1221561

# WASTE SITE RECLASSIFICATION FORM

**Operable Unit:** 100-DR-1 **Control No.:** 2013-052

**Waste Site Code(s)/Subsite Code(s):** 100-D-78, 100-D Yellow Stained Soils

**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-78, 100-D Yellow Stained Soils 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* (Remaining Sites ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999) 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), as a candidate site for further evaluation. This waste site was composed of four stained soil areas located between the former 183-D and 186-D Buildings. Stained soil areas 1 and 2 are associated with the subsurface acid-proof brick trench that extended nearly the entire length of the west wall of the former 186-D Building. Confirmatory sampling of areas 1 and 2 concluded that remediation was required for these stained areas as well as for the material contained within the entire length of the 186-D Building acid-proof brick trench. Stained soil areas 3 and 4 did not require remediation based on confirmatory sample results.

The remediation of stained soil areas 1 and 2 consisted of removal of the entire length of the acid-proof brick trench, and hence the entire length of subsurface structure along what was once the west wall of the 186-D Building. The above-ground portions of the 186-D Building had been previously removed. Remediation of the 100-D-78 waste site was conducted between April 2 and April 26, 2012 and extended to a depth of 2 m (6.6 ft) bgs. Approximately 4,823 bank cubic meters of soil, building debris, and acid brick were removed, stockpiled, and disposed to the Environmental Restoration Disposal Facility (ERDF). The intent of the remediation was to remove the contents of the acid trench and any impacted underlying soils. As a practical matter, the structure of the trench (acid brick) and the west wall of 186-D were removed; however, some remnants of the structural concrete that was part the outside wall of the 186-D Building remain. A small volume of ion-exchange resin found within the acid trench was also removed and disposed to ERDF.

Verification sampling of the 100-D-78 waste site was conducted on January 16, 2013. Verification sampling of the associated stockpile area was conducted on April 1, 2013. Samples were analyzed for chemical contamination as required by the *100 Area Remedial Action Sampling and Analysis Plan* DOE/RL-96-22, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2009a). Laboratory analytical results were compared to cleanup levels in accordance with remedial action objectives and goals established in the Remaining Sites ROD (EPA 1999) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Areas* (100 Area RDR/RAWP), DOE/RL-97-17, Rev. 6, U.S. Department of Energy, Richland, Washington (DOE-RL 2009b). The selected remedy for the 100-D-78 waste site involved (1) removal of contaminated soils and debris, (2) disposal of contaminated materials at ERDF, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the waste site for reclassification to Interim Closed Out.

**Basis for reclassification:**

Verification sampling results were evaluated in comparison to cleanup levels. In accordance with this evaluation, the verification sampling results support a reclassification of the 100-D-78 waste site to Interim Closed Out. The current site conditions achieve the remedial action goals established by the Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009b). The evaluation of the results of verification sampling demonstrate that residual contaminant concentrations do not preclude any future land uses (as bounded by a rural-residential scenario) and allow for unrestricted future use of shallow zone soils (i.e., surface to 4.6 m [15 ft]). The results also show that residual contaminant concentrations are protective of groundwater and the Columbia River. The 100-D-78 waste site contamination did not extend into the deep zone soils. Therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the site are not required. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-D-78, 100-D Yellow Stained Soils Waste Site* (attached).

Attached to: 1221560

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A-6006-136 (REV 0)

# WASTE SITE RECLASSIFICATION FORM

**Operable Unit:** 100-DR-1 **Control No.:** 2013-052

**Waste Site Code(s)/Subsite Code(s):** 100-D-78, 100-D Yellow Stained Soils

**Regulator Comments:**

**Waste Site Controls:**

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

| | | |
|---|---|---|
| J. P. Neath | J P Neath | 8/15/13 |
| DOE Federal Project Director (printed) | Signature | Date |
| N. Menard | Nina M. Menard | 8/21/13 |
| Ecology Project Manager (printed) | Signature | Date |
| N/A | | |
| EPA Project Manager (printed) | Signature | Date |

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# REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-78, 100-D YELLOW STAINED SOILS WASTE SITE

**Attachment to Waste Site Reclassification Form 2013-052**

**August 2013**

# REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-78, 100-D YELLOW STAINED SOILS WASTE SITE

## EXECUTIVE SUMMARY

The 100-D-78, 100-D Yellow Stained Soils 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* (Remaining Sites ROD) (EPA 1999) by the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington* (EPA 2009) as a candidate site for further evaluation. This waste site comprised four locations where surface staining was observed between the 183-D and the 186-D Buildings. The staining was generally yellow in nature, but there was some white crusty material as well. Due to the location of the stains it was assumed that the source of the staining was sulfuric acid used in the 186-D Building and disposed to the 120-D-2 Waste Acid Reservoir.

Stained soil areas 1 and 2 were associated with a subsurface acid-proof brick trench that extended nearly the entire interior length of the west wall of the former 186-D Building. Confirmatory sampling results and field observations of areas 1 and 2 in September 2008 concluded that remediation was required for these areas as well as for the material contained within the acid-proof brick trench that connected between areas 1 and 2.

Stained soil area 3 is near the southwest corner of the former 120-D-2 Waste Acid Reservoir. Stained soil area 4 is also southwest of the waste acid reservoir but is farther away and not associated with any waste sites. Confirmatory sampling results from September 2008 found that neither stained soil area 3 nor 4 required remediation.

The remediation of stained soil areas 1 and 2 consisted of removal of the entire length of the acid-proof brick trench, and hence the entire length of subsurface structure along what was once the west wall of the 186-D Building. The above-ground portions of the 186-D Building had been previously removed. Remediation of areas 1 and 2 of the 100-D-78 waste site was conducted between April 2 and April 26, 2012 and extended to a depth of 2 m (6.6 ft) bgs. Approximately 4,823 bank cubic meters of soil, building debris, and acid brick were removed, stockpiled, and later disposed at the Environmental Restoration Disposal Facility (ERDF). The intent of the remediation was to remove the contents of the acid trench and any impacted underlying soils. As a practical matter, the structure of the trench (acid brick) and the then-remaining west wall of the 186-D Building were removed; however, some elements of the structural concrete that was part the outside wall of the 186-D Building remain. A small volume of ion-exchange resin found within the acid trench was also removed and disposed at the ERDF.

Verification sampling of the 100-D-78 waste site was conducted on January 16, 2013. Verification sampling of the associated stockpile area (SPA) was conducted on April 1, 2013. Samples were analyzed for contaminants of potential concern (COPCs) as indicated in the *Work Instruction for Verification Sampling of the 100-D-78, 100-D Yellow Stained Soils* (WCH 2012) and required by the *100 Area Remedial Action Sampling and Analysis Plan* (DOE-RL 2009a). Laboratory analytical results were compared to cleanup levels in accordance with remedial action objectives and goals established in the Remaining Sites ROD (EPA 1999) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Areas* (RDR/RAWP) (DOE-RL 2009b). The selected remedy for the 100-D-78 waste site involved (1) removal of contaminated soils and debris, (2) disposal of contaminated materials at ERDF, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the waste site for reclassification to Interim Closed Out.

The analytical results indicate that the 100-D-78 waste site achieves compliance with the remedial action objectives and remedial action goals (RAGs) of the Remaining Sites ROD (EPA 1999) and the RDR/RAWP (DOE-RL 2009b). A summary of the cleanup evaluation for the soil analyses against the applicable RAGs is presented in Table ES-1. The results of the verification sampling are used to make reclassification decisions for the 100-D-78 waste site in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2011b).

In accordance with this evaluation, the verification sampling results support a reclassification of this site to Interim Closed. These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario.

**Table ES-1. Summary of Remedial Action Goals for the 100-D-78 Waste Site. (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 are not COPCs for this site. | NA |
| Direct Exposure – Nonradionuclides | Attain individual COPC RAGs. | All individual COPC concentrations are below the direct exposure criteria. | Yes |
| Risk Requirements – Nonradionuclides | Attain a hazard quotient of <1 for all individual noncarcinogens. | All hazard quotients are <1. | Yes |
| | Attain a cumulative hazard quotient of <1 for noncarcinogens. | The cumulative hazard quotient ($4.6 \times 10^{-3}$) is <1. | |
| | Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens. | All individual carcinogens have an excess risk below $1 \times 10^{-6}$. | |
| | Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens. | The cumulative excess cancer risk is $1.8 \times 10^{-7}$. | |

**Table ES-1. Summary of Remedial Action Goals for the 100-D-78 Waste Site. (2 Pages)**

| Regulatory Requirement | Remedial Action Goals | Results | Remedial Action Objectives Attained? |
|---|---|---|---|
| Groundwater/River Protection – Radionuclides | Attain single-COPC groundwater and river protection RAGs. | Radionuclides are not COPCs for this site. | NA |
| | Attain national primary drinking water standards [a]: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs. | Radionuclides are not COPCs for this site. | |
| | 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]. | Radionuclides are not COPCs for this site. | |
| | Meet total uranium standard of 30 µg/L (21.2 pCi/L) [c]. | Uranium was not a COPC at this site. | |
| Groundwater/River Protection – Nonradionuclides | Attain individual nonradionuclide groundwater and river cleanup requirements. | All COPCs meet groundwater and river cleanup requirements. | 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).

