1229285

0081602H

# WASTE SITE RECLASSIFICATION FORM

**Operable Unit:** 100-DR-1 **Control No.:** 2014-102

**Waste Site Code(s)/Subsite Code(s):** 100-D-96:2

**Reclassification Category:** Interim ☒ Final ☐

**Reclassification Status:** Closed Out ☒ No Action ☐ Rejected ☐
RCRA Postclosure ☐ Consolidated ☐ None ☐

**Approvals Needed:** DOE ☒ Ecology ☒ EPA ☐

**Description of current waste site condition:**

The 100-D-96:2, 100-D/DR Additional French Drains Group 2 subsite, part of the 100-DR-1 Operable Unit, was a french drain believed to have received steam condensate from a nonradioactive building. The 100-D-96:2 subsite was located west of the former 1902-D Water Tank. The 100-D-96 waste site consisted of seven french drains and one dry well, and underwent confirmatory sampling in 2012. The FD-4 french drain was determined to be contaminated with concentrations of benzo(a)pyrene above the direct exposure remedial action goal (RAG) during confirmatory sampling of the 100-D-96 waste site. Therefore, this single french drain became the 100-D-96:2 subsite, while the remaining waste site features are included in the 100-D-96:1 subsite. The 100-D-96:1 subsite was reclassified to Interim No Action per the *Remaining Sites Verification Package for the 100-D-96:1, 100-D/DR Additional French Drains Group 1 Subsite* (WCH 2013). The 100-D-96 waste site was added to the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999), as a candidate site for confirmatory sampling by the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 2009).

Remediation of the 100-D-96:2 subsite was performed on May 13, 2014. Verification sampling was conducted at the 100-D-96:2 subsite on August 27, 2014. Remediation, verification sampling, and comparison of residual contaminant concentrations against cleanup levels have been performed in accordance with remedial action objectives and RAGs established by the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP), DOE/RL-97-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2009), and the Remaining Sites ROD (EPA 1999). The selected remedy involved (1) excavating the subsite to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility at the 200 Area of the Hanford Site, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the subsite for reclassification as Interim Closed Out.

**Basis for reclassification:**

Cleanup verification sampling results were evaluated in comparison to the RAGs. In accordance with this evaluation, the verification sampling results support a reclassification of this subsite to Interim Closed Out. The current site conditions achieve the remedial action objectives and the corresponding RAGs established in the100 Area RDR/RAWP (DOE-RL 2009) and the Remaining Sites ROD (EPA 1999). The evaluation, which may include fate-and-transport modeling, of all verification sample data collected from the 100-D-96:2 waste site resulted in a determination that residual contaminant concentrations do not preclude any future uses, as bounded by the rural-residential scenario, and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-D-96:2, 100-D/DR Additional French Drains Group 2 Subsite* (attached). Site contamination did not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

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# WASTE SITE RECLASSIFICATION FORM

**Operable Unit:** 100-DR-1 **Control No.:** 2014-102

**Waste Site Code(s)/Subsite Code(s):** 100-D-96:2

**Regulator comments:**

**Waste Site Controls:**

Engineered Controls: ☐ Yes ☒ No Institutional Controls: ☐ Yes ☒ No O&M Requirements: ☐ Yes ☒ No

If any of the Waste Site Controls are checked Yes, specify control requirements including reference to the Record of Decision, TSD Closure Letter, or other relevant documents:

| | | |
|---|---|---|
| J. P. Neath | | 2/12/15 |
| DOE Federal Project Director (printed) | Signature | Date |
| N. Menard | | 2/18/15 |
| Ecology Project Manager (printed) | Signature | Date |
| N/A | | |
| EPA Project Manager (printed) | Signature | Date |

# REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-96:2, 100-D/DR ADDITIONAL FRENCH DRAINS GROUP 2 SUBSITE

**Attachment to Waste Site Reclassification Form 2014-102**

**March 2015**

# REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-96:2, 100-D/DR ADDITIONAL FRENCH DRAINS GROUP 2 SUBSITE

## EXECUTIVE SUMMARY

The 100-D-96:2, 100-D/DR Additional French Drains Group 2 subsite, part of the 100-DR-1 Operable Unit, consisted of one french drain (FD-4) that was determined to be contaminated during confirmatory sampling of the 100-D-96 waste site. The 100-D-96:2 subsite was located west of the 1902-D water tank.

The 100-D-96 waste site consisted of seven french drains and one dry well and underwent confirmatory sampling in 2012 (WCH 2012). The 100-D-96:2 subsite french drain FD-4 was determined to be contaminated with concentrations of benzo(a)pyrene above the direct exposure remedial action goal (RAG) during confirmatory sampling of the 100-D-96 waste site. Therefore, french drain FD-4 was designated for remediation as the 100-D-96:2 subsite. The remaining waste site features are included in the 100-D-96:1 subsite. The 100-D-96:1 subsite was reclassified to Interim No Action in the *Remaining Sites Verification Package for the 100-D-96:1, 100-D/DR Additional French Drains Group 1 Subsite* (WCH 2013).

Remediation of the 100-D-96:2 subsite was performed on May 13, 2014. Approximately 150 bank cubic meters (196 bank cubic yards) of excavated materials were removed and staged for disposal at the Environmental Restoration Disposal Facility. No anomalous materials were encountered during the excavation. No overburden material was associated with the subsite.

Verification sampling was conducted at the 100-D-96:2 subsite on August 27, 2014, per the *Work Instruction for Verification Sampling of the 100-D-96:2, 100-D/DR Additional French Drains Group 2 Subsite* (WCH 2014b). The results indicate that the waste removal action achieved compliance with the remedial action objectives and RAGs of the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units* (Remaining Sites ROD) (EPA 1999). A summary of the cleanup evaluation for the soil results against the applicable criteria presented in Table ES-1.

**Table ES-1. Summary of Remedial Action Goals for the 100-D-96:2 Subsite. (2 Pages)**

| Regulatory Requirement | Remedial Action Goals | Results | Remedial Action Objectives Attained? |
|---|---|---|---|
| Direct Exposure – Radionuclides | Attain dose rate of <15 mrem/yr above background for 1,000 years. | Radionuclides were not COPCs for the 100-D-96:2 subsite. | NA |
| Direct Exposure – Nonradionuclides | Attain individual COPC direct exposure RAGs. | All individual COPC concentrations are below the direct exposure criteria. | Yes |

**Table ES-1. Summary of Remedial Action Goals for the 100-D-96:2 Subsite. (2 Pages)**

| Regulatory Requirement | Remedial Action Goals | Results | Remedial Action Objectives Attained? |
|---|---|---|---|
| Risk Requirements – Nonradionuclides | Attain a hazard quotient of <1 for all individual noncarcinogens. | The hazard quotients for individual nonradionuclide COPCs are <1. | Yes |
| | Attain a cumulative hazard quotient of <1 for noncarcinogens. | The cumulative hazard quotient for all sampling areas ($2.9 \times 10^{-3}$) is <1. | |
| | Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens. | The excess cancer risk for hexavalent chromium, the only constituent subject to the cancer risk calculation is $<1 \times 10^{-6}$. | |
| | Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens. | The total excess cancer risk is $9.7 \times 10^{-8}$, and thus is $<1 \times 10^{-5}$. | |
| Groundwater/River Protection – Radionuclides | Attain single-COPC groundwater and river protection RAGs. | Radionuclides were not COPCs for the 100-D-96:2 subsite. | NA |
| | Attain national primary drinking water standards [a]: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs. | | |
| | Meet drinking water standards for alpha emitters: the most stringent of 15 pCi/L MCL or 1/25th of the derived concentration guides from DOE Order 5400.5 [b]. | | |
| | Meet total uranium standard of 30 µg/L (21.2 pCi/L) [c]. | | |
| Groundwater/River Protection – Nonradionuclides | Attain individual nonradionuclide groundwater and river cleanup requirements. | Residual concentrations of lead and benzo(a)anthracene within the site excavation and staging pile area are above the soil RAGs for groundwater and/or river protection. However, RESRAD modeling predicts that these constituents will not reach groundwater (and, therefore, the Columbia River) within 1,000 years [d]. | Yes |

[a] "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).

[b] *Radiation Protection of the Public and the Environment* (DOE Order 5400.5).

[c] Based on the isotopic distribution of uranium in the 100 Area, the 30 µg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* (BHI 2001).

[d] Based on the RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009), residual concentrations of lead and benzo(a)anthracene are not expected to migrate more than 1.8 m (5.9 ft) vertically in 1,000 years (based on the lowest $K_d$ of the contaminants [lead with a $K_d$ of 30 mL/g]). The vadose zone underlying the soil below the 100-D-96:2 subsite excavation is a minimum of 22 m (72.2 ft) thick. Therefore, residual concentrations of lead and benzo(a)anthracene are predicted to be protective of groundwater and the Columbia River.

COPC = contaminant of potential concern
DOE = U.S. Department of Energy
$K_d$ = distribution coefficient
MCL = maximum contaminant level
NA = not applicable
RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)

The results of the verification sampling are used to make reclassification decisions for the 100-D-96:2 subsite in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2011). In accordance with this evaluation, the verification sampling results support a reclassification of this subsite to Interim Closed Out.

The current site conditions achieve the remedial action objectives and the corresponding RAGs established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2009) and the Remaining Sites ROD (EPA 1999). The results of verification sampling show that residual contaminant concentrations do not preclude any future uses, as bounded by the rural-residential scenario, and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Site contamination did not extend into the deep zone soils (i.e., below 4.6 m [15 ft]); therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the site contaminants of potential concern and other constituents. Those constituents exceeding the ecological screening level in the 2007 *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup," Table 749-3 were boron, lead, and vanadium. The U.S. Environmental Protection Agency ecological soil screening levels were exceeded for antimony, lead, manganese, and vanadium. Exceeding screening values does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of antimony, manganese, and vanadium are below background levels, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for ecological effects as a part of the final closeout decision for the Columbia River corridor portion of the Hanford Site. A table showing contaminant concentrations from the 100-D-96:2 subsite that exceed ecological screening levels is provided in Appendix A.

# REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-96:2, 100-D/DR ADDITIONAL FRENCH DRAINS GROUP 2 SUBSITE

## STATEMENT OF PROTECTIVENESS

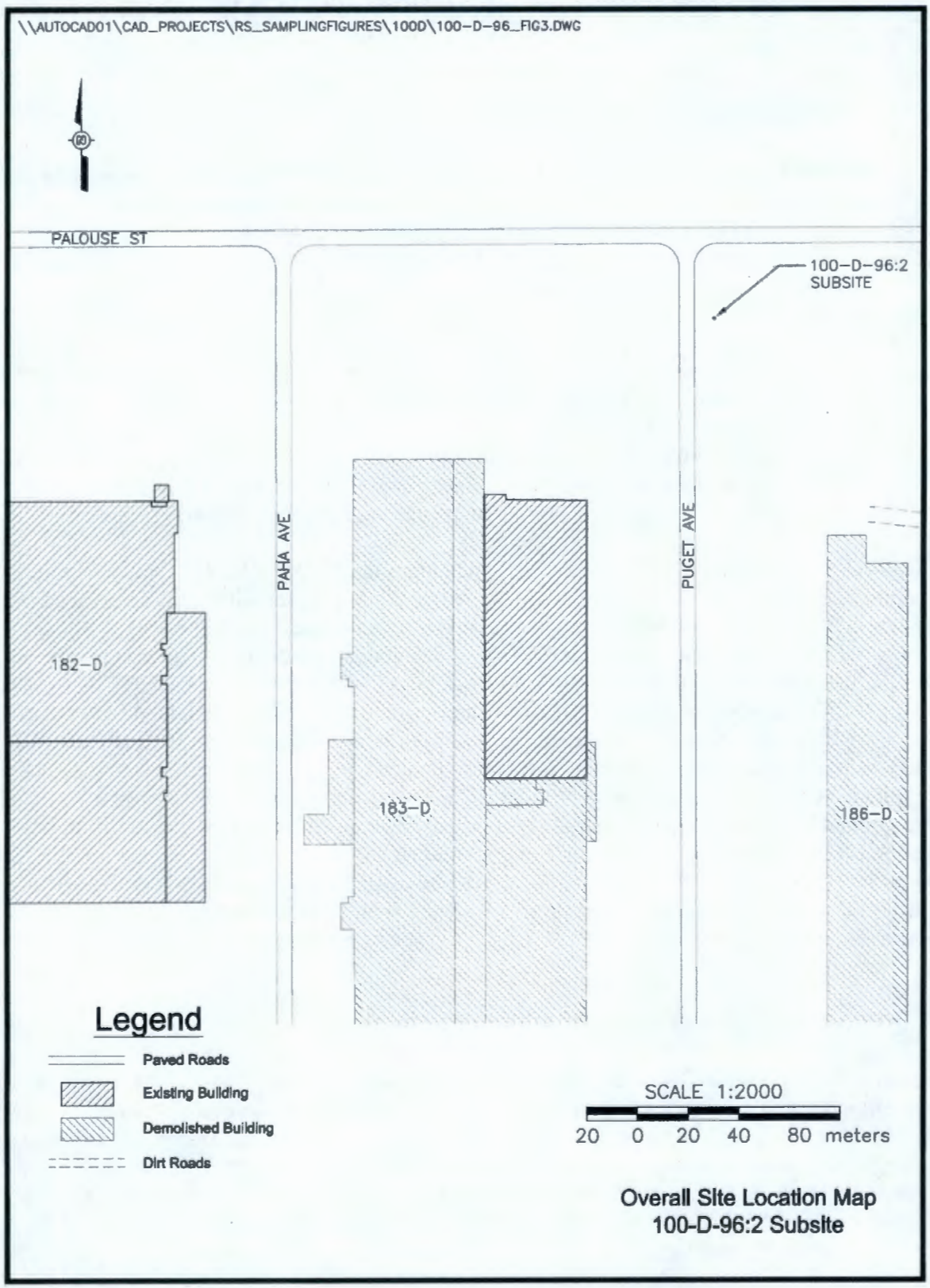
The 100-D-96:2, 100-D/DR Additional French Drains Group 2 subsite verification sampling data, site evaluations, and supporting documentation demonstrate that this site meets the objectives established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 2009) and the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD) (EPA 1999). These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft]) and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River. Site contamination did not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the site contaminants of potential concern (COPCs) and other constituents. Those constituents exceeding the ecological screening level in the 2007 *Washington Administrative Code* (WAC) 173-340, "Model Toxic Control Act – Cleanup," Table 749-3 were boron, lead, and vanadium. The U.S. Environmental Protection Agency (EPA) ecological soil screening levels were exceeded for antimony, lead, manganese, and vanadium. Exceeding screening values does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of antimony, manganese, and vanadium are below background levels, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for ecological effects as a part of the final closeout decision for the Columbia River corridor portion of the Hanford Site. A table showing contaminant concentrations from the 100-D-96:2 subsite that exceed ecological screening levels is provided in Appendix A.

