 precision metric for hot acid extraction of metals. However, CV >20% was found to be the result of one holding time data set that was well outside the Day 0 mean. The remaining data sets exhibited fairly tight CVs across time ranging from 5.6 to 15.8%. The CV data suggests that no chemically significant change in concentration occurred during the holding time sequence and the pooled data exhibited no clear cut difference between moist or dry sample handling." In addition, "results suggest that it would take a minimum of 709 days before the acid-extractable As, Cu, Pb, or Zn concentration would be reduced by 20%."

For the hexavalent chromium study, "chromate extraction of all soils/sediments was performed strictly according to SW-846 Method 3060A-Alkaline Digestion for Hexavalent Chromium. Analysis of the sediment/soil extracts was conducted according SW-846 Method 7196A-Chromium, Hexavalent (colorimetric)." The study summarized conclusions for the hexavalent chromium portion of the study as follows. "The purpose of this study was to investigate if the extractable Cr(VI) concentration in soils/sediments was effected [sic] by the holding time prior to extraction according to SW-846 Method 3060A procedures. Of the six soils studied, five exhibited no or limited influence of holding time prior to extraction for the 224 days of this study regardless of the holding condition (4°C or -20°). The sixth Cr(VI) contaminated soil exhibited poor recovery (<5%) of the matrix spikes from the outset of the study" (thus, results of this sixth sample were determined to be impacted by other factors and it was reasonable to base the conclusions only on the other 5 samples).

The EPA hold-time study results show that for sediment samples, analysis results are not negatively affected by refrigerated storage of the samples over the storage durations tested in the study, which were significantly longer than the analysis method hold times.

In considering the EPA hold-time study in relation to the 200-DV-1 sampling and analysis campaign, because samples are sealed and in refrigerated storage and the bulk groundwater/pore water from the sampled zone contains oxygen (similar to conditions in the EPA study), the biogeochemical conditions and associated contaminant conditions are expected to remain stable while in storage. Thus, biogeochemical reactions are anticipated to be minimal during this time and analysis results would be suitable for interpreting biogeochemical conditions, contaminant speciation, contaminant distribution among aqueous and sediment phases, and for assessments of contaminant mobility parameters. As with any sample obtained through split-spoon sampling, sediment disturbance with creation of fresh mineral surfaces (e.g., as rocks are abraded) may induce short term biogeochemical reactions. However, these reactions are expected to occur rapidly, are a potential interference even with near-term analysis of samples, and would not be expected to continue at a significant magnitude during refrigerated storage.

No hold time exceedances are expected for this approach.