COPC = contaminant of potential concern
MCL = maximum contaminant level
NA = not applicable
RAG = remedial action goal

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 contaminant levels remaining in the soil are protective of groundwater and the Columbia River. The 100-D-78 waste site contamination did not extend into the deep zone soils. Institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the site 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 ROD, a comparison against ecological risk screening levels has been made for the site contaminants of potential concern and other constituents. Those constituents exceeding an ecological screening level in the *Washington Administrative Code* 173-340 are boron, mercury, and vanadium. U.S. Environmental Protection Agency ecological soil screening levels are exceeded by manganese, vanadium, and zinc. Exceeding screening values does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of manganese, mercury, vanadium, and zinc 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-78 waste site that exceed ecological screening levels is provided in Appendix A.

# REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-78, 100-D YELLOW STAINED SOILS WASTE SITE

## STATEMENT OF PROTECTIVENESS

The 100-D-78, 100-D Yellow Stained Soils waste site verification data and supporting documentation demonstrate that this site meets the remedial action objectives (RAOs) and corresponding remedial action goals (RAGs) established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2009b) 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. The 100-D-78 waste site contamination does not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the site 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 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 an ecological screening level in the *Washington Administrative Code* (WAC) 173-340 are boron, mercury, and vanadium. U.S. Environmental Protection Agency (EPA) ecological soil screening levels are exceeded by manganese, vanadium, and zinc. Exceeding screening values does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of manganese, mercury, vanadium, and zinc 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-78 waste site that exceed ecological screening levels is provided in Appendix A.

## GENERAL SITE INFORMATION AND BACKGROUND

The 100-D-78, 100-D Yellow Stained Soils waste site comprised four locations where surface staining was observed between the 183-D and 186-D Buildings. The staining was generally yellow in nature, but there was some white crusty material as well. Due to the location of the stains it was assumed that the source of the staining was sulfuric acid used in the 186-D Building and disposed to the 120-D-2, Waste Acid Reservoir waste site.

Stained soil areas 1 and 2 of the 100-D-78 waste site were located on opposite ends of the acid-proof brick trench that extended nearly the entire interior length of the west wall of the former 186-D Building (Figure 1). Stained soil area 3 is near the southwest corner of the waste acid reservoir (120-D-2 waste site). Stained soil area 4 is southwest of the waste acid reservoir.

The acid-proof brick trench that contained stained soil areas 1 and 2 was approximately 1.2 m by 1.8 m (4 ft deep by 6 ft wide) and extended almost the entire length of the former 186-D Building (HEW 1944a, 1944b, and 1944c). The trench emptied into the 186-D Waste Acid Reservoir (120-D-2 waste site). Approximately 3 m (10 ft) west of the south end of the building were six exterior, horizontal, above-ground steel sulfuric-acid tanks.

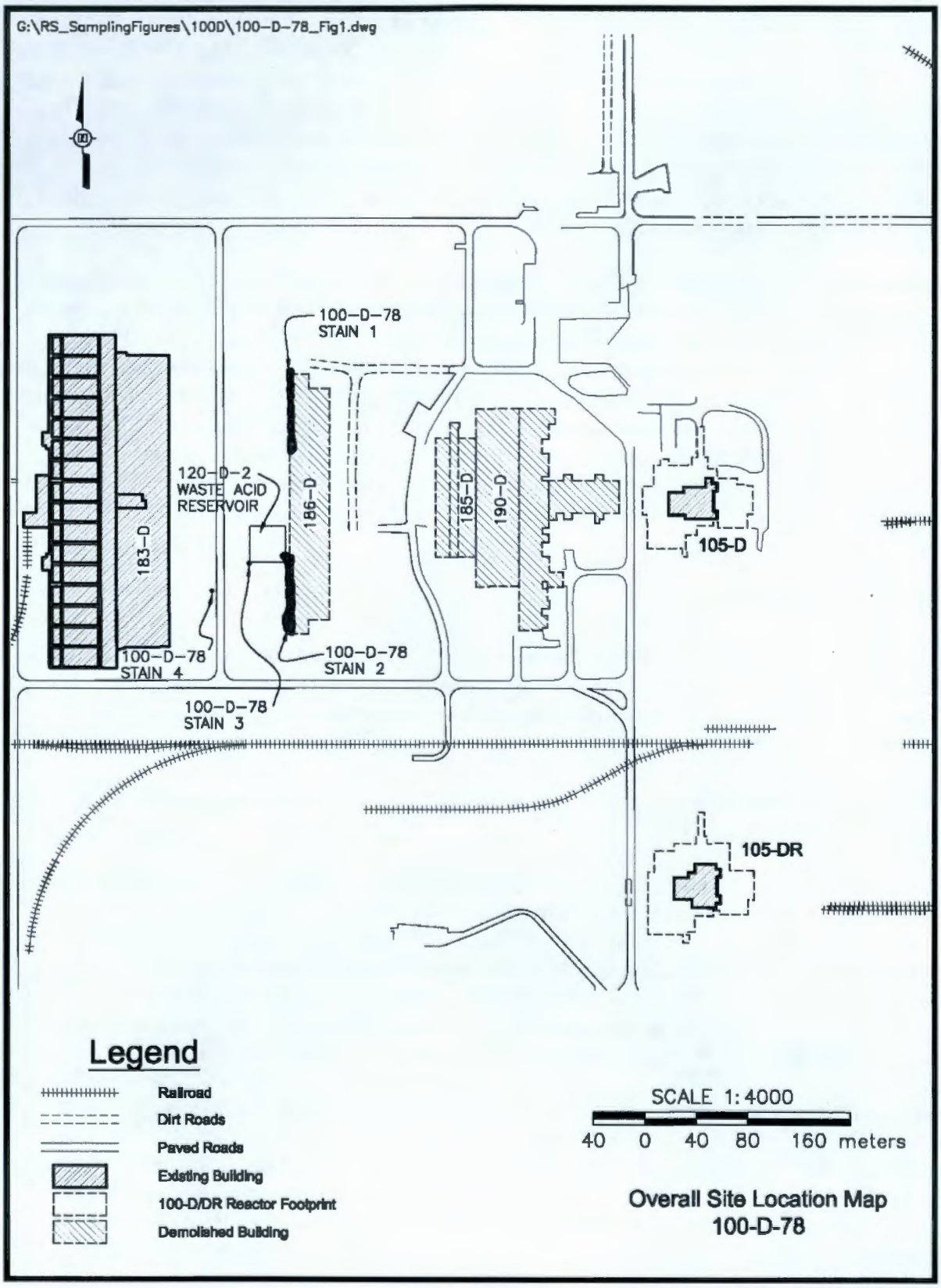
The 186-D Building was originally built as a demineralization facility, but it was not used for its intended purpose (WHC 1993). However, historical records show the facility underwent a 5-day test period where the facility was run at partial capacity to determine if the equipment operated correctly and the plant operations could run on a fully automatic basis (Haaga 1945).

While additional details of 186-D Building operations are not well documented, evidence of significant acid use in this area has been observed during 120-D-2, Waste Acid Reservoir remediation. Stained soil observed during the remediation of the 120-D-2, Waste Acid Reservoir was most likely associated with stained soil areas 1 and 2. Results from samples collected at the 120-D-2 and 100-D-78 waste sites show high sulfate content with low soil pH, and below background concentrations of total chromium and hexavalent chromium. Based on this information, it is likely that the soil discoloration seen at the 100-D-78 waste site and during the 120-D-2 waste site remediation were both due to sulfuric acid contamination rather than hexavalent chromium contamination, which creates a similar appearing stain.

## CONFIRMATORY SAMPLING SUMMARY

Historical data, process knowledge, geophysical survey results, site walkdown observations, and other available information are used to develop a site-specific sample design. The confirmatory sampling was performed to collect information to support evaluation of the site against the RAGs identified in the Remaining Sites ROD (EPA 1999). Confirmatory sampling at the 100-D-78 subsite was performed per the *Work Instruction for Confirmatory Sampling of the 100-D-78, Stained Soil Sites* (WCH 2008b) from September 11 through September 17, 2008, to collect data to support a determination if remedial action would be required. The following subsections provide additional discussion of the information used to develop the confirmatory sampling design and evaluation of the analytical results.

**Figure 1. 100-D-78 Waste Site Location.**



**Contaminants of Potential Concern**

The COPCs for confirmatory sampling of the 100-D-78 waste site were inductively coupled plasma (ICP) metals (arsenic, antimony, barium, beryllium, boron, cadmium, chromium [total], cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc), hexavalent chromium, mercury, ion chromatography (IC) anions (bromide, chloride, fluoride, nitrite, nitrate, phosphate, and sulfate), and pH. Phosphorus (as phosphate), potassium, and sodium are essential soil nutrients and were included in the expanded analytical list for EPA method 6010. These three elements were included only for the purposes of data collection, not for determining a remedial action requirement.