## GENERAL SITE INFORMATION AND BACKGROUND

The 100-D-96:2, 100-D/DR Additional French Drains Group 2 subsite, part of the 100-DR-1 Operable Unit, was a french drain (FD-4) that was determined to be contaminated with concentrations of benzo(a)pyrene above the direct exposure remedial action goal (RAG) during confirmatory sampling of the 100-D-96 waste site. The french drain FD-4 was a cobble-filled 0.6-m (2-ft) concrete french drain at grade level located at Washington State Plane coordinates N 151775.9, E 573403.9, approximately 90 m (295 ft) northeast of the 183-D, Water Treatment Plant (Figure 1).

**Figure 1. Location of the 100-D-96:2 Subsite in the 100-D/DR Area.**



## CONFIRMATORY SAMPLING SUMMARY

Confirmatory sampling of 100-D-96:2 french drain FD-4 was performed on June 7, 2012. The FD-4 french drain was excavated and found to be two sections of reinforced concrete pipe. Stacked together vertically, these two sections of pipe extended to approximately 1.5 m (5 ft) below ground surface (bgs) (Figure 2). The contents of the french drain were primarily rusty cobbles at the top and sandy soil near the bottom. A sample (J1PR51) was collected of sandy soil inside the french drain. A sample (J1PR52) and duplicate (J1PR53) were collected of the underlying soil, at an approximate depth of 2.7 m (9 ft) bgs. Following sample collection of the underlying soil, the concrete pipe structures were placed sideways at the bottom of the excavation and backfilled with the excavated materials.

**Figure 2. Photograph of the 100-D-96:2 Subsite Confirmatory Sampling Excavation (June 7, 2012).**

Because no suspected asbestos-containing material was observed during confirmatory sampling, analysis was not performed for asbestos. Radiological activity was not detected in the field during confirmatory sampling activities; therefore, no analysis for radionuclides was performed.

The 100-D-96:2 subsite is identified for remediation at french drain location FD-4. In the polycyclic aromatic hydrocarbon (PAH) analysis, benzo(a)pyrene was detected above the direct exposure RAGs (in sample J1PR51), and it was determined that the FD-4 site would require remediation. A summary of the samples collected for the 100-D-96:2 subsite (identified as FD-4 in the confirmatory sampling instruction) is provided in Table 1. Confirmatory sampling results are presented in Appendix B.

**Table 1. 100-D-96:2 Subsite French Drain FD-4 Confirmatory Sampling Summary Table.**

| Test Pit | Sample Media | HEIS Sample Number | WSP Coordinate Location (m) | Depth (bgs) | Sample Analysis |
|---|---|---|---|---|---|
| FD-4 | French drain contents | J1PR51 | N 151776 E 573404 | 7 ft | ICP metals [a], mercury, IC anions [b], PAH, hexavalent chromium $NO_2/NO_3$ |
| | Underlying soil | J1PR52 | | 9 ft | |
| | Hazardous/anomalous debris/media | N/A | | NA | |
| Duplicate of J1RP52 | Soil | J1PR53 | N 151776 E 573404 | 9 ft | ICP metals [a], mercury, IC anions [b], PAH, hexavalent chromium, $NO_2/NO_3$ |
| Equipment blank | Silica sand | J1PR48 | NA | NA | ICP metals [a], mercury |

[a] The expanded list of ICP metals included antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.

[b] Analyses were mistakenly ordered and performed for the extended list of IC anions including bromide, chloride, fluoride, nitrate, nitrite, and phosphate. IC anions are not contaminants of potential concern for the 100-D-96:2 subsite.

bgs = below ground surface
HEIS= Hanford Environmental Information System
IC = ion chromatography
ICP = inductively coupled plasma
NA = not applicable
WSP = Washington State Plane

## REMEDIATION ACTION SUMMARY

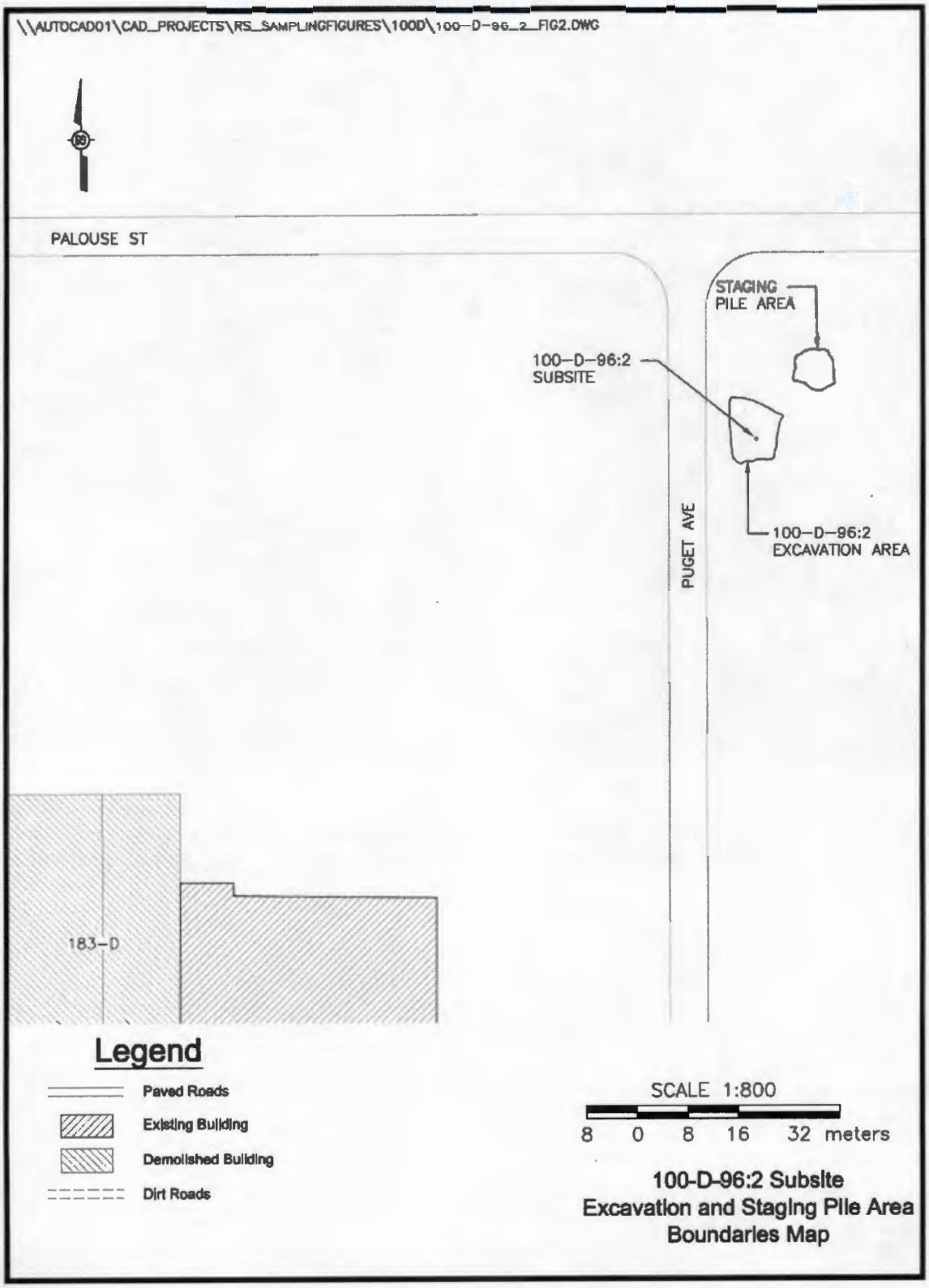
Remediation of the 100-D-96:2 subsite was performed on May 13, 2014. Approximately 150 bank cubic meters (196 bank cubic yards) of excavated materials were removed and staged for disposal at the Environmental Restoration Disposal Facility (ERDF). The depth of the waste site excavation was approximately 1.8 m (6 ft) bgs. Excavated materials consisted of soil, french drain rock, and reinforced concrete pipe. The french drain concrete pipe sections were found at an approximate depth of 1.5 m (5 ft) bgs during remediation. These concrete pipe sections and an additional 0.3 m (1 ft) of underlying soil were excavated for disposal at the ERDF. Figure 3 shows a photograph of the waste materials removed from the 100-D-96:2 subsite excavation.

**Figure 3. Photograph of the 100-D-96:2 Subsite Excavated Materials (Staging Pile Area).**

All excavated materials were stockpiled adjacent to the excavation in an approved staging pile area. Only 100-D-96:2 subsite waste materials were staged within the staging pile area (Figure 4).

No overburden materials were salvaged from the 100-D-96:2 subsite excavation; therefore, there is no overburden pile associated with the 100-D-96:2 subsite. Radiological field screening was performed during and immediately following remediation. No radiation was detected within the 100-D-96:2 excavation area. No anomalies were found during remediation of the 100-D-96:2 subsite.

**Figure 4. 100-D-96:2 Excavation and Staging Pile Area.**



## VERIFICATION SAMPLING ACTIVITIES

This section describes the basis for selection of a verification sample design for the 100-D-96:2 subsite. The area identified for the purpose of verification sampling for the 100-D-96:2 subsite consists of two decision units, the excavated area, and the staging pile area. Because of the small size of the areas to be sampled (<1,000 $m^2$), a focused sample design was utilized for verification sampling.

### Contaminants of Concern for Verification Sampling

The COPCs for the 100-D-96:2 subsite were identified based on the process history of the 184-D powerhouse that supplied the high-pressure steam, of which a portion was condensed to liquid and discharged to the below-grade covered french drain that comprised the 100-D-96:2 subsite. The COPC list included the expanded list of inductively coupled plasma metals and mercury. Nitrate was detected above background in confirmatory sampling; therefore, verification samples were analyzed for nitrate/nitrite. Confirmatory sampling data indicated that benzo(a)pyrene was above the direct exposure RAGs; therefore, verification samples were analyzed for PAHs. Hexavalent chromium was undetected in the confirmatory sampling; therefore, it was excluded from the COPC list. Sulfate was detected in confirmatory sampling below background levels and was analyzed using ion chromatography anions method for verification sampling.

No suspected asbestos-containing material was observed and no radiological activity was detected during confirmatory sampling and remediation of the 100-D-96:2 subsite.

### Verification Sampling Design

Verification sampling was conducted at the 100-D-96:2 subsite on August 27, 2014, per the *Work Instruction for Verification Sampling of the 100-D-96:2, 100-D/DR Additional French Drains Group 2 Subsite* (WCH 2014b). All sampling was performed in accordance with ENV-1, *Environmental Monitoring and Management*, to support a determination that residual contaminant concentrations in the soil meet cleanup criteria specified in the 100 Area RDR/RAWP (DOE-RL 2009) and the Remaining Sites ROD (EPA 1999).

The size of the remediated waste site is 68.7 $m^2$ (740 $ft^2$) and the staging pile area is 33.7 $m^2$ (363 $ft^2$). Because of the small size of the areas to be sampled (less than 1,000 $m^2$), a statistical sample design was not utilized for verification sampling. The remediated subsite and the staging pile area were each divided into halves for verification sampling. One discrete grab soil sample was collected from each half. Each sample location was at the approximate center of the half. No residual staining was identified within the excavated subsite and staging pile area. The 100-D-96:2 subsite verification sample locations are shown in Figure 5. The post remediation topography of the site is shown in Figure 6.