A portion of the 100-D-50:7, 183-DR Head House Floor Drains and Catch Basins Pipelines subsite was present in relative proximity to the 100-D-78 stained soil areas 3 and 4 and the former 120-D-2, 186-D Waste Acid Reservoir, to the west of the 186-D Building. The 100-D-50:7 pipelines were not connected to the 186-D Building but one segment was connected to the 186-D mixing tanks. This segment of 100-D-50:7 (service area 1) was sampled during confirmatory sampling in 2005. Manganese, copper, and zinc were detected above RAGs for groundwater and/or river protection in samples from the 100-D-50:7 pipe sediment. These metals were found at levels below background in the soil underlying the pipeline. However, based on the pipe sediment results, manganese, copper, and zinc were included as COPCs for the 100-D-78 waste site.

**Confirmatory Sample Design**

A focused sampling approach was used to assess 100-D-78 stained soil areas. Test pits were excavated at locations corresponding to areas of suspect contamination. Samples were collected from locations most likely to contain the highest levels of residual contamination. The objectives of sampling at the 100-D-78 waste site were as follows:

- Determine the presence or absence of environmental contaminants, as provided for in the Remaining Sites ROD (EPA 1999)
- Determine the nature and estimate the extent of potential contamination, as provided for in the Remaining Sites ROD (EPA 1999).

Confirmatory sampling was performed to collect information to support evaluation of the 100-D-78 Stained Soil Sites against the RAOs and corresponding RAGs identified in Remaining Sites ROD (EPA 1999). Analytical sample results were evaluated against the cleanup criteria specified in the RDR/RAWP (DOE-RL 2005) to support a remedial action decision.

**Stained Soil Areas 1 and 2**

Stained soil areas 1 and 2 appeared to be associated with the subsurface, acid-proof brick trench located along the west edge of the former 186-D Building. The stained surface soil observed at the site was likely associated with discharges of sulfuric acid to this trench. At the time of confirmatory sampling, it was unknown if this trench was removed during 186-D Building demolition.

Stained soil area 1 was located on the northwest side of the 186-D Building footprint and measured 4 m (13 ft) wide by 66 m (216 ft) long. Stained soil area 2 was located on the southwest side of the 186-D Building footprint and originally measured 9.1 m (30 ft) wide by 65 m (213 ft) long. However, a portion of the stained soil area 2 was removed as part of the 120-D-2 waste site remediation (Figure 2). Five test pits were planned within each of these two stained soil areas to intercept the base of the brick trench (Figure 3). Three of the five test pits, designated A, C, and E for each stained soil area, were to be sampled at three soil depths. An observational approach was to be used to investigate for staining to locate the remaining two test pits, designated B and D, with a single sample taken at the base of the test pit (1.5 m [5 ft] bgs).

**Stained Soil Area 3**

As previously discussed, stained soil area 3 was partially removed during remediation of the 120-D-2 waste site, the waste acid reservoir (Figure 2). The stain observed at this location was likely associated with the sulfate stains seen at the 120-D-2 waste site. Discrete soil samples were collected at depths of 0, 0.6, and 1.2 m (0, 2, and 4 ft) at the stained soil location. The sampling location was just outside the 120-D-2 excavation.

**Stained Soil Area 4**

Stained soil area 4 was located between the 183-D Clearwells and the 186-D Building, approximately 40 m (131 ft) southwest of the boundary of the waste acid reservoir (Figure 2). This area was approximately 4 $m^2$ (43 $ft^2$). The staining observed at this location is not associated with any known structure or waste site. One test pit was excavated at this location with discrete soil samples collected at depths of 0, 0.6, and 1.2 m (0, 2, and 4 ft).

**Summary of Confirmatory Sampling Activities**

Confirmatory sampling was performed at the 100-D-78 site between September 11 and September 17, 2008, as described in the field logbook (WCH 2008a). A summary of confirmatory samples taken at this site is provided in Table 1. A discussion of field activities follows.

**Stained Soil Areas 1 and 2**

The confirmatory sampling design called for five test pits each of stained soil areas 1 and 2, for a total of 10 test pits. The sampling began at sample area 2E, the most southern location in stained soil area 2 (Figure 3). A sample was collected at the surface (J17FK0). As excavation continued, the brick trench was encountered and concrete walls were visible on each side of the trench (Figure 4). A strong odor of sulfur was present and yellow staining was observed (Figure 5).