**Figure 5. 100-D-96:2 Subsite Verification Sample Locations.**

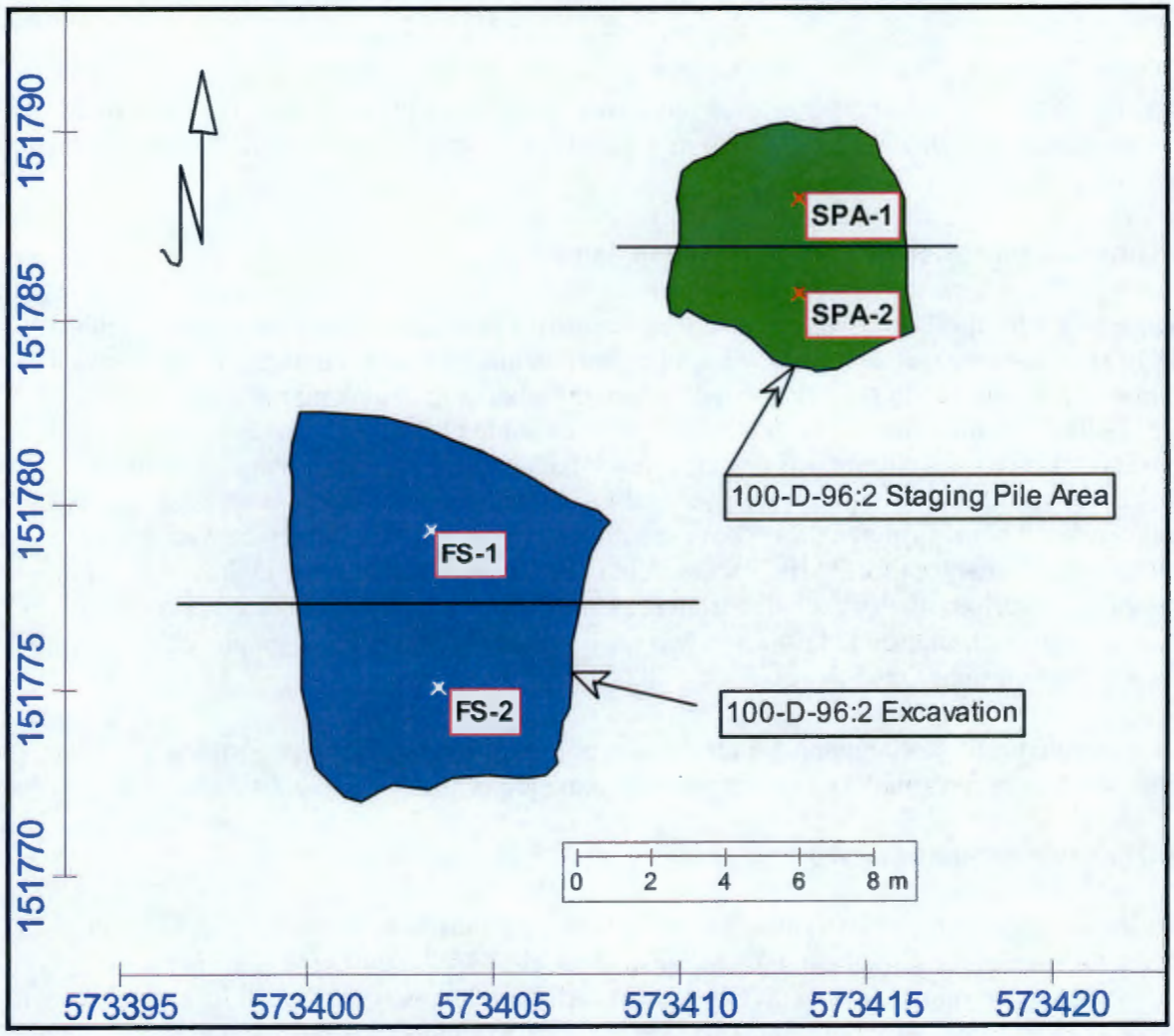
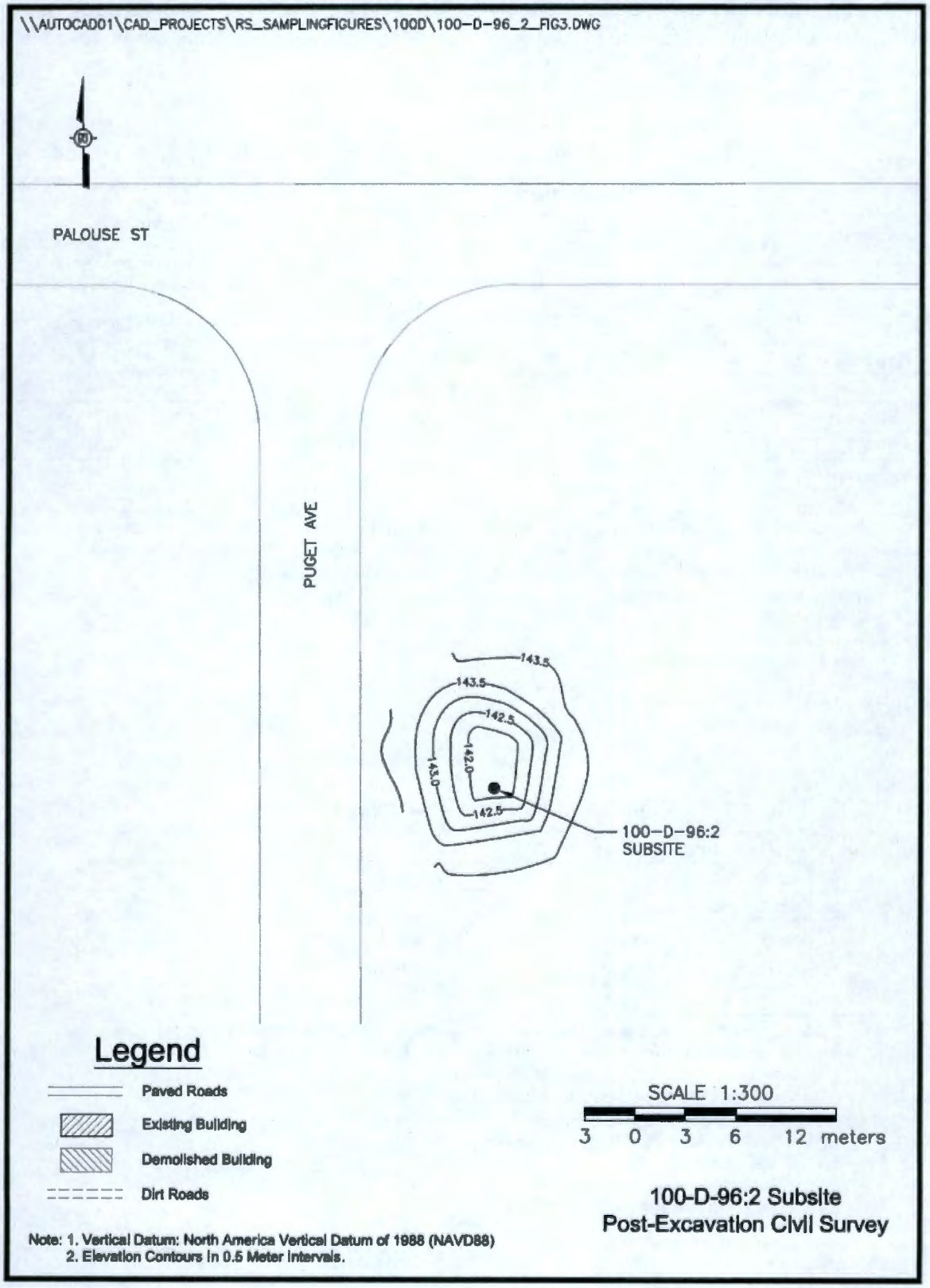


**Figure 6. 100-D-96:2 Post-Remediation Topographic Map.**



A summary of the verification samples collected and laboratory analyses performed is provided in Table 2. Table 3 identifies the EPA-approved methods for the analyses performed for verification sampling. Additional information related to verification sampling can be found in the field sampling logbooks (WCH 2014a).

**Table 2. 100-D-96:2 Sample Summary (WCH 2014).**

| Sample Location | HEIS Sample Number | Washington State Plane Coordinates (m) | | Sample Analysis [a] |
|---|---|---|---|---|
| | | Northing (m) | Easting (m) | |
| **Excavation Area** | | | | |
| FS-1 | J1TXT1 | 151779.3 | 573403.4 | ICP metals [a], mercury, IC anions [b], nitrate/nitrite, PAH |
| FS-2 | J1TXT2 | 151775.0 | 573403.5 | |
| Duplicate | J1TXT3 | 151788.2 | 573413.2 | |
| **Staging Pile Area** | | | | |
| SPA-1 | J1TXT4 | 151788.2 | 573413.2 | ICP metals [a], mercury, IC anions [b], nitrate/nitrite, PAH |
| SPA-2 | J1TXT5 | 151785.7 | 573413.2 | |
| Equipment blank | J1TXT6 | NA | NA | ICP metals [a], mercury |

[a] The expanded list of ICP metals included antimony, arsenic, barium, beryllium, boron, cadmium, chromium(total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc in the analytical results package.
[b] IC anions analyses included bromide, chloride, fluoride, nitrate, nitrite, phosphate, and sulfate.

HEIS = Hanford Environmental Information System
FS = focused sample
IC = ion chromatography
ICP = inductively coupled plasma
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
SPA = staging pile area

**Table 3. Laboratory Analytical Methods.**

| Analytical Method | COPCs |
|---|---|
| ICP metals [a] – EPA Method 6010 | Metals [a] |
| Mercury – EPA Method 7471 | Mercury |
| IC Anions [b] – EPA Method 300.0 | Sulfate |
| Nitrate/nitrite – EPA Method 353.2 | Nitrate |
| PAH – EPA Method 8310 | Polycyclic aromatic hydrocarbons |

[a] The expanded list of ICP metals included antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc in the analytical results package.
[b] IC anions analyses include bromide, chloride, fluoride, nitrate, nitrite, phosphate, and sulfate.

COPC= contaminant of potential concern
EPA = U. S. Environmental Protection Agency
IC = ion chromatography
ICP = inductively coupled plasma
PAH = polycyclic aromatic hydrocarbons

**Verification Sampling Results**

All verification samples were analyzed using analytical methods approved by EPA (DOE-RL 2009). Evaluation of the verification data from the 100-D-96:2 excavation and staging pile area was performed by direct comparison of the maximum sample results for each COPC against cleanup criteria.

Comparisons of the maximum results for COPCs and the site RAGs for the 100-D-96:2 subsite are presented in Table 4. Contaminants that were not detected by laboratory analysis are excluded from these tables. Calculated cleanup levels are not presented in the Cleanup Levels and Risk Calculations database (Ecology 2014) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COPCs and are also not included in these tables. The complete laboratory results are stored in the Washington Closure Hanford project-specific database prior to submitting to the Hanford Environmental Information System (HEIS) for archiving and are provided in Appendix C.

**Table 4. Comparison of Contaminant Concentrations to Remedial Action Goals for the 100-D-96:2 Subsite Excavation and Staging Pile Area Maximum Verification Sample Results. (2 Pages)**

| COPC | Maximum Result (mg/kg) | Remedial Action Goals (mg/kg) [a] | | | Does the Maximum Result Exceed RAGs? | Does the Maximum Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Soil Cleanup Level for Groundwater Protection | Soil Cleanup Level for River Protection | | |
| Antimony | 0.75 (<BG) | 32 | 5 [b] | 5 [b] | No | -- |
| Arsenic | 3.5 (<BG) | 20 [b] | 20 [b] | 20 [b] | No | -- |
| Barium | 92.0 (<BG) | 5,600 | 200 | 400 | No | |
| Boron [c] | 4.3 | 7,200 | 320 | -- [d] | No | -- |
| Cadmium | 0.077 (<BG) | 13.9 [e] | 0.81 [b] | 0.81 [b] | No | -- |
| Chromium | 11.0 (<BG) | 80,000 | 18.5 [b] | 18.5 [b] | No | -- |
| Cobalt | 7.4 (<BG) | 24 | 15.7 [b] | -- [d] | No | -- |
| Copper | 15.9 (<BG) | 2,960 | 59.2 | 22.0 [b] | No | -- |
| Lead | 64.6 | 353 | 10.2 [b] | 10.2 [b] | Yes | Yes [f] |
| Manganese | 328 (<BG) | 3,760 | 512 [b] | -- [d] | No | -- |
| Mercury | 0.028 (<BG) | 24 | 0.33 [b] | 0.33 [b] | No | -- |
| Molybdenum [c] | 0.45 | 400 | 8 | -- [d] | No | -- |
| Nickel | 12.3 (<BG) | 1,600 | 19.1 [b] | 27.4 | No | -- |
| Silver | 0.29 (<BG) | 400 | 8 | 0.73 [b] | No | -- |
| Vanadium | 56.8 (<BG) | 560 | 85.1 [b] | -- [d] | No | -- |
| Zinc | 45.5 (<BG) | 24,000 | 480 | 67.8 [b] | No | -- |
| Chloride | 72.7 (<BG) | -- | 25,000 | -- [d] | No | -- |
| Fluoride | 3.9 | 4,800 | 96 | 400 | No | -- |
| Nitrogen in nitrite [c] | 1.1 | 8,000 | 100 | 200 | No | -- |

**Table 4. Comparison of Contaminant Concentrations to Remedial Action Goals for the 100-D-96:2 Subsite Excavation and Staging Pile Area Maximum Verification Sample Results. (2 Pages)**

| COPC | Maximum Result (mg/kg) | Remedial Action Goals (mg/kg) [a] | | | Does the Maximum Result Exceed RAGs? | Does the Maximum Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Soil Cleanup Level for Groundwater Protection | Soil Cleanup Level for River Protection | | |
| Nitrogen in nitrite and nitrate | 15.9 | 128,000 | 1,000 | 2,000 | No | -- |
| Sulfate | 37.4 (<BG) | -- [d] | 25,000 | -- [d] | No | -- |
| Benzo(a)anthracene | 0.026 | 1.37 | 0.015 [g] | 0.015 [g] | Yes | Yes [f] |
| Benzo(a)pyrene | 0.0095 | 0.137 | 0.015 [g] | 0.015 [g] | No | -- |
| Benzo(b)fluoranthene | 0.0099 | 1.37 | 0.015 [g] | 0.015 [g] | No | -- |
| Chrysene | 0.020 | 13.7 | 0.12 | 0.1 [g] | No | -- |
| Fluoranthene | 0.075 | 3,200 | 64 | 18.0 | No | -- |
| Phenanthrene [h] | 0.047 | 24,000 | 240 | 1,920 | No | -- |
| Pyrene | 0.075 | 2,400 | 48 | 192 | No | -- |

[a] RAGs obtained from the 100 Area RDR/RAWP (DOE-RL 2009).