**Figure 2. Overlap of 120-D-2 Excavation and the 100-D-78 Stained Soil Waste Site Areas 1 and 2.**

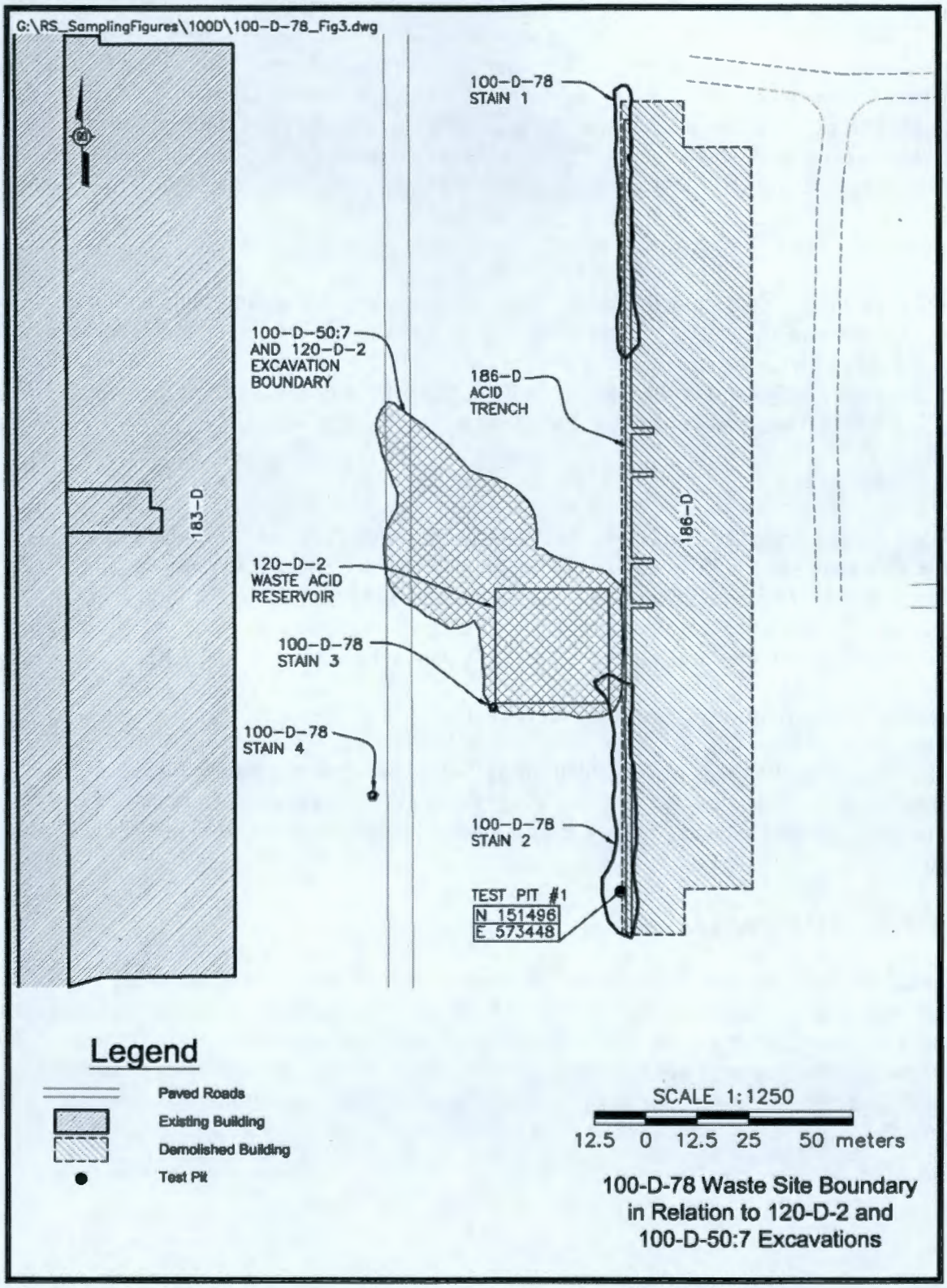


**Figure 3. Confirmatory Sampling Areas at the 100-D-78 Stained Soil Waste Site Areas 1 and 2.**

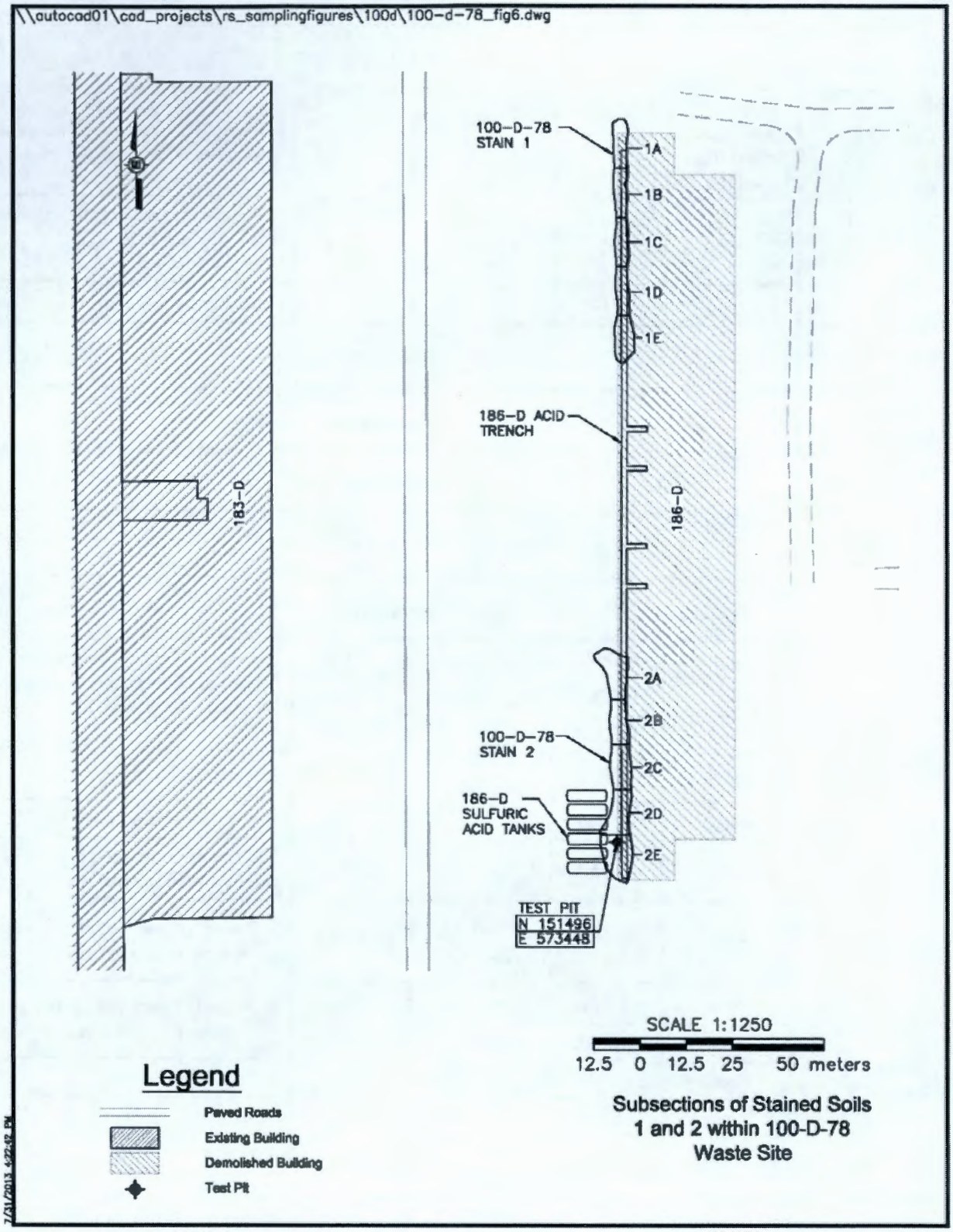


**Table 1. 100-D-78 Confirmatory Sample Summary Table. (2 Pages)**

| Sample Location | Sample Media | Sample Number | Coordinate Locations | Depth (bgs) | Sample Analysis |
|---|---|---|---|---|---|
| Soil stain 1 Test pit 1A | Not sampled | | | | |
| Soil stain 1 Test pit 1B | Ion exchange resin-like material | J17FL3 | N 151673 E 573450 | 1.2 m (4 ft) 1.2 m (4 ft) | ICP metals [a], mercury, hexavalent chromium, IC anions, pH |
| | Liquid | J17J48 | | | ICP metals [a], mercury, IC anions, pH, VOAs, pesticides [b], herbicides [c], GEA |
| | Liquid | J17J49 | | | Hexavalent chromium |
| Soil stain 1 Test pit 1C | Not sampled | | | | |
| Soil stain 1 Test pit 1D | Not sampled | | | | |
| Soil stain 1 Test pit 1E | Not sampled | | | | |
| Soil stain 2 Test pit 2A | Not sampled | | | | |
| Soil stain 2 Test pit 2B | Not sampled | | | | |
| Soil stain 2 Test pit 2C | Soil | J17FK5 | N 151518 E 573450 | 0 | ICP metals [a], mercury, hexavalent chromium, IC anions, pH |
| | Soil | J17FK6 | | 0.6 m (2 ft) | |
| | Soil | J17FK7 | | 1 m (3.5 ft) | |
| | Mortar | J17FN5 [d] | | | ICP metals [a], mercury |
| | Mortar | J17FM5 [e] | | | Hexavalent chromium |
| | Soil | J17FK8 | | 1.2 m (4 ft) | ICP metals [a], mercury, hexavalent chromium, IC anions, pH |
| Soil stain 2 Test pit 2D | Soil | J17FK4 | N 151505 E 573450 | 1.5 m (5 ft) | ICP metals [a], mercury, hexavalent chromium, IC anions, pH |
| Soil stain 2 Test pit 2E | Soil | J17FK0 | N 151496 E 573448 | 0 | ICP metals [a], mercury, hexavalent chromium, IC anions, pH |
| | Soil | J17FK1 | | 0.6 m (2 ft) | |
| | Mortar | J17FN4 [d] | | 1 m (3.5 ft) | ICP metals [a], mercury |
| | Mortar | J17FM4 [e] | | | Hexavalent chromium |
| | Mortar | J17HR3 | | | Asbestos [f] |
| Soil stain 2 Test pit 2E [g] | Soil | J17FK2 | N 151496 E 573447 | 1.2 m (4 ft) | ICP metals [a], mercury, hexavalent chromium, IC anions, pH |

**Table 1. 100-D-78 Confirmatory Sample Summary Table. (2 Pages)**

| Sample Location | Sample Media | Sample Number | Coordinate Locations | Depth (bgs) | Sample Analysis |
|---|---|---|---|---|---|
| Soil stain 3 | Soil | J17HM2 | N 151541 E 573417 | 0 | ICP metals [a], mercury, hexavalent chromium, IC anions, pH |
| | | J17HM3 | | 0.6 m (2 ft) | |
| | | J17HM4 | | 1.2 m (4 ft) | |
| Soil stain 4 | Soil | J17FK9 | N 151519 E 573387 | 0 | ICP metals [a], mercury, hexavalent chromium, IC anions, pH |
| | | J17FL0 | | 0.6 m (2 ft) | |
| | | J17FL1 | | 1.2 m (4 ft) | |
| Duplicate of J17FK2 [g] | Soil | J17FK3 | N 151496 E 573448 | 1.2 m (4 ft) | ICP metals [a], mercury, hexavalent chromium, IC anions, pH |
| Equipment blank | Silica sand | J17FJ9 | NA | NA | ICP metals [a], mercury, hexavalent chromium, IC anions, pH |

[a] The expanded list of ICP metals included arsenic, antimony, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, phosphorus, potassium, selenium, silver, sodium, vanadium, and zinc in the analytical results package. Phosphorus, potassium, and sodium were included in the expanded analytical list for EPA method 6010 for data collection purposes only, not for determining a remedial action requirement.

[b] Analysis for pesticides performed using EPA Method 8081.

[c] Analysis for herbicides performed using EPA Method 8151.

[d] Analyses for anions and pH were inadvertently not requested on chain of custody.

[e] Due to matrix interference, no data was obtained or reported from this sample.

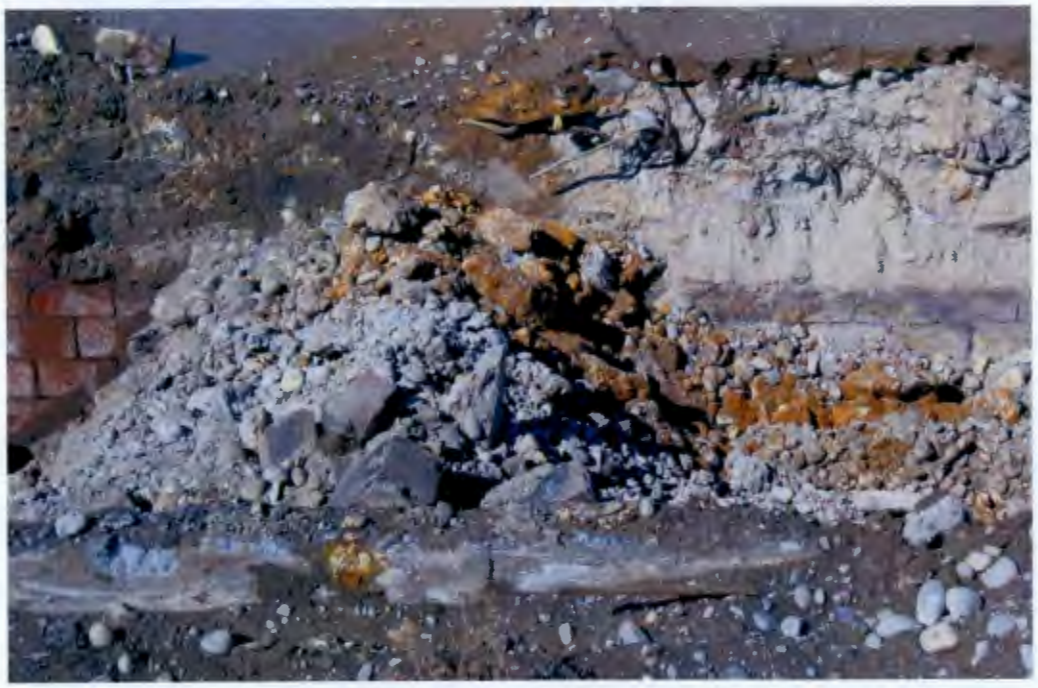
[f] Analysis for asbestos performed using NIOSH Method 7400

[g] Due to unsuccessful attempts to break through the brick trench, a second test pit was excavated approximately 1 m (3 ft) to the west of the initial 2E test pit location to collect soil at 1.2 m (4 ft) bgs. This new location was to the west of the brick trench wall and within the boundary of stained soil area 2.

bgs = below ground surface
GEA = gamma energy analysis
IC = ion chromatography
ICP = inductively coupled plasma
NA = not applicable
NIOSH = National Institute for Occupational Safety and Health
pH = hydrogen ion concentration
VOA = volatile organic analysis

**Figure 4. Excavation in Brick Trench at Sample Area 2E.**

**Figure 5. Yellow Staining at Sample Area 2E in the 186-D Building Brick Trench.**



A sample was collected at 0.6 m (2 ft) bgs (J17FK1). Samples of the mortar at the surface of the trench base were collected for metals, mercury, anions, pH (J17FN4), and hexavalent chromium (J17FM4) analyses. A third sample of mortar (J17HR3) was taken for asbestos analysis. Attempts were made to penetrate the bottom of the trench but it appeared to be too thick to break through. Because of this a separate test pit was excavated on the outside of the building foundation approximately 1 m (3 ft) to the west of the initial 2E location to a depth of approximately 1.2 m (4 ft), which was deeper than the base of the brick trench. A sample (J17FK2) and a duplicate (J17FK3) were taken at this depth.

At sample area 2D, additional attempts were made to penetrate the trench floor. The excavator broke through the floor and brought up soil from beneath the trench (1.2 m [4 ft] bgs) and a sample was collected (J17FK4).

At sample area 2C, soil samples were taken at the surface (J17FK5), 0.6 m (2 ft) bgs (J17FK6), at the trench floor (J17FK7), and below the trench (J17FK8). Samples of the mortar at the base of the trench were collected for metals, mercury, anions, pH (J17FN5), and hexavalent chromium (J17FM5) analyses.

During the excavation of sample area 1B, material resembling ion-exchange resin was found in the trench (Figure 6). Because the 186-D Building was a water treatment facility and ion-exchange resin is often used in water treatment, it was a reasonable material to encounter. A sample (J17FL3) was taken of the resin. The excavation continued in an attempt to break through the trench floor but water began to seep into the excavation (Figure 7). A sample of the water (J17J48) was taken on September 17, 2008. Due to the unexpected nature of the water intrusion, additional analyses were conducted for gamma energy analysis (GEA), volatile organic carbons (VOCs), pesticides, and herbicides. No further excavation was conducted at stained soil areas 1 and 2 as the field observations indicated that remediation would be required.

**Stained Soil Area 3**

Stained soil area 3 was sampled at surface (J17HM2), 0.6 m (2 ft) bgs (J17HM3), and 1.2 m (4 ft) bgs (J17HM4).

**Stained Soil Area 4**

Stained soil area 4 was sampled at surface (J17FK9), 0.6 m (2 ft) bgs (J17FL0), and 1.2 m (4 ft) bgs (J17FL1).

No elevated VOCs or radiological activity were detected with field instrumentation during any of the 100-D-78 sampling activities.

**Figure 6. Ion Exchange Resin Found in Sample Area 1B.**

**Figure 7. Water Intrusion in Sample Area 1B.**

## CONFIRMATORY SAMPLE RESULTS

Samples were analyzed using EPA approved analytical methods. The results were stored in the Environmental Restoration (ENRE) project-specific database prior to archiving in the Hanford Environmental Information System (HEIS) and are included in Appendix B. Analytical sample results from the confirmatory sampling were evaluated against the cleanup criteria specified in the RDR/RAWP (DOE-RL 2005) to support remediation decisions.

### Stained Soil Areas 1 and 2

A comparison of the maximum analytical results against soil cleanup levels identified in the RDR/RAWP (DOE-RL 2005) was performed. This comparison indicated that 100-D-78 stained soil area 2 failed the direct exposure RAG for arsenic and the groundwater protection/river protection RAGs for antimony, chromium, copper, lead, and zinc (Table 2). Analytical results from stained soil area 1 water sample exceeded the groundwater MCL for arsenic, beryllium, cadmium, cobalt, chromium, copper, mercury, manganese, nickel, lead, vanadium, and zinc (Table 3). The pH of the water was low (3.8), which was likely attributable to prior use of sulfuric acid in the trench.

**Table 2. Confirmatory Sample Results for 100-D-78 Stained Soil Areas 1 and 2. (2 Pages)**

| COPC | Maximum Result (mg/kg) | Soil Cleanup Levels (mg/kg)[a] | | | Does the Maximum Result Exceed RAGs? | Does the Maximum Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Groundwater Protection | River Protection | | |
| Antimony | 5.5 | 32 | 5[b] | 5[b] | Yes | --[c] |
| Arsenic | 37.7 | 20 | 20 | 20 | Yes | --[d] |
| Barium | 93.5 (<BG) | 5,600 | 132[b] | 224 | No | -- |
| Beryllium | 0.35 (<BG) | 10.4[e] | 1.51[b] | 1.51[b] | No | -- |
| Boron[f] | 5.6 | 16,000 | 320 | NA | No | -- |
| Cadmium | 0.18 (<BG) | 13.9[e] | 0.81[b] | 0.81[b] | No | -- |
| Chromium, total | 24.5 | 80,000 | 18.5[b] | 18.5[b] | Yes | Yes |
| Chromium (hexavalent)[f] | 0.27 | 2.1[d] | 4.8 | 2 | No | -- |
| Cobalt | 9.1 (<BG) | 1,600 | 32 | NA | No | -- |
| Copper | 75.7 | 2,960 | 59.2 | 22.0[b] | Yes | Yes |
| Lead | 51.7 | 353 | 10.2[b] | 10.2[b] | Yes | Yes |
| Manganese | 340 (<BG) | 11,200 | 512[b] | 512[b] | No | -- |
| Mercury | 0.15 (<BG) | 24 | 0.33[b] | 0.33[b] | No | -- |
| Molybdenum[e] | 1.7 | 400 | 8 | NA | No | -- |
| Nickel | 13.1 (<BG) | 1,600 | 19.1[b] | 27.4 | No | -- |
| Selenium | 0.6 (<BG) | 400 | 5 | 1 | No | -- |
| Vanadium | 81.3 (<BG) | 560 | 85.1[b] | NA | No | -- |
| Zinc | 166 | 24,000 | 480 | 67.8[b] | Yes | --[c] |
| Nitrate (as nitrogen) | 1.5 (<BG) | 128,000 | 1,000 | 2,000 | No | -- |
| Nitrite (as nitrogen) | 1.4 | 8,000 | 100 | 200 | No | -- |

## Table 2. Confirmatory Sample Results for 100-D-78 Stained Soil Areas 1 and 2. (2 Pages)

| COPC | Maximum Result (mg/kg) | Soil Cleanup Levels (mg/kg)[a] | | | Does the Maximum Result Exceed RAGs? | Does the Maximum Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Groundwater Protection | River Protection | | |
| Sulfate | 14,500 | NA | 25,000 | 50,000 | No | -- |

[a] Lookup values and RAGs obtained from the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005) or calculated per WAC 173-340-720, WAC 173-340-730, and WAC 173-340-740, Method B, unless otherwise noted.

[b] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d].

[c] The groundwater/river protection evaluation was not completed because one or more COPCs failed direct exposure cleanup criteria and the site was remediated.

[d] A RESRAD evaluation was not performed because the result failed direct exposure RAG.

[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$^3$ (WDOH 1997).