[b] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d) (Ecology 1996). The arsenic cleanup level 20 mg/kg has been agreed to by the Tri-Party Agreement Project Managers as discussed in Section 2.1.2.1 of the 100 Area RDR/RAWP (DOE-RL 2009).

[c] No Hanford Site-specific or Washington State background value available.

[d] No parameters (bioconcentration factors or ambient water quality criteria values) are available from the Washington State Department of Ecology Cleanup Levels and Risk Calculations database (Ecology 2014) or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], Ecology 1996 [Method B for surface waters]).

[e] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3]) using an airborne particulate mass-loading rate of 0.0001 g/m$^3$ (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).

[f] Based on the RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009), residual concentrations of lead and benzo(a)anthracene are not expected to migrate more than 1.8 m (5.9 ft) vertically in 1,000 years (based on the lowest $K_d$ of the contaminants [lead with a $K_d$ of 30 mL/g]). The vadose zone underlying the soil below the 100-D-96:2 subsite excavation is a minimum of 22 m (72.2 ft) thick. Therefore, residual concentrations of lead and benzo(a)pyrene are predicted to be protective of groundwater and the Columbia River.

[g] Where cleanup levels are less than RDLs, cleanup levels default to RDLs per WAC 173-340-707(2) (Ecology 1996). The cited RDLs are based on EPA-approved analytical methods that may not be available for rapid turnaround analyses. Prior notification and concurrence with the laboratory may be necessary to meet this RDL. Actual detection limits may differ from any RDL.

[h] Toxicity data for this chemical are not available. Cleanup levels are based on surrogate chemicals: phenanthrene; surrogate: anthracene.

-- = not applicable
BG = background
COPC = contaminant of potential concern
EPA = U.S. Environmental Protection Agency
$K_d$ = distribution coefficient
RAG = remedial action goal
RDL = required detection limit
RDR/RAWP= remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

## DATA EVALUATION

This section demonstrates that remedial actions at the 100-D-96:2 subsite have achieved the applicable RAGs developed to support unrestricted land use at the 100 Area as established in the Remaining Sites ROD (EPA 1999) and documented in the 100 Area RDR/RAWP (DOE-RL 2009).

### Attainment of Nonradionuclide RAGs

All COPCs for all sampling areas were quantified below their respective soil RAGs or lookup values with the exception of lead and benzo(a)anthracene in comparison against the soil RAGs for groundwater and/or river protection in the site excavation and staging pile area decision units. However, given the lowest soil-partitioning coefficient ($K_d$) of these contaminants (the $K_d$ for lead of 30 mL/g), these contaminants would not be expected to migrate more than 1.8 m (5.9 ft) vertically in 1,000 years based on RESidual RADioactivity (RESRAD) modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009). The vadose zone thickness beneath the excavation is approximately 22 m (72.2 ft). Therefore, residual concentrations of lead and benzo(a)anthracene are predicted to be protective of groundwater and, thus, the Columbia River.

### Three-Part Test for Nonradionuclides

The WAC 173-340-740(7)(e) three-part test is a statistical evaluation of the data that does not apply to results of focused samples such as those taken at the 100-D-96:2 subsite.

### Nonradionuclide Direct Contact Hazard Quotient and Carcinogenic Risk RAGs Attained

Nonradionuclide risk requirements include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than $1 \times 10^{-6}$, and a cumulative carcinogenic risk of less than $1 \times 10^{-5}$. For the 100-D-96:2 subsite, these risk values were not calculated for constituents that were either not detected or were detected at concentrations below Hanford Site or Washington State background. All individual hazard quotients for noncarcinogenic constituents were less than 1.0. The cumulative hazard quotient for those noncarcinogenic constituents above background or detected levels is $2.9 \times 10^{-3}$. The total carcinogenic risk value is $9.7 \times 10^{-8}$, which is below the individual and cumulative cancer risk standards of $1 \times 10^{-6}$ and $1 \times 10^{-5}$, respectively. Therefore, the 100-D-96:2 subsite meets the requirements for the direct contact hazard quotient and excess carcinogenic risk as identified in the 100 Area RDR/RAWP (DOE-RL 2009).

### Nonradionuclide Groundwater Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 100-D-96:2 subsite included calculation of the hazard quotient and carcinogenic (excess cancer) risk values for groundwater protection for nonradionuclides. The requirements include an individual and cumulative hazard quotient of less than 1.0, an individual excess carcinogenic risk of less than $1 \times 10^{-6}$, and a cumulative excess carcinogenic risk of less than $1 \times 10^{-5}$. These risk values were conservatively calculated for the entire subsite using the maximum value for each COPC. Risk values were calculated for

constituents that were detected at concentrations above Hanford Site or Washington State background values or for which there is no background value. In addition, the $K_d$ values for these contaminants are less than that necessary to show no migration to groundwater in 1,000 years based on RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009). Based on this model and a vadose zone of approximately 22 m (72 ft) in thickness at the excavation, a $K_d$ of 3.4 or greater is required to show no predicted migration to groundwater within 1,000 years. All individual hazard quotients for noncarcinogenic constituents are less than 1.0. The cumulative hazard quotient for the 100-D-96:2 subsite is $2.7 \times 10^{-2}$, which is less than 1.0. The 100-D-96:2 subsite does not have any carcinogenic constituents subject to the groundwater cancer risk calculation; therefore, the criterion for excess cancer risk is met. Nonradionuclide risk requirements related to groundwater are met.

## DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the verification sampling approach, the field logbook (WCH 2014a), and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications. The DQA for the 100-D-96:2 subsite established that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. The cleanup verification sample analytical data are stored in the Washington Closure Hanford project-specific database for data evaluation prior to archival in the HEIS and are summarized in Appendix C. The detailed DQA is presented in Appendix D.

## SUMMARY FOR INTERIM CLOSURE

The 100-D-96:2 subsite has been evaluated in accordance with the Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009). Verification sampling was performed, and the analytical results indicate that the residual concentrations of COPCs at this subsite meet the remedial action objectives for direct exposure, groundwater protection, and river protection. In accordance with this evaluation, the verification sampling results support a reclassification of the 100-D-96:2 subsite to Interim Closed Out. Site contamination did not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

## REFERENCES

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# APPENDIX A

# ECOLOGICAL RISK COMPARISON TABLE

**Table A-1. Contaminants Exceeding Ecological Screening Levels for the 100-D-96:2 Waste Site[a].**

| Hazardous Substance | | 2007 WAC 173-340, Table 749-3 | | | EPA Ecological Soil Screening Levels[b] | | | | Waste Site Analyses |
|---|---|---|---|---|---|---|---|---|---|
| | | Plants | Soil Biota | Wildlife | Plants | Soil Biota | Avian[c] | Mammalian[c] | |
| Metals (mg/kg): | | | | | | | | | |
| | Background | | | | | | | | |
| Antimony | 5 | 5 | -- | -- | -- | 78 | -- | 0.27 | 0.75 (<BG) |
| Boron[d] | -- | 0.5 | -- | -- | -- | -- | -- | -- | 4.3 |
| Lead | 10.2 | 50 | 500 | 118 | 120 | 1,700 | 11 | 56 | 64.6 |
| Manganese | 512 | 1,100[e] | -- | 1,500 | 220 | 450 | 4,300 | 4,000 | 328 (<BG) |
| Vanadium | 85.1 | 2 | -- | -- | -- | -- | 7.8 | 280 | 56.8 (<BG) |

NOTE: Shaded cells are exceeded by the maximum or the statistical result.
Blank cells = Values not available.

[a] Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. All exceedances must be evaluated in the context of additional lines of evidence for ecological effects following a baseline risk assessment for the river corridor portion of the Hanford Site, which will include a more complete quantitative ecological risk assessment.

[b] Available on the Internet at www.epa.gov/ecotox/ecossl.

[c] Wildlife.

[d] No Hanford Site-specific or Washington State background available.

[e] Benchmark replaced by Washington State natural background concentration from Ecology, 1994, *Natural Background Soil Metals Concentrations in Washington State*, Publication 94-115, Washington State Department of Ecology, Olympia, Washington.

BG = background
EPA = U.S. Environmental Protection Agency
WAC = *Washington Administrative Code*

# APPENDIX B

# CONFIRMATORY SAMPLING RESULTS

**Table B-1. 100-D-96:2 Subsite Confirmatory Sample Results - Metals (Page 1 of 2).**

| Sample Location | HEIS Number | Sample Date | Aluminum | | | Antimony | | | Arsenic | | | Barium | | | Beryllium | | | Boron | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| FD4 - Underlying Soil | J1PR52 | 6/7/2012 | 3670 | | 3.36 | 0.403 | U | 0.403 | 1.25 | | 0.672 | 38.7 | | 0.336 | 0.173 | | 0.134 | 1.02 | B | 1.34 |
| Duplicate of J1PR52 | J1PR53 | 6/7/2012 | 4820 | | 4.85 | 0.583 | U | 0.583 | 1.58 | | 0.971 | 53.9 | | 0.485 | 0.204 | | 0.194 | 1.14 | B | 1.94 |
| FD4 - FD Content | J1PR51 | 6/7/2012 | 5300 | | 4.90 | 0.694 | | 0.588 | 3.20 | | 0.980 | 138 | | 0.490 | 0.281 | | 0.196 | 11.8 | | 1.96 |
| Equipment Blank | J1PR48 | 6/7/2012 | 217 | | 3.29 | 0.395 | U | 0.395 | 0.201 | B | 0.658 | 2.22 | | 0.329 | 0.132 | U | 0.132 | 1.32 | U | 1.32 |

| Sample Location | HEIS Number | Sample Date | Cadmium | | | Calcium | | | Chromium | | | Cobalt | | | Copper | | | Iron | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| FD4 - Underlying Soil | J1PR52 | 6/7/2012 | 0.0550 | B | 0.134 | 3500 | | 67.2 | 3.29 | | 0.134 | 5.54 | | 1.34 | 11.2 | | 0.672 | 16200 | | 13.4 |
| Duplicate of J1PR52 | J1PR53 | 6/7/2012 | 0.0682 | B | 0.194 | 4480 | | 97.1 | 4.64 | | 0.194 | 7.15 | | 1.94 | 13.7 | | 0.971 | 20600 | | 19.4 |
| FD4 - FD Content | J1PR51 | 6/7/2012 | 0.165 | B | 0.196 | 5340 | | 98.0 | 11.2 | | 0.196 | 5.56 | | 1.96 | 20.8 | | 0.980 | 18200 | | 19.6 |
| Equipment Blank | J1PR48 | 6/7/2012 | 0.132 | U | 0.132 | 36.0 | B | 65.8 | 0.132 | U | 0.132 | 1.32 | U | 1.32 | 0.658 | U | 0.658 | 296 | | 13.2 |

| Sample Location | HEIS Number | Sample Date | Lead | | | Magnesium | | | Manganese | | | Mercury | | | Molybdenum | | | Nickel | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| FD4 - Underlying Soil | J1PR52 | 6/7/2012 | 3.17 | | 0.336 | 2910 | | 50.4 | 209 | | 3.36 | 0.0248 | U | 0.0248 | 0.257 | B | 1.34 | 6.32 | | 2.69 |
| Duplicate of J1PR52 | J1PR53 | 6/7/2012 | 3.65 | | 0.485 | 3860 | | 72.8 | 260 | | 4.85 | 0.0248 | U | 0.0248 | 0.319 | B | 1.94 | 7.72 | | 3.88 |
| FD4 - FD Content | J1PR51 | 6/7/2012 | 32.6 | | 0.490 | 3070 | | 73.5 | 238 | | 4.90 | 0.0297 | B | 0.0320 | 0.582 | B | 1.96 | 9.09 | | 3.92 |
| Equipment Blank | J1PR48 | 6/7/2012 | 0.479 | | 0.329 | 22.9 | B | 49.4 | 7.16 | | 3.29 | 0.0257 | U | 0.0257 | 1.32 | U | 1.32 | 2.63 | U | 2.63 |

| Sample Location | HEIS Number | Sample Date | Potassium | | | Selenium | | | Silicon | | | Silver | | | Sodium | | | Vanadium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| FD4 - Underlying Soil | J1PR52 | 6/7/2012 | 470 | | 269 | 0.202 | U | 0.202 | 179 | | 1.34 | 0.134 | U | 0.134 | 217 | | 33.6 | 47.7 | | 1.68 |
| Duplicate of J1PR52 | J1PR53 | 6/7/2012 | 556 | | 388 | 0.291 | U | 0.291 | 245 | | 1.94 | 0.194 | U | 0.194 | 340 | | 48.5 | 52.6 | | 2.43 |
| FD4 - FD Content | J1PR51 | 6/7/2012 | 571 | | 392 | 0.294 | U | 0.294 | 242 | | 1.96 | 0.196 | U | 0.196 | 296 | | 49.0 | 47.2 | | 2.45 |
| Equipment Blank | J1PR48 | 6/7/2012 | 46.2 | B | 263 | 0.197 | U | 0.197 | 89.2 | | 1.32 | 0.132 | U | 0.132 | 7.44 | B | 32.9 | 0.288 | B | 1.65 |

| Sample Location | HEIS Number | Sample Date | Zinc | | | Percent Solids | | |
|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | % | Q | PQL |
| FD4 - Underlying Soil | J1PR52 | 6/7/2012 | 33.9 | | 6.72 | 95.3 | | 0.1 |
| Duplicate of J1PR52 | J1PR53 | 6/7/2012 | 40.6 | | 9.71 | 95.4 | | 0.1 |
| FD4 - FD Content | J1PR51 | 6/7/2012 | 68.5 | | 9.80 | 88.0 | | 0.1 |
| Equipment Blank | J1PR48 | 6/7/2012 | 1.32 | B | 6.58 | 100 | | 0.1 |