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

-- = not applicable
BG = background
COPC = contaminant of potential concern
NA = not available
RAG = remedial action goal
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

## Table 3. 100-D-78 Stained Soil Area 1B Water Sample Results. (2 Pages)

| COPC | Maximum Result (µg/L) | Groundwater Cleanup Level[a] (µg/L) | | Groundwater MCL[b] (µg/L) | Does the Maximum Result Exceed Cleanup Level/MCL? |
|---|---|---|---|---|---|
| | | Carcinogen | Noncarcinogen | | |
| Arsenic | 47.3 | 0.0583 | 4.80 | 5 | Yes |
| Barium | 626 | NA | 3,200 | 2,000 | No |
| Beryllium | 41.6 | NA | 32 | 4 | Yes |
| Boron | 340 | NA | 3,200 | NA | No |
| Cadmium | 333 | NA | 8.00 | 5 | Yes |
| Chromium, total | 451 | NA | 24,000 | 100 | Yes |
| Chromium (hexavalent) | 27 | NA | 48 | NA | No |
| Cobalt | 1,960 | NA | 320 | NA | Yes |
| Copper | 1,950 | NA | 592 | 1,000 | Yes |
| Lead | 632 | NA | NA | 15 | Yes |
| Manganese | 77,100 | NA | 2,240 | 50 | Yes |
| Mercury | 4 | NA | 4.80 | 2 | Yes |
| Molybdenum | 14 | NA | 80 | NA | No |
| Nickel | 1,190 | NA | 320 | 100 | Yes |
| Selenium | 18 | NA | 80 | 50 | No |
| Vanadium | 297 | NA | 112 | NA | Yes |
| Zinc | 21,400 | NA | 4,800 | 5,000 | Yes |
| Silvex | 0.35 | NA | 120 | 50 | No |
| 4-(2,4-Dichlorophenoxy) butanoic acid | 0.16 | NA | 128 | NA | No |
| Dichloroprop | 0.17 | NA | 160 | 70 | No |

**Table 3. 100-D-78 Stained Soil Area 1B Water Sample Results. (2 Pages)**

| COPC | Maximum Result (µg/L) | Groundwater Cleanup Level [a] (µg/L) | | Groundwater MCL [b] (µg/L) | Does the Maximum Result Exceed Cleanup Level/MCL? |
|---|---|---|---|---|---|
| | | Carcinogen | Noncarcinogen | | |
| Di-n-butylphthalate | 0.60 | NA | 1,600 | NA | No |
| Acetone | 17 | NA | 7,200 | NA | No |

[a] Calculated using the appropriate formulas from WAC 173-340-720, with toxicity values updated through April 11, 2007, from the EPA Integrated Risk Information System (IRIS) at http://www.epa.gov/iris or from the Risk Assessment Information System (RAIS) database of the Oak Ridge National Laboratory (ORNL) on the Internet at http://risk.lsd.ornl.gov.
[b] Maximum contaminant levels (MCL) (40 CFR 141) and secondary maximum contaminant levels (40 CFR 143).

COPC = contaminant of potential concern
EPA = U.S. Environmental Protection Agency
NA = Not applicable
WAC = *Washington Administrative Code*

While most of the hexavalent chromium samples were able to be analyzed, the samples of the trench brick and mortar were not quantifiable due to matrix interference. Therefore, hexavalent chromium results at stained soil area 2 were not obtained for samples J17FM4 and J17FM5.

Based on the arsenic result (37.7 mg/kg) from stained soil area 2, the multiple metals exceeding MCLs in the stained soil area 1 water sample, and the condition and contents of the subsurface brick trench, both stained soil areas 1 and 2 of the 100-D-78 waste site were recommended for remediation.

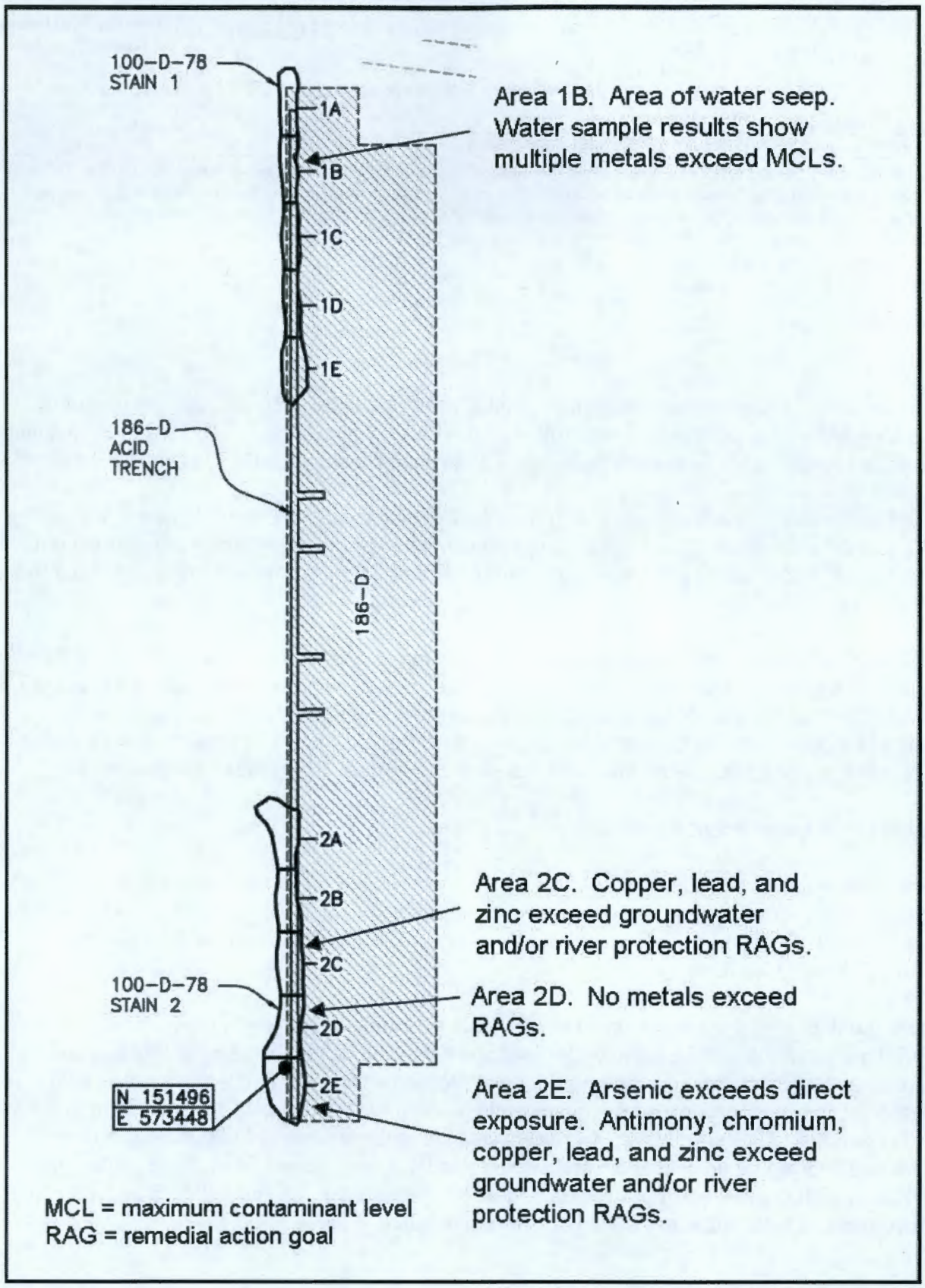
As shown in Figure 8, the confirmatory sample locations covered both ends of the subsurface brick trench of the demolished 186-D Building. During the confirmatory sampling excavation, it was evident that the trench was left intact and contained free liquids in the northern section (sample location 1B). Therefore, remediation of both stained soil areas 1 and 2, as well as the material within the 186-D Building brick trench between these areas, was recommended.

**Stained Soil Areas 3 and 4**

A comparison of the maximum analytical results from stained soil areas 3 and 4 against soil cleanup levels shows that no cleanup levels were exceeded (Tables 4 and 5). The soil staining at area 3 was likely due to sulfate from previous use of sulfuric acid, as seen in the adjacent 120-D-2 Waste Acid Reservoir.

The staining at area 4 was also due to the presence of sulfate based on the maximum result of 15,000 mg/kg in the surface sample. It is unknown why sulfate was present at this location as there are no adjacent structures or known waste sites, however, it is likely that sulfuric acid was released at this location. An acid release would account for the low pH (3.6) measured in the surface sample. The sulfate levels were concentrated at the surface (15,000 mg/kg) with only 1,130 and 448 mg/kg present at 0.6 and 1.2 m (2 and 4 ft) bgs, respectively. Soil acidity also decreased with depth with pH values of 7.5 and 8.4 measured at 0.6 and 1.2 m (2 and 4 ft) bgs, respectively. Therefore, remedial action was not required at areas 3 and 4.