Table B-1. 100-D-96:2 Subsite Confirmatory Sample Results -Anions (Page 2 of 2).

| Sample Location | HEIS Number | Sample Date | Bromide | | | Chloride | | | Fluoride | | | Nitrate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| FD4 - Underlying Soil | J1PR52 | 6/7/2012 | 0.9 | U | 0.9 | 0.9 | U | 0.9 | 0.9 | U | 0.9 | 12.3 | | 0.9 |
| Duplicate of J1PR52 | J1PR53 | 6/7/2012 | 1.0 | U | 1.0 | 1.0 | U | 1.0 | 1.0 | U | 1.0 | 13.7 | | 1.0 |
| FD4 - FD Content | J1PR51 | 6/7/2012 | 1.1 | U | 1.1 | 1.1 | B | 1.1 | 1.1 | U | 1.1 | 123 | | 2.1 |

| Sample Location | HEIS Number | Sample Date | Nitrite | | | Nitrogen in Nitrite and Nitrate | | | Phosphate | | | Sulfate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| FD4 - Underlying Soil | J1PR52 | 6/7/2012 | 0.9 | U | 0.9 | 3.04 | | 0.09 | 1.9 | U | 1.9 | 15.3 | | 0.9 |
| Duplicate of J1PR52 | J1PR53 | 6/7/2012 | 1.0 | U | 1.0 | 3.26 | | 0.10 | 2.3 | B | 2.1 | 14.5 | | 1.0 |
| FD4 - FD Content | J1PR51 | 6/7/2012 | 1.1 | U | 1.1 | 28.4 | D | 0.54 | 7.6 | B | 2.1 | 171 | D | 2.1 |

**Table B-2. 100-D-96:2 Subsite Confirmatory Sample Results - Additional Analysis (Polycyclic Aromatic Hydrocarbons - PAH).**

| CONSTITUENT | CLASS | J1PR51, FD-4 contents | | | J1PR52, FD-4 underlying soil | | | J1PR53, duplicate of J1PR52 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 6/7/12 12:08 | | | 6/7/12 12:12 | | | 6/7/12 12:12 | | |
| | | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL |
| Acenaphthene | PAH | 37.3 | UD | 37.3 | 3.40 | U | 3.40 | 3.39 | U | 3.39 |
| Acenaphthylene | PAH | 1300 | D | 37.3 | 89.4 | | 3.40 | 81.3 | | 3.39 |
| Anthracene | PAH | 37.3 | UD | 37.3 | 3.40 | U | 3.40 | 3.39 | U | 3.39 |
| Benzo(a)anthracene | PAH | 133 | D | 37.3 | 5.90 | | 3.40 | 7.25 | | 3.39 |
| Benzo(a)pyrene | PAH | 265 | D | 37.3 | 23.9 | | 3.40 | 15.5 | | 3.39 |
| Benzo(b)fluoranthene | PAH | 115 | D | 37.3 | 6.61 | | 3.40 | 2.58 | J | 3.39 |
| Benzo(ghi)perylene | PAH | 37.3 | UD | 37.3 | 3.40 | U | 3.40 | 3.39 | U | 3.39 |
| Benzo(k)fluoranthene | PAH | 61.0 | D | 37.3 | 3.40 | U | 3.40 | 4.58 | | 3.39 |
| Chrysene | PAH | 57.0 | D | 37.3 | 2.06 | J | 3.40 | 4.44 | | 3.39 |
| Dibenz[a,h]anthracene | PAH | 37.3 | UD | 37.3 | 3.40 | U | 3.40 | 3.39 | U | 3.39 |
| Fluoranthene | PAH | 665 | D | 37.3 | 40.8 | | 3.40 | 38.5 | | 3.39 |
| Fluorene | PAH | 79.0 | D | 37.3 | 5.01 | | 3.40 | 4.31 | | 3.39 |
| Indeno(1,2,3-cd)pyrene | PAH | 89.6 | D | 37.3 | 4.27 | | 3.40 | 2.08 | J | 3.39 |
| Naphthalene | PAH | 861 | D | 37.3 | 55.7 | | 3.40 | 38.8 | | 3.39 |
| Phenanthrene | PAH | 291 | D | 37.3 | 11.1 | | 3.40 | 6.44 | | 3.39 |
| Pyrene | PAH | 84.8 | D | 37.3 | 5.20 | | 3.40 | 3.19 | J | 3.39 |

**Table B-2. 100-D-96:2 Subsite Confirmatory Sample Results - Additional Analysis.**

| Sample Location | HEIS Number | Sample Date | Hexavalent Chromium | | |
|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL |
| FD4 - Underlying Soil | J1PR52 | 6/7/2012 | 0.22 | U | 0.22 |
| Duplicate of J1PR52 | J1PR53 | 6/7/2012 | 0.22 | U | 0.22 |
| FD4 - FD Content | J1PR51 | 6/7/2012 | 0.21 | U | 0.21 |

# APPENDIX C

# CALCULATIONS

# APPENDIX C

## CALCULATION BRIEFS

The calculations provided in this appendix are copies of the originals that are kept in the active Washington Closure Hanford project files and are available upon request. When the project is completed, the files will be stored in a U.S. Department of Energy, Richland Operations Office repository. These calculations have been prepared in accordance with ENG-1, *Engineering Services*, ENG-1-4.5, "Project Calculation," Washington Closure Hanford, Richland, Washington. The calculations provided in this appendix include:

*100-D-96:2 Subsite Relative Percent Difference and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations,* 0100D-CA-V0555, Rev. 0, Washington Closure Hanford, Richland, Washington.

*100-D-96:2 Subsite Protection of Groundwater Hazard Quotient and Carcinogenic Risk Calculation*, 0100D-CA-V0556, Rev. 0, Washington Closure Hanford, Richland, Washington.

**DISCLAIMER FOR CALCULATIONS**

The calculations that are provided in this appendix have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents in the administrative record.

Acrobat 8.0

# CALCULATION COVER SHEET

Project Title: 100-D Area Closure Operations **Job No. 14655**

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0555

Subject: 100-D-96:2 Subsite Relative Percent Difference and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations

Computer Program: Excel Program No: Excel 2010

The attached calculations have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

| Rev. | Sheet Numbers | Originator | Checker | Reviewer | Approval | Date |
|---|---|---|---|---|---|---|
| 0 | Cover = 1<br>Sheets = 6<br>Attm. = 4<br>Total = 11 | I. B. Berezovskiy | J. D. Skoglie | R. J. Nielson | S. G. Wilkinson | 10/27/14 |
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## SUMMARY OF REVISION

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WCH-DE-018 (05/08/2007) *Obtain Calc. No. from Document Control and Form from Intranet

Washington Closure Hanford CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | I. B. Berezovskiy | Date: | 10/6/2014 | Calc. No.: | 0100D-CA-V0555 | Rev.: | 0 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | J. D. Skoglie | Date: | 10/6/2014 |
| Subject: | 100-D-96:2 Subsite Relative Percent Difference and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations | | | | | Sheet No. 1 of 6 | |

## PURPOSE:

Provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 100-D-96:2 subsite. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009b), the following criteria must be met:

1) An HQ of <1.0 for all individual noncarcinogens
2) A cumulative HQ of <1.0 for noncarcinogens
3) An excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens
4) A cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.

Also, calculate the relative percent difference (RPD) for the primary-duplicate sample pairs from the 100-D-96:2 subsite verification sampling, as necessary.

## GIVEN/REFERENCES:


1) DOE-RL, 2009a, *100 Area Remedial Action Sampling and Analysis Plan,* DOE/RL-96-22, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

2) DOE-RL, 2009b, *Remedial Design Report/Remedial Action Work Plan for the 100 Area,* DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

3) EPA, 1994, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, U.S. Environmental Protection Agency, Washington, D.C.

4) WAC 173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, 1996.

5) WCH, 2014, *Remaining Sites Verification Package for the 100-D-96:2, 100-D/DR Additional French Drains Group 2 Subsite,* Attachment to Waste Site Reclassification Form 2014-102, Washington Closure Hanford, Richland, Washington.


## SOLUTION:

1) Generate an HQ for each noncarcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the individual HQ of <1.0 (DOE-RL 2009b).

2) Sum the HQs and compare this value to the cumulative HQ of <1.0.

3) Generate an excess cancer risk value for each carcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the excess cancer risk of $<1 \times 10^{-6}$ (DOE-RL 2009b).

Washington Closure Hanford CALCULATION SHEET

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|---|---|---|---|---|---|---|---|
| Originator: | I. B. Berezovskiy | Date: | 10/6/2014 | Calc. No.: | 0100D-CA-V0555 | Rev.: | 0 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | J. D. Skoglie | Date: | 10/6/2014 |
| Subject: | 100-D-96:2 Subsite Relative Percent Difference and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations | | | | | Sheet No. 2 of 6 | |

4) Sum the excess cancer risk value(s) and compare it to the cumulative cancer risk of $<1 \times 10^{-5}$.

5) Use data from WCH (2014) to perform the RPD calculations for primary-duplicate sample pairs, as required.

**METHODOLOGY:**

The 100-D-96:2 subsite underwent discrete focused sampling at four locations for the purpose of verification sampling. One duplicate sample was collected. The direct contact hazard quotient and carcinogenic risk calculations for the 100-D-96:2 subsite were conservatively calculated for the entire waste site using the greatest of the maximum soil sample results (WCH 2014). Of the contaminants of potential concern (COPCs) for this site, fluoride and nitrogen in nitrite and nitrate require HQ and risk calculations because these analytes were detected above background value. Boron, molybdenum, nitrite and the detected polycyclic aromatic hydrocarbons require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. Lead was quantitated at a concentration above Hanford Site background; however, lead is not included in the calculation based on modeling of child blood levels, which is fundamentally different from the oral reference dose and cancer slope factors used to calculate typical cleanup levels and associated HQs and cancer risks. All other site nonradionuclide COPCs were not detected or were quantified below background levels. An example of the HQ and risk calculations is presented below:

1) For example, the maximum value for boron is 4.3 mg/kg, divided by the noncarcinogenic RAG value of 7,200 mg/kg (calculated in accordance with the noncarcinogenic toxics effects formula in WAC 173-340-740[3]), produces a HQ value of $6.0 \times 10^{-4}$. Comparing this value, and all other individual values, to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation. The sum of the HQ values is $2.9 \times 10^{-3}$. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum value is divided by the carcinogenic RAG value, then multiplied by $1.0 \times 10^{-6}$. For example, the maximum value for benzo(a)anthracene is 0.026 mg/kg, divided by 1.37 mg/kg, and multiplied as indicated, is $1.9 \times 10^{-8}$. Comparing this value, and all other individual values, to the requirement of $<1 \times 10^{-6}$, this criterion is met.

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk can be obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual cancer risk values prior to rounding are used for this calculation. The sum of the excess cancer risk values is $9.7 \times 10^{-8}$. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

5) The RPD is calculated when both the primary value and the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDLs are pre-determined values for analytical methods and constituents with cleanup levels as listed in Table 2-1 of the SAP (DOE-RL 2009a). Table 2-1 includes nominal TDLs for identified methods based

Washington Closure Hanford CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | I. B. Berezovskiy | Date: | 10/6/2014 | Calc. No.: | 0100D-CA-V0555 | Rev.: | 0 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | J. D. Skoglie | Date: | 10/6/2014 |
| Subject: | 100-D-96:2 Subsite Relative Percent Difference and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations | | | | | Sheet No. 3 of 6 | |

organic analyses. The nominal TDLs are also used in support of the RPD calculation for the methods based analytes. TDLs not included in Table 2-1 are based on the laboratory and/or methods used. Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

$$RPD = [\ |M-D|/((M+D)/2)]*100$$

where, M = main sample value D = duplicate sample value

When an analyte is detected in the primary or duplicate sample, but was quantified at less than 5 times the TDL in one or both samples, an additional parameter is evaluated. In this case, if the difference between the primary and duplicate results exceeds a control limit of 2 times the TDL, further assessment regarding the usability of the data is performed. This assessment is provided in the data quality assessment section of the RSVP.

For quality assurance/quality control (QA/QC) duplicate RPD calculations, a value less than 30% indicates the data compare favorably. For regulatory splits, a threshold of 35% is used (EPA 1994). If the RPD is greater than 30% (or 35% for regulatory split data), further investigation regarding the usability of the data is performed. No split samples were collected for the verificaiton sampling of the subject site. Additional discussion is provided in the data quality assessment section of the applicable RSVP (WCH 2013), as necessary.

**RESULTS:**

1) List individual noncarcinogens and corresponding HQs >1.0: None
2) List the cumulative noncarcinogenic HQ >1.0: None
3) List individual carcinogens and corresponding excess cancer risk >1 x $10^{-6}$: None
4) List the cumulative excess cancer risk for carcinogens >1 x $10^{-5}$: None

Table 1 shows the results of the direct contact hazard quotient calculations.

5) The evaluation of the QA/QC duplicate RPD calculations are performed within the data quality assessment section of the RSVP.

Table 2 shows the results of the RPD calculations for the 100-D-96:2 subsite.

Washington Closure Hanford CALCULATION SHEET

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|---|---|---|---|---|---|---|---|
| Originator: | I. B. Berezovskiy | Date: | 10/6/2014 | Calc. No.: | 0100D-CA-V0555 | Rev.: | 0 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | J. D. Skoglie | Date: | 10/6/2014 |
| Subject: | 100-D-96:2 Subsite Relative Percent Difference and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations | | | | | Sheet No. 4 of 6 | |

**Table 1. Direct Contact Hazard Quotient and Excess Cancer Risk Results for the 100-D-96:2 Subsite.**

| Contaminants of Potential Concern | Maximum Value [a] (mg/kg) | Noncarcinogen RAG [b] (mg/kg) | Hazard Quotient | Carcinogen RAG [b] (mg/kg) | Carcinogen Risk |
|---|---|---|---|---|---|
| ***Metals*** | | | | | |
| Boron | 4.3 | 7,200 | 6.0E-04 | -- | -- |
| Lead [c] | 64.6 | 353 | -- | -- | -- |
| Molybdenum | 0.45 | 400 | 1.1E-03 | -- | -- |
| ***Anions*** | | | | | |
| Fluoride | 3.9 | 4,800 | 8.1E-04 | -- | -- |
| Nitrogen in nitrite and nitrate | 15.9 | 128,000 | 1.2E-04 | -- | -- |
| Nitrite | 1.1 | 8,000 | 1.4E-04 | -- | -- |
| ***Polycyclic Aromatic Hydrocarbons*** | | | | | |
| Benzo(a)anthracene | 0.026 | -- | -- | 1.37 | 1.9E-08 |
| Benzo(a)pyrene | 0.0095 | -- | -- | 0.137 | 6.9E-08 |
| Benzo(b)fluoranthene | 0.0099 | -- | -- | 1.37 | 7.2E-09 |
| Chrysene | 0.020 | -- | -- | 13.7 | 1.5E-09 |
| Fluoranthene | 0.075 | 3,200 | 2.3E-05 | -- | -- |
| Phenanthrene [d] | 0.047 | 24,000 | 2.0E-06 | -- | -- |
| Pyrene | 0.075 | 2,400 | 3.1E-05 | -- | -- |
| ***Totals*** | | | | | |
| **Cumulative Hazard Quotient:** | | | **2.9E-03** | | |
| **Cumulative Excess Cancer Risk:** | | | | | **9.7E-08** |

Notes:

[a] = From WCH (2014).

[b] = Value obtained from the RDR/RAWP (DOE-RL 2009b) or *Washington Administrative Code* (WAC) 173-340-740(3), Method B, 1996, unless otherwise noted.

[c] = Value for the noncarcinogenic RAG calculated using Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children, EPA/540/R 93/081, Publication No. 9285.7, U.S. Environmental Protection Agency, Washington, D.C.

[d] = Toxicity data for this chemical is not available. The cleanup level is based on the use of a surrogate chemical.

phenanthrene surrogate: anthracene

-- = not applicable

RAG = remedial action goal

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| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | J. D. Skoglie | Date: | 10/6/2014 |
| Subject: | 100-D-96:2 Subsite Relative Percent Difference and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations | | | | | Sheet No. 5 of 6 | |

## Table 2. Relative Percent Difference Calculations for the 100-D-96:2 Subsite. (2 Pages)

**100-D-96:2 Subsite Duplicate Analysis**

| Sampling Area | HEIS Number | Sample Date | Aluminum mg/kg | Q | PQL | Arsenic mg/kg | Q | PQL | Barium mg/kg | Q | PQL | Boron mg/kg | Q | PQL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPA-1 | J1TXT4 | 8/27/14 | 8490 | X | 1.6 | 3.2 | | 0.66 | 89.2 | X | 0.076 | 4.3 | | 0.98 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 8710 | X | 1.5 | 2.9 | | 0.63 | 88.3 | X | 0.072 | 4.1 | | 0.93 |

**Analysis:**

| | | | | | |
|---|---|---|---|---|---|
| TDL | | 5 | 10 | 2 | 2 |
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | Yes (calc RPD) | No-Stop (acceptable) | Yes (calc RPD) | No-Stop (acceptable) |
| | RPD | 2.6% | | 1.0% | |
| | Difference > 2 TDL? | Not applicable | No - acceptable | Not applicable | No - acceptable |

**100-D-96:2 Subsite Duplicate Analysis**

| Sampling Area | HEIS Number | Sample Date | Cadmium mg/kg | Q | PQL | Calcium mg/kg | Q | PQL | Chromium mg/kg | Q | PQL | Cobalt mg/kg | Q | PQL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPA-1 | J1TXT4 | 8/27/14 | 0.077 | B | 0.041 | 5500 | X | 14.2 | 10.8 | X | 0.058 | 7.3 | X | 0.10 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 0.062 | B | 0.039 | 5130 | X | 13.4 | 11.0 | X | 0.055 | 7.3 | X | 0.095 |

**Analysis:**

| | | | | | |
|---|---|---|---|---|---|
| TDL | | 0.2 | 100 | 1 | 2 |
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) | No-Stop (acceptable) |
| | RPD | | 7.0% | 1.8% | |
| | Difference > 2 TDL? | No - acceptable | Not applicable | Not applicable | No - acceptable |

**100-D-96:2 Subsite Duplicate Analysis**

| Sampling Area | HEIS Number | Sample Date | Copper mg/kg | Q | PQL | Iron mg/kg | Q | PQL | Lead mg/kg | Q | PQL | Magnesium mg/kg | Q | PQL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPA-1 | J1TXT4 | 8/27/14 | 15.6 | X | 0.22 | 21700 | X | 3.8 | 4.3 | XJ | 0.27 | 4870 | X | 3.7 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 15.9 | X | 0.21 | 21100 | X | 3.6 | 4.3 | XJ | 0.26 | 4770 | X | 3.5 |

**Analysis:**

| | | | | | |
|---|---|---|---|---|---|
| TDL | | 1 | 5 | 5 | 75 |
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | Yes (calc RPD) | Yes (calc RPD) | No-Stop (acceptable) | Yes (calc RPD) |
| | RPD | 1.9% | 2.8% | | 2.1% |
| | Difference > 2 TDL? | Not applicable | Not applicable | No - acceptable | Not applicable |

**100-D-96:2 Subsite Duplicate Analysis**

| Sampling Area | HEIS Number | Sample Date | Manganese mg/kg | Q | PQL | Mercury mg/kg | Q | PQL | Nickel mg/kg | Q | PQL | Potassium mg/kg | Q | PQL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPA-1 | J1TXT4 | 8/27/14 | 325 | X | 0.10 | 0.028 | | 0.0052 | 12.3 | X | 0.12 | 1190 | | 41.2 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 328 | X | 0.095 | 0.0081 | B | 0.0053 | 11.7 | X | 0.12 | 1220 | | 39.1 |

**Analysis:**

| | | | | | |
|---|---|---|---|---|---|
| TDL | | 5 | 0.2 | 4 | 400 |
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | Yes (calc RPD) | No-Stop (acceptable) | No-Stop (acceptable) | No-Stop (acceptable) |
| | RPD | 0.9% | | | |
| | Difference > 2 TDL? | Not applicable | No - acceptable | No - acceptable | No - acceptable |

**100-D-96:2 Subsite Duplicate Analysis**

| Sampling Area | HEIS Number | Sample Date | Silicon mg/kg | Q | PQL | Silver mg/kg | Q | PQL | Sodium mg/kg | Q | PQL | Vanadium mg/kg | Q | PQL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPA-1 | J1TXT4 | 8/27/14 | 296 | NJ | 5.7 | 0.17 | B | 0.16 | 315 | | 59.2 | 47.2 | X | 0.094 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 270 | NJ | 5.4 | 0.20 | | 0.15 | 314 | | 56.2 | 46.5 | X | 0.090 |

**Analysis:**

| | | | | | |
|---|---|---|---|---|---|
| TDL | | 2 | 50 | 50 | 2.5 |
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | Yes (calc RPD) | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) |
| | RPD | 9.2% | | 0.3% | 1.5% |
| | Difference > 2 TDL? | Not applicable | No - acceptable | Not applicable | Not applicable |

Washington Closure Hanford CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | I. B. Berezovskiy | Date: | 10/6/2014 | Calc. No.: | 0100D-CA-V0555 | Rev.: | 0 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | J. D. Skoglie | Date: | 10/6/2014 |
| Subject: | 100-D-96:2 Subsite Relative Percent Difference and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations | | | | | Sheet No. 6 of 6 | |

## Table 2. Relative Percent Difference Calculations for the 100-D-96:2 Subsite. (2 Pages)

**100-D-96:2 Subsite Duplicate Analysis**

| Sampling Area | HEIS Number | Sample Date | Zinc | | | Chloride | | | Fluoride | | | Nitrogen in Nitrate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | ug/kg | Q | PQL |
| SPA-1 | J1TXT4 | 8/27/14 | 40.1 | X | 0.40 | 69.2 | | 2.0 | 2.9 | BJ | 0.82 | 1.8 | BJ | 0.31 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 42.2 | X | 0.38 | 61.5 | | 2.0 | 3.9 | BJ | 0.82 | 1.7 | BJ | 0.32 |

**Analysis:**

| TDL | | 1 | 2 | 5 | 0.75 |
|---|---|---|---|---|---|
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | Yes (calc RPD) | Yes (calc RPD) | No-Stop (acceptable) | No-Stop (acceptable) |
| | RPD | 5.1% | 11.8% | | |
| | Difference > 2 TDL? | Not applicable | Not applicable | No - acceptable | No - acceptable |

**100-D-96:2 Subsite Duplicate Analysis**

| Sampling Area | HEIS Number | Sample Date | Nitrogen in nitrite and nitrate | | | Nitrogen in nitrite | | | Sulfate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1TXT4 | 8/27/14 | 0.71 | B | 0.36 | 1.1 | BJ | 0.33 | 27.4 | | 1.7 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 0.48 | B | 0.36 | 1.1 | BJ | 0.34 | 37.4 | | 1.7 |

**Analysis:**

| TDL | | 0.75 | 0.75 | 5 |
|---|---|---|---|---|
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | No-Stop (acceptable) | No-Stop (acceptable) | Yes (calc RPD) |
| | RPD | | | *30.9%* |
| | Difference > 2 TDL? | No - acceptable | No - acceptable | Not applicable |

## CONCLUSION:

The calculations in Tables 1 and 2 demonstrate that the 100-D-96:2 subsite met the requirements for the direct contact hazard quotient and carcinogenic (excess cancer) risk and RPDs, respectively, as identified in the RDR/RAWP (DOE-RL 2009b). The hazard quotient and carcinogenic (excess cancer) risk and RPD calculations are for use in the RSVP for this subsite.

**Attachment 1. 100-D-96:2 Subsite Verification Sample Results (Metals).**

| Location | HEIS Number | Sample Date | Aluminum | | | Antimony | | | Arsenic | | | Barium | | | Beryllium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1TXT4 | 8/27/14 | 8490 | X | 1.6 | 0.38 | BJ | 0.38 | 3.2 | | 0.66 | 89.2 | X | 0.076 | 0.033 | UJ | 0.033 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 8710 | X | 1.5 | 0.36 | UJ | 0.36 | 2.9 | | 0.63 | 88.3 | X | 0.072 | 0.031 | UJ | 0.031 |
| FS-1 | J1TXT1 | 8/27/14 | 6830 | X | 1.5 | 0.65 | J | 0.37 | 3.0 | | 0.65 | 92.0 | X | 0.074 | 0.032 | UNJ | 0.032 |
| FS-2 | J1TXT2 | 8/27/14 | 7470 | X | 1.5 | 0.38 | UJ | 0.38 | 2.7 | | 0.65 | 87.6 | X | 0.075 | 0.033 | UJ | 0.033 |
| SPA-2 | J1TXT5 | 8/27/14 | 8280 | X | 1.3 | 0.75 | J | 0.33 | 3.5 | | 0.57 | 81.7 | X | 0.066 | 0.029 | UJ | 0.029 |
| Equipment blank | J1TXT6 | 8/27/14 | 149 | X | 1.4 | 0.34 | UJ | 0.34 | 0.59 | U | 0.59 | 1.4 | X | 0.069 | 0.054 | BJ | 0.030 |

| Location | HEIS Number | Sample Date | Boron | | | Cadmium | | | Calcium | | | Chromium | | | Cobalt | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1TXT4 | 8/27/14 | 4.3 | | 0.98 | 0.077 | B | 0.041 | 5500 | X | 14.2 | 10.8 | X | 0.058 | 7.3 | X | 0.10 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 4.1 | | 0.93 | 0.062 | B | 0.039 | 5130 | X | 13.4 | 11.0 | X | 0.055 | 7.3 | X | 0.095 |
| FS-1 | J1TXT1 | 8/27/14 | 3.0 | N | 0.96 | 0.071 | B | 0.040 | 5410 | X | 13.8 | 7.7 | X | 0.057 | 7.2 | X | 0.098 |
| FS-2 | J1TXT2 | 8/27/14 | 2.8 | | 0.97 | 0.054 | B | 0.040 | 5130 | X | 13.9 | 8.4 | X | 0.057 | 7.1 | X | 0.099 |
| SPA-2 | J1TXT5 | 8/27/14 | 2.0 | | 0.85 | 0.046 | B | 0.035 | 5180 | X | 12.2 | 10.0 | X | 0.050 | 7.4 | X | 0.086 |
| Equipment blank | J1TXT6 | 8/27/14 | 0.88 | U | 0.88 | 0.037 | U | 0.037 | 32.6 | BX | 12.7 | 0.19 | XCUJ | 0.052 | 0.13 | BX | 0.090 |

| Location | HEIS Number | Sample Date | Copper | | | Iron | | | Lead | | | Magnesium | | | Manganese | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1TXT4 | 8/27/14 | 15.6 | X | 0.22 | 21700 | X | 3.8 | 4.3 | XJ | 0.27 | 4870 | X | 3.7 | 325 | X | 0.10 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 15.9 | X | 0.21 | 21100 | X | 3.6 | 4.3 | XJ | 0.26 | 4770 | X | 3.5 | 328 | X | 0.095 |
| FS-1 | J1TXT1 | 8/27/14 | 13.9 | X | 0.21 | 22800 | X | 3.7 | 64.6 | XMNJ | 0.26 | 4250 | X | 3.6 | 308 | X | 0.098 |
| FS-2 | J1TXT2 | 8/27/14 | 13.8 | X | 0.21 | 22200 | X | 3.8 | 5.7 | XJ | 0.27 | 4390 | X | 3.7 | 308 | X | 0.099 |
| SPA-2 | J1TXT5 | 8/27/14 | 14.2 | X | 0.19 | 21700 | X | 3.3 | 3.9 | XJ | 0.23 | 4730 | X | 3.2 | 322 | X | 0.086 |
| Equipment blank | J1TXT6 | 8/27/14 | 0.48 | BX | 0.20 | 488 | X | 3.4 | 0.24 | UXJ | 0.24 | 25.6 | X | 3.3 | 4.5 | X | 0.090 |

Acronyms and notes apply to all of the tables in this attachment.