**Figure 8. Sample Results from Confirmatory Test Pit Locations 1B, 2C, 2D, and 2E.**



## Table 4. Confirmatory Sample Results for 100-D-78 Stained Soil Area 3.

| COPC | Maximum Result (mg/kg) | Soil Cleanup Levels (mg/kg) [a] | | | Does the Maximum Result Exceed RAGs? | Does the Maximum Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Groundwater Protection | River Protection | | |
| Arsenic | 3.1 (<BG) | 20 [b] | 20 [b] | 20 [b] | No | -- |
| Barium | 72.0 (<BG) | 5,600 | 200 | 400 | No | -- |
| Beryllium | 0.34 (<BG) | 10.4 [c] | 1.51 [b] | 1.51 [b] | No | -- |
| Boron [d] | 1.7 | 7,200 | 320 | -- [e] | No | -- |
| Chromium, total | 12.9 (<BG) | 80,000 | 18.5 [b] | 18.5 [b] | No | -- |
| Cobalt | 9.8 (<BG) | 24 | 15.7 | -- [e] | No | -- |
| Copper | 15.4 (<BG) | 2,960 | 59.2 | 22.0 [b] | No | -- |
| Lead | 8.8 (<BG) | 353 | 10.2 [b] | 10.2 [b] | No | -- |
| Manganese | 333 (<BG) | 3,760 | 512 [b] | 512 [b] | No | -- |
| Mercury | 0.05 (<BG) | 24 | 0.33 [b] | 0.33 [b] | No | |
| Molybdenum [d] | 0.69 | 400 | 8 | -- [e] | No | -- |
| Nickel | 12.2 (<BG) | 1,600 | 19.1 [b] | 27.4 | No | -- |
| Vanadium | 71.1 (<BG) | 560 | 85.1 [b] | -- [e] | No | -- |
| Zinc | 50.4 (<BG) | 24,000 | 480 | 67.8 [b] | No | -- |
| Nitrate (as nitrogen) | 1.1 (<BG) | 128,000 | 1,000 | 2,000 | No | -- |
| Nitrite (as nitrogen) | 0.89 | 8,000 | 100 | 200 | No | -- |
| Sulfate | 720 | -- | 25,000 | -- [e] | No | -- |

[a] RAGs obtained from the RDR/RAWP (DOE-RL 2009b).
[b] Where cleanup levels are less than background, cleanup levels default to background ("Model Toxics Control Act – Cleanup," WAC 173-340-700[4][d]) (1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Section 2.1.2.1 of the RDR/RAWP (DOE-RL 2009b).
[c] 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$^3$ (WDOH 1997).
[d] No Hanford Site-specific or Washington State background value available.
[e] 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 2012) or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).

-- = not applicable
BG = background
COPC = contaminant of potential concern
NA = not available
RAG = remedial action goal
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

## Table 5. Confirmatory Sample Results for 100-D-78 Stained Soil Area 4. (2 Pages)

| COPC | Maximum Result (mg/kg) | Soil Cleanup Levels (mg/kg) [a] | | | Does the Maximum Result Exceed RAGs? | Does the Maximum Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Groundwater Protection | River Protection | | |
| Arsenic | 3.5 (<BG) | 20 [b] | 20 [b] | 20 [b] | No | -- |
| Barium | 84.8 (<BG) | 5,600 | 200 | 400 | No | -- |
| Beryllium | 0.38 (<BG) | 10.4 [c] | 1.51 [b] | 1.51 [b] | No | -- |
| Boron [d] | 2.8 | 7,200 | 320 | -- [e] | No | -- |
| Chromium, total | 15.6 (<BG) | 80,000 | 18.5 [b] | 18.5 [b] | No | -- |
| Cobalt | 8.1 (<BG) | 24 | 15.7 | -- [e] | No | -- |
| Copper | 16.4 (<BG) | 2,960 | 59.2 | 22.0 [b] | No | -- |
| Lead | 7.3 (<BG) | 353 | 10.2 [b] | 10.2 [b] | No | -- |
| Manganese | 329 (<BG) | 3,760 | 512 [b] | 512 [b] | No | -- |
| Mercury | 0.009 (<BG) | 24 | 0.33 [b] | 0.33 [b] | No | |
| Molybdenum [d] | 0.48 | 400 | 8 | -- [e] | No | -- |

**Table 5. Confirmatory Sample Results for 100-D-78 Stained Soil Area 4. (2 Pages)**

| COPC | Maximum Result (mg/kg) | Soil Cleanup Levels (mg/kg) [a] | | | Does the Maximum Result Exceed RAGs? | Does the Maximum Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Groundwater Protection | River Protection | | |
| Nickel | 12.1 (<BG) | 1,600 | 19.1 [b] | 27.4 | No | -- |
| Vanadium | 76.9 (<BG) | 560 | 85.1 [b] | -- [e] | No | -- |
| Zinc | 42.6 (<BG) | 24,000 | 480 | 67.8 [b] | No | -- |
| Nitrate (as nitrogen) | 1.4 (<BG) | 128,000 | 1,000 | 2,000 | No | -- |
| Nitrite (as nitrogen) | 1.8 | 8,000 | 100 | 200 | No | -- |
| Sulfate | 15,000 | -- | 25,000 | -- [e] | No | -- |

[a] RAGs obtained from the RDR/RAWP (DOE-RL 2009b).
[b] Where cleanup levels are less than background, cleanup levels default to background ("Model Toxics Control Act – Cleanup," WAC 173-340-700[4][d]) (1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Section 2.1.2.1 of the RDR/RAWP (DOE-RL 2009b).
[c] 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$^3$ (WDOH 1997).
[d] No Hanford Site-specific or Washington State background value available.
[e] 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 2012) or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).

-- = not applicable
BG = background
COPC = contaminant of potential concern
NA = not available
RAG = remedial action goal
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

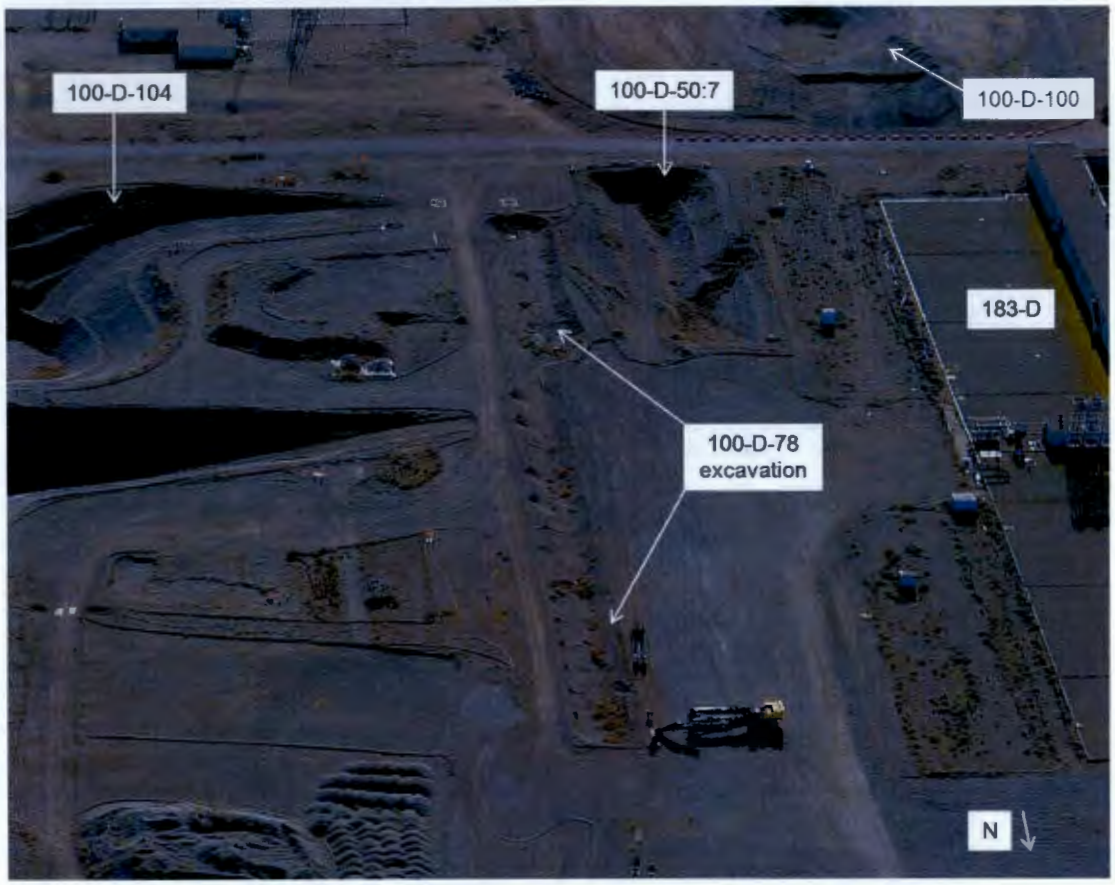
## Remediation Activities

The remove, treat, and dispose (RTD) of stained soil areas 1 and 2 consisted of removal of the entire length of the acid trench, and hence the entire length of subsurface structure along what was once the west wall of the 186-D Building. The above-ground portions of the 186-D Building had been previously removed. Remediation of the 100-D-78 waste site was conducted between April 2 and April 26, 2012, and extended to a depth of 2 m (6.6 ft) bgs. Approximately 4,823 BCM of soil, building debris, and acid brick from the acid trench were removed, stockpiled, and then disposed at the Environmental Restoration Disposal Facility (ERDF). The intent of the RTD action was to remove the contents of the acid trench and any impacted underlying soils. As a practical matter, the structure of the trench (acid brick) and the west wall of 186-D were removed; however, some remnants of the structural concrete that was part the outside wall of 186-D remained. Additionally, a small volume of ion-exchange resin found within the acid trench was also removed and stockpiled for later disposal at ERDF. A post-excavation photograph is presented in Figure 9.