**Gray cells indicate not applicable.**

Note: Data qualified with B, C, J, M, N and X are considered acceptable values.

B = estimated

C= the analyte was detected in both the sample and the associated QC bank, and the sample concentration was </=5X the blank concentration.

HEIS = Hanford Environmental Information system

J = estimate

M = sample duplicate precision not met.

N = recovery is outside control limits

PAH = polycyclic aromatic hydrocarbon

PQL = practical quantitation limit

Q = qualifier

R = rejected

U = undetected

X = serial dilution in analytical batch indicates physical and chemcial interferences (metals)

X = more than 40% difference between columns, lower result reported (organics)

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 1 of 4 |
| Originator | I. B. Berezovskiy | Date | 10/6/2014 |
| Checked | J. D. Skoglie | Date | 10/6/2014 |
| Calc. No. | 0100D-CA-V0555 | Rev. No. | 0 |

**Attachment 1. 100-D-96:2 Subsite Verification Sample Results (Metals).**

| Location | HEIS Number | Sample Date | Mercury | | | Molybdenum | | | Nickel | | | Potassium | | | Selenium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1TXT4 | 8/27/14 | 0.028 | | 0.0052 | 0.26 | U | 0.26 | 12.3 | X | 0.12 | 1190 | | 41.2 | 0.86 | U | 0.86 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 0.0081 | B | 0.0053 | 0.25 | U | 0.25 | 11.7 | X | 0.12 | 1220 | | 39.1 | 0.82 | U | 0.82 |
| FS-1 | J1TXT1 | 8/27/14 | 0.0097 | B | 0.0049 | 0.45 | BM | 0.25 | 9.1 | X | 0.12 | 1230 | | 40.1 | 0.84 | U | 0.84 |
| FS-2 | J1TXT2 | 8/27/14 | 0.0079 | B | 0.0053 | 0.27 | B | 0.26 | 9.8 | X | 0.12 | 1240 | | 40.5 | 0.85 | U | 0.85 |
| SPA-2 | J1TXT5 | 8/27/14 | 0.0062 | B | 0.0054 | 0.23 | B | 0.22 | 11.4 | X | 0.11 | 1190 | | 35.4 | 0.74 | U | 0.74 |
| Equipment blank | J1TXT6 | 8/27/14 | 0.0054 | U | 0.0054 | 0.23 | U | 0.23 | 0.26 | BX | 0.11 | 39.2 | B | 37.0 | 0.78 | U | 0.78 |

| Location | HEIS Number | Sample Date | Silicon | | | Silver | | | Sodium | | | Vanadium | | | Zinc | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1TXT4 | 8/27/14 | 296 | NJ | 5.7 | 0.17 | B | 0.16 | 315 | | 59.2 | 47.2 | X | 0.094 | 40.1 | X | 0.40 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 270 | NJ | 5.4 | 0.20 | | 0.15 | 314 | | 56.2 | 46.5 | X | 0.090 | 42.2 | X | 0.38 |
| FS-1 | J1TXT1 | 8/27/14 | 221 | NJ | 5.5 | 0.29 | | 0.16 | 280 | | 57.8 | 56.8 | X | 0.092 | 45.5 | X | 0.39 |
| FS-2 | J1TXT2 | 8/27/14 | 238 | NJ | 5.6 | 0.27 | | 0.16 | 264 | | 58.3 | 51.7 | X | 0.093 | 44.2 | X | 0.39 |
| SPA-2 | J1TXT5 | 8/27/14 | 286 | NJ | 4.9 | 0.19 | | 0.14 | 242 | | 51.0 | 48.7 | X | 0.081 | 40.7 | X | 0.34 |
| Equipment blank | J1TXT6 | 8/27/14 | 71.6 | NJ | 5.1 | 0.14 | U | 0.14 | 53.2 | U | 53.2 | 0.50 | BX | 0.085 | 1.5 | X | 0.36 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 2 of 4 |
| Originator | I. B. Berezovskiy | Date | 10/6/2014 |
| Checked | J. D. Skoglie | Date | 10/6/2014 |
| Calc. No. | 0100D-CA-V0555 | Rev. No. | 0 |

**Attachment 1. 100-D-96:2 Subsite Verification Sample Results (Anions, Physical).**

| Location | HEIS Number | Sample Date | Bromide | | | Chloride | | | Fluoride | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1TXT4 | 8/27/14 | 0.39 | U | 0.39 | 69.2 | | 2.0 | 2.9 | BJ | 0.82 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 0.39 | U | 0.39 | 61.5 | | 2.0 | 3.9 | BJ | 0.82 |
| FS-1 | J1TXT1 | 8/27/14 | 0.39 | U | 0.39 | 8.9 | MCJ | 2.0 | 1.1 | BNMJ | 0.82 |
| FS-2 | J1TXT2 | 8/27/14 | 0.38 | U | 0.38 | 53.2 | | 2.0 | 3.4 | BJ | 0.80 |
| SPA-2 | J1TXT5 | 8/27/14 | 0.39 | U | 0.39 | 72.7 | | 2.0 | 3.1 | BJ | 0.82 |

| Location | HEIS Number | Sample Date | Nitrogen in Nitrate | | | Nitrogen in Nitrite and Nitrate | | | Nitrogen in Nitrite | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1TXT4 | 8/27/14 | 1.8 | BJ | 0.31 | 0.71 | B | 0.36 | 1.1 | BJ | 0.33 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 1.7 | BJ | 0.32 | 0.48 | B | 0.36 | 1.1 | BJ | 0.34 |
| FS-1 | J1TXT1 | 8/27/14 | 12.1 | J | 0.31 | 15.9 | M | 0.36 | 0.34 | UR | 0.34 |
| FS-2 | J1TXT2 | 8/27/14 | 3.1 | J | 0.31 | 1.9 | | 0.36 | 0.33 | UR | 0.33 |
| SPA-2 | J1TXT5 | 8/27/14 | 2.1 | BJ | 0.31 | 0.42 | B | 0.36 | 1.0 | BJ | 0.33 |

| Location | HEIS Number | Sample Date | Phosphorous in phosphate | | | Sulfate | | | Percent moisture (wet sample) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | % | Q | PQL |
| SPA-1 | J1TXT4 | 8/27/14 | 1.2 | UR | 1.2 | 27.4 | | 1.7 | 2.3 | | 0.10 |
| Duplicate of J1TXT4 | J1TXT3 | 8/27/14 | 1.2 | UR | 1.2 | 37.4 | | 1.7 | 1.9 | | 0.10 |
| FS-1 | J1TXT1 | 8/27/14 | 1.2 | UR | 1.2 | 25.0 | N | 1.7 | 1.8 | | 0.10 |
| FS-2 | J1TXT2 | 8/27/14 | 1.2 | UR | 1.2 | 28.5 | | 1.7 | 1.7 | | 0.10 |
| SPA-2 | J1TXT5 | 8/27/14 | 1.2 | UR | 1.2 | 8.3 | | 1.7 | 2.0 | | 0.10 |
| Equipment blank | J1TXT6 | 8/27/14 | | | | | | | 0.10 | U | 0.10 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 3 of 4 |
| Originator | I. B. Berezovskiy | Date | 10/6/2014 |
| Checked | J. D. Skoglie | Date | 10/6/2014 |
| Calc. No. | 0100D-CA-V0555 | Rev. No. | 0 |

**Attachment 1. 100-D-96:2 Subsite Verification Sample Results (Organics).**

| CONSTITUENT | CLASS | J1TXT4, SPA-1 | | | J1TXT3, Duplicate of J1TXT4 | | | J1TXT1, FS-1 | | | J1TXT2, FS-2 | | | J1TXT5, SPA-2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 08/27/14 | | | 08/27/14 | | | 08/27/14 | | | 08/27/14 | | | 08/27/14 | | |
| | | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL |
| Acenaphthene | PAH | 9.8 | U | 9.8 | 10 | U | 10 | 9.5 | U | 9.5 | 9.9 | U | 9.9 | 10 | U | 10 |
| Acenaphthylene | PAH | 8.9 | U | 8.9 | 9.1 | U | 9.1 | 8.5 | U | 8.5 | 8.9 | U | 8.9 | 9.0 | U | 9.0 |
| Anthracene | PAH | 3.0 | U | 3.0 | 3.1 | U | 3.1 | 2.9 | U | 2.9 | 3.0 | U | 3.0 | 3.0 | U | 3.0 |
| Benzo(a)anthracene | PAH | 3.1 | U | 3.1 | 3.2 | U | 3.2 | 26 | X | 3.0 | 3.2 | U | 3.2 | 3.2 | U | 3.2 |
| Benzo(a)pyrene | PAH | 6.3 | U | 6.3 | 6.5 | U | 6.5 | 9.5 | J | 6.1 | 6.4 | U | 6.4 | 6.4 | U | 6.4 |
| Benzo(b)fluoranthene | PAH | 4.1 | U | 4.1 | 4.3 | U | 4.3 | 9.9 | JX | 4.0 | 4.2 | U | 4.2 | 4.2 | U | 4.2 |
| Benzo(ghi)perylene | PAH | 7.1 | U | 7.1 | 7.3 | U | 7.3 | 6.8 | U | 6.8 | 7.2 | U | 7.2 | 7.2 | U | 7.2 |
| Benzo(k)fluoranthene | PAH | 3.9 | U | 3.9 | 4.0 | U | 4.0 | 3.7 | U | 3.7 | 3.9 | U | 3.9 | 3.9 | U | 3.9 |
| Chrysene | PAH | 4.8 | U | 4.8 | 4.9 | U | 4.9 | 20 | J | 4.6 | 4.8 | U | 4.8 | 4.8 | U | 4.8 |
| Dibenz[a,h]anthracene | PAH | 11 | U | 11 | 11 | U | 11 | 10 | U | 10 | 11 | U | 11 | 11 | U | 11 |
| Fluoranthene | PAH | 13 | U | 13 | 13 | U | 13 | 75 | | 12 | 13 | U | 13 | 13 | U | 13 |
| Fluorene | PAH | 5.2 | U | 5.2 | 5.4 | U | 5.4 | 5.0 | U | 5.0 | 5.2 | U | 5.2 | 5.3 | U | 5.3 |
| Indeno(1,2,3-cd)pyrene | PAH | 12 | U | 12 | 12 | U | 12 | 11 | U | 11 | 12 | U | 12 | 12 | U | 12 |
| Naphthalene | PAH | 12 | U | 12 | 12 | U | 12 | 11 | U | 11 | 12 | U | 12 | 12 | U | 12 |
| Phenanthrene | PAH | 12 | U | 12 | 12 | U | 12 | 47 | | 11 | 12 | U | 12 | 12 | U | 12 |
| Pyrene | PAH | 12 | U | 12 | 12 | U | 12 | 75 | | 11 | 12 | U | 12 | 12 | U | 12 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 4 of 4 |
| Originator | I. B. Berezovskiy | Date | 10/6/2014 |
| Checked | J. D. Skoglie | Date | 10/6/2014 |
| Calc. No. | 0100D-CA-V0555 | Rev. No. | 0 |

Acrobat 8.0

# CALCULATION COVER SHEET

Project Title: 100-D Area Closure Operations **Job No. 14655**

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0556

Subject: 100-D-96:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater

Computer Program: Excel Program No: Excel 2010

The attached calculations have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

| Rev. | Sheet Numbers | Originator | Checker | Reviewer | Approval | Date |
|---|---|---|---|---|---|---|
| 0 | Cover = 1<br>Sheets = 3<br>Total = 4 | L. B. Berezovskiy | J. D. Skoglie | R. J. Nielson | S. G. Wilkinson | 10/27/14 |
| | | | | | | |
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## SUMMARY OF REVISION

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WCH-DE-018 (05/08/2007) *Obtain Calc. No. from Document Control and Form from Intranet

Washington Closure Hanford CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | I. B. Berezovskiy | Date: | 9/23/2014 | Calc. No.: | 0100D-CA-V0556 | Rev.: | 0 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | J. D. Skoglie | Date: | 9/23/2014 |
| Subject: | 100-D-96:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater | | | | | Sheet No. 1 of 3 | |

**PURPOSE:**

Provide documentation to support the calculation of the hazard quotient (HQ) and excess carcinogenic risk associated with soil contaminant levels compared to soil cleanup levels for protection of groundwater for the 100-D-96:2 subsite. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009), the following criteria must be met:

1) An HQ of <1.0 for all individual noncarcinogens
2) A cumulative HQ of <1.0 for noncarcinogens
3) An excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens
4) A cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.

**GIVEN/REFERENCES:**


1) BHI, 2005, *100 Area Analogous Sites RESRAD Evaluation*, Calculation No. 0100X-CA-V0050 Rev 0, Bechtel Hanford, Inc., Richland, Washington.

2) DOE-RL, 2009, *Remedial Design Report/Remedial Action Work Plan for the 100 Areas*, DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

3) WAC 173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, 1996.

4) WCH, 2014, *100-D-96:2 Subsite Relative Percent Difference and Direct Contact Hazard Quotient and Carcinogenic Risk Calculation*, 0100D-CA-V0555, Rev. 0, Washington Closure Hanford, Inc., Richland, Washington.


**SOLUTION:**

1) Generate a HQ for each noncarcinogenic constituent detected above background in soil and with a $K_d$ less than that required to show no migration to groundwater in 1,000 years using the RESRAD generic site model (BHI 2005).

2) Sum the HQs and compare this value to the cumulative HQ of <1.0.

3) Generate an excess cancer risk value for each carcinogenic constituent detected above background in soil and with a $K_d$ less than that required to show no migration to groundwater in 1,000 years using the RESRAD generic site model (BHI 2005).

4) Sum the excess cancer risk value(s) and compare it to the cumulative cancer risk of $<1 \times 10^{-5}$.

Washington Closure Hanford CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | I. B. Berezovskiy | Date: | 9/23/2014 | Calc. No.: | 0100D-CA-V0556 | Rev.: | 0 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | J. D. Skoglie | Date: | 9/23/2014 |
| Subject: | 100-D-96:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater | | | | | Sheet No. 2 of 3 | |

## METHODOLOGY:

Hazard quotient and carcinogenic risk calculations for potential impact to groundwater at the 100-D-96:2 subsite were conservatively calculated for the entire waste site using the maximum value for each analyte in the entire decision unit from the Relative Percent Difference and Direct Contact Hazard Quotient and Carcinogenic Risk Calculation (WCH 2014). Contaminants of potential concern (COPCs) are included in this calculation if they were detected above established Hanford Site background concentrations and have small enough distribution coefficients ($K_d$) to migrate to groundwater within 1,000 years, as predicted by the generic site model RESRAD model (BHI 2005). Based on this model and a vadose zone of approximately 22 m (72 ft) thickness, a $K_d$ of 3.4 or greater is required to show no predicted migration to groundwater in 1,000 years. Of the contaminants of potential concern (COPCs) for this site, boron and nitrite are included because no Washington State or Hanford background value has been established and the distribution coefficients are less than that necessary to show no migration to groundwater in 1,000 years using the generic site RESRAD model (BHI 2005). Nitrogen in nitrite and nitrate is included because it was detected above background and has a $K_d$ less than 3.4. All other site nonradionuclide COPCs were not detected, quantified below background levels, or have a $K_d$ greater than or equal to 3.4. An example of the HQ and risk calculations for soil constituents with a potential impact to groundwater is presented below:

1) The hazard quotient is defined as the ratio of the dose of a substance obtained over a specified time (mg/kg/day) to a reference dose for the same substance derived over the same specified time (mg/kg/day). The hazard quotient can also be calculated as the ratio of the concentration in soil (maximum or statistical value) (mg/kg) to the soil RAG (mg/kg) for protection of groundwater, where the RAG is the groundwater cleanup level (mg/L) (calculated with, and related to the hazard quotient through, WAC 173-340-720(3)(a)(ii)(A), 1996) x 100 x 1 mg/1000 mg (conversion factor). This is based on the "100 times rule" of WAC 173-340-740(3)(a)(ii)(A) (1996). For example, the maximum value for boron 4.3 mg/kg, divided by the noncarcinogenic RAG value of 320 mg/kg is $1.3 \times 10^{-2}$. Comparing this value to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation.) The cumulative HQ for the 100-D-96:2 subsite is $2.7 \times 10^{-2}$. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum value is divided by the carcinogenic RAG value, and then multiplied by $1 \times 10^{-6}$. The 100-D-96:2 subsite does not have any constituents with carcinogen RAGs, the criterion for excess cancer risk is met. Consequently, the criterion for cumulative excess cancer risk for carcinogens is also met.

4) The soil cleanup RAGs for protection of groundwater are based on the "100 times" provision in WAC 173-340-740(3)(a)(ii)(A). WAC 173-340-740(3)(a)(ii)(A) (1996) provides the "100 times rule" but also states "unless it can be demonstrated that a higher soil concentration is protective of ground water at the site." When the "100 times rule" values are exceeded, RESRAD was used to demonstrate that higher soil concentrations may be protective of groundwater.

Washington Closure Hanford CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | I. B. Berezovskiy | Date: | 9/23/2014 | Calc. No.: | 0100D-CA-V0556 | Rev.: | 0 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | J. D. Skoglie | Date: | 9/23/2014 |
| Subject: | 100-D-96:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater | | | | | Sheet No. 3 of 3 | |

## RESULTS:

1) List individual noncarcinogens and corresponding HQs >1.0: None
2) List the cumulative noncarcinogenic HQ >1.0: None
3) List individual carcinogens and corresponding excess cancer risk >1 x $10^{-6}$: None
4) List the cumulative excess cancer risk for carcinogens >1 x $10^{-5}$: None.

Table 1 shows the results of the calculations.

**Table 1. Hazard Quotient and Excess Cancer Risk Results for the 100-D-96:2 Subsite.**

| Contaminants of Potential Concern | Maximum Value[a] (mg/kg) | Noncarcinogen RAG[b] (mg/kg) | Hazard Quotient | Carcinogen RAG[b] (mg/kg) | Carcinogen Risk |
|---|---|---|---|---|---|
| *Metals* | | | | | |
| Boron | 4.3 | 320 | 1.3E-02 | -- | -- |
| *Anions* | | | | | |
| Nitrite | 1.1 | 160 | 6.9E-03 | -- | -- |
| Nitrogen in nitrate and nitrite | 15.9 | 2,560 | 6.2E-03 | -- | -- |
| *Totals* | | | | | |
| **Cumulative Hazard Quotient:** | | | **2.7E-02** | | |
| **Cumulative Excess Cancer Risk:** | | | | | **0.0E+00** |

Notes:
[a] = From WCH (2014).
[b] = Value obtained from the Cleanup Levels and Risk Calculations (CLARC) database using Groundwater, Method B, results and the "100 times" model.
-- = not applicable
RAG = remedial action goal

## CONCLUSION:

The calculation in Table 1 demonstrates that the 100-D-96:2 subsite met the requirements for the hazard quotient and excess carcinogenic risk for protection of groundwater as identified in the RDR/RAWP (DOE-RL 2009).

# APPENDIX D

# DATA QUALITY ASSESSMENT

# APPENDIX D

# DATA QUALITY ASSESSMENT

## VERIFICATION SAMPLING

A data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WCH 2014b). This DQA was performed in accordance with site-specific data quality objectives found in the *100 Area Remedial Action Sampling and Analysis Plan* (100 Area SAP) (DOE-RL 2009).

A review of the sample design (WCH 2014b), the field logbook (WCH 2014a), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design, with minimal alterations, as warranted by field conditions.

To ensure quality data, the 100 Area SAP (DOE-RL 2009) data assurance requirements and the data validation procedures for chemical analysis (BHI 2000) are used as appropriate. This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use (i.e., closeout decisions). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process (EPA 2006).

Verification data from samples collected at the 100-D-96:2 subsite were provided by the laboratories in one sample delivery group (SDG): SDG JP0855. SDG JP0855 was submitted for third-party validation. Major and minor deficiencies are discussed for the 100-D-96:2 data set, as follows below. If no comments are made about a specific analysis, it should be assumed that no deficiencies affecting the quality of the data were found.

## MAJOR DEFICIENCIES

Due to holding time exceedances in the method 300.0 ion chromatography (IC) anions analysis, of greater than twice the limit of 48 hours, third-party validation qualified the all undetected nitrite and orthophosphate results in SDG JP0855 as rejected with "R" flags. All detected nitrite and orthophosphate data was qualified as estimated with "J" flags by third-party validation. This result was anticipated and the U.S. Environmental Protection Agency analytical method 353.2 was also requested to provide acceptable nitrate/nitrite data for decision-making purposes. Therefore, the estimated and rejected data for nitrate and nitrite do not hinder the evaluation of the 100-D-96:2 subsite. Phosphate is not a regulated chemical under *Washington Administrative Code* 173-340, "Model Toxics Control Act-Cleanup."

## MINOR DEFICIENCIES

### SDG JP0855

This SDG comprises four focused soil samples (J1TXT1, J1TXT2, J1TXT4, J1TXT5) from the excavation and staging pile area. This SDG includes one field duplicate pair (J1TXT4/J1XTX3). All samples were analyzed for inductively coupled plasma (ICP) metals, mercury, IC anions and polycyclic aromatic hydrocarbons. In addition, one field equipment blank sample (J1TXT6) was collected and analyzed for ICP metals and mercury. SDG JP0855 was submitted for third-party validation. Minor deficiencies are as follows.

In the IC anions analysis, holding times were exceeded by more than twice the specified holding time for nitrate and nitrite. All detected nitrate and nitrite results in SDG JP0855 were qualified by third-party validation as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the IC anions analysis, due to method blank (MB) contamination, chloride results in sample J1TXT1 was qualified by third-party validation as estimated with "J" flag. Estimated data are usable for decision-making purposes.

In the IC anions analysis, the matrix spike (MS) recovery for fluoride (66%) is outside the project quality control (QC) limits. Third-party validation qualified all fluoride results in SDG JP0855 as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, due to MB contamination, third-party validation qualified chromium result in sample J1TXT6 as undetected with "UJ" flags. Data are usable for decision-making purposes.

In the ICP metals analysis, the MS recoveries are outside the project acceptance criteria for seven analytes (aluminum [1,590%], antimony [42%], beryllium [68%], iron [2,255%], lead [-38], manganese [190%], and silicon [16%]). For aluminum, iron, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the variability of the native concentration rather than a measure of the recovery from the sample. Antimony, beryllium, lead, and silicon did not have a mismatched spike and native concentrations in the MS. All antimony, beryllium, lead, and silicon results for SDG JP0855 were qualified by third-party validation as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP analysis, the laboratory control sample recovery for silicon is below the project QC limits, at 9%. All silicon results for SDG JP0855 were qualified by third-party validation as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory duplicate relative percent difference (RPD) for lead (169%) is above the project QC limit of 30%. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. All lead results in

SDG JP0855 were qualified by third-party validation as estimated with "J" flags. Estimated data are usable for decision-making purposes.

## FIELD QUALITY ASSURANCE/QUALITY CONTROL

Relative percent difference evaluations of main sample(s) versus the laboratory duplicate(s) are routinely performed and reported by the laboratory. Any deficiencies in those calculations are reported by SDG in the previous sections.

Field quality assurance (QA)/QC measures are used to assess potential sources of error and cross contamination of samples that could bias results. Field QA/QC samples, listed in the field logbook (WCH 2014a), are shown in Table D-1. The main and QA/QC sample results are presented in Appendix C.

**Table D-1. Field Quality Assurance/Quality Control Samples.**

| Sample Area | Main Sample | Duplicate Sample |
|---|---|---|
| Excavation Area | J1TXT4 | J1TXT3 |

Field duplicate samples are collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the sample/duplicate pair(s) for each contaminant of potential concern. Relative percent differences are not calculated for analytes that are not detected in both the main and duplicate sample at more than five times the target detection limit. Relative percent differences of analytes detected at low concentrations (less than five times the detection limit) are not considered to be indicative of the analytical system performance. The calculation brief in Appendix C provides details on duplicate pair evaluation and RPD calculation.

In the duplicate evaluation, the RPD calculated for sulfate (30.9%) is below the acceptance criteria of 30%. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. There is no indication that the analytical system was operating out of control. The data are usable for decision-making purposes.

A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the target detection limit (TDL), including undetected analytes. In these cases, a control limit of ±2 times the TDL is used (Appendix C) to indicate that a visual check of the data is required by the reviewer. No data required this check. A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are usable for decision-making purposes.

## Summary

Limited, random, or sample matrix-specific influenced batch QC issues, such as those discussed above, are a potential for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 100-D-96:2 subsite verification sampling data found that the analytical results are accurate within the standard errors associated with the analytical methods, sampling, and sample handling. The DQA review for the 100-D-96:2 subsite concludes that the reviewed data are of the right type, quality, and quantity to support the intended use. The analytical data were found acceptable for decision-making purposes.

The verification sample analytical data are stored in the Washington Closure Hanford project-specific database prior to being submitted for inclusion in the Hanford Environmental Information System database. The verification sample analytical data are also summarized in Appendix C.

## REFERENCES

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