## Contaminants of Potential Concern

The COPCs for the 100-D-78 waste site were based on results from confirmatory sampling (WCH 2009) and included ICP metals (antimony, arsenic, barium, beryllium, boron, cadmium, chromium [total], cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc), hexavalent chromium, mercury, and pH.

**Figure 9. January 2013 Aerial Photograph of the 100-D-78 Excavation (View to the South).**




Additionally, nitrate, nitrite, and sulfate were considered COPCs for the 100-D-78 waste site. Nitrate and nitrite were determined by EPA Method 353.2 to avoid holding time issues associated with EPA Method 300.0. Sulfate was determined by EPA Method 300.0.

**Verification Sampling Activities**

Verification sampling of the 100-D-78 waste site was conducted on January 16, 2013. Verification sampling of the associated stockpile area (SPA) was conducted on April 1, 2013. Samples were analyzed for COPCs as indicated in the *Work Instruction for Verification Sampling of the 100-D-78, 100-D Yellow Stained Soils* (WCH 2012). All sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management*, to fulfill the requirements of the *100 Area Remedial Action Sampling and Analysis Plan* (DOE-RL 2009a). Field observations during sampling are provided in the field logbook (WCH 2013).

Table 6 presents a summary of the samples collected at the site and the analyses performed for each. The 100-D-78 waste site verification sample locations are shown in Figures 10, 11, and 12.

## Table 6. 100-D-78 Verification Sample Summary.

| Sample Location | HEIS Sample Number | Washington State Plane Coordinates | | Sample Analysis [a] |
|---|---|---|---|---|
| | | Northing (m) | Easting (m) | |
| **100-D-78 Statistical Excavation Area Samples** | | | | |
| 78D-1 | J1R681 | 151494.9 | 573447.4 | ICP metals [b], mercury, hexavalent chromium, pH, IC anions [c], nitrate/nitrite [c] |
| 78D-2 | J1R682 | 151508.8 | 573439.4 | |
| 78D-3 | J1R683 | 151522.7 | 573447.4 | |
| 78D-4 | J1R684 | 151536.6 | 573439.4 | |
| 78D-5 | J1R685 | 151550.5 | 573447.4 | |
| 78D-6 | J1R686 | 151578.2 | 573447.4 | |
| 78D-7 | J1R687 | 151606.0 | 573447.4 | |
| 78D-8 | J1R688 | 151633.8 | 573447.4 | |
| 78D-9 | J1R689 | 151647.7 | 573455.4 | |
| 78D-10 | J1R690 | 151661.6 | 573447.4 | |
| 78D-11 | J1R691 | 151675.5 | 573455.4 | |
| 78D-12 | J1R692 | 151689.4 | 573447.4 | |
| Duplicate of J1R684 | J1R693 | 151536.6 | 573439.4 | |
| Equipment blank | J1R694 | NA | NA | ICP metals, mercury |
| **100-D-78 Statistical Staging Pile Area Samples** | | | | |
| SPA-1 | J1R695 | 151902.5 | 573589.6 | ICP metals [b], mercury, hexavalent chromium, pH, IC anions [c], nitrate/nitrite [c] |
| SPA-2 | J1R696 | 151902.5 | 573611.8 | |
| SPA-3 | J1R697 | 151902.5 | 573634.1 | |
| SPA-4 | J1R698 | 151902.5 | 573656.3 | |
| SPA-5 | J1R699 | 151921.7 | 573600.7 | |
| SPA-6 | J1R6C0 | 151921.7 | 573623.0 | |
| SPA-7 | J1R6C1 | 151921.7 | 573645.2 | |
| SPA-8 | J1R6C2 | 151921.7 | 573667.4 | |
| SPA-9 | J1R6C3 | 151941.0 | 573589.6 | |
| SPA-10 | J1R6C4 | 151941.0 | 573611.8 | |
| SPA-11 | J1R6C5 | 151941.0 | 573634.1 | |
| SPA-12 | J1R6C6 | 151941.0 | 573656.3 | |
| Duplicate of J1R695 | J1R6C7 | 151902.5 | 573589.6 | |
| Equipment blank | J1R6C8 | NA | NA | ICP metals, mercury |

[a] Full protocol laboratory analysis.
[b] The expanded list of ICP metals were requested to include antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.
[c] Nitrate and nitrite were determined by EPA Method 353.2 to avoid holding time issues associated with EPA Method 300.0. Sulfate was determined by EPA Method 300.0.

HEIS = Hanford Environmental Information System
IC = ion chromatography
ICP = inductively coupled plasma
NA = not applicable

**Figure 10. Excavation and Staging Pile Area Verification Sampling Locations.**

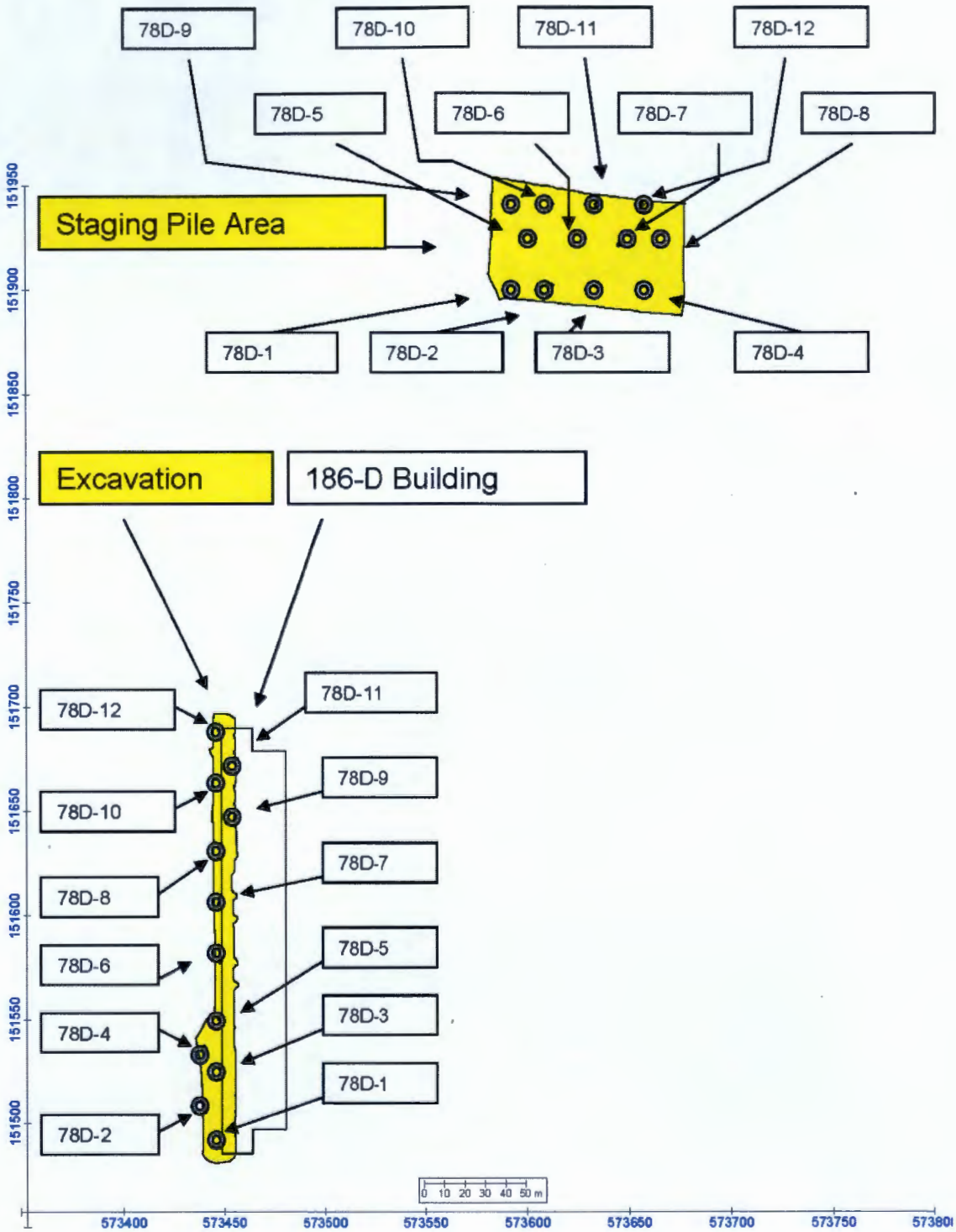


**Figure 11. Verification Sample Locations for the 100-D-78 Excavation.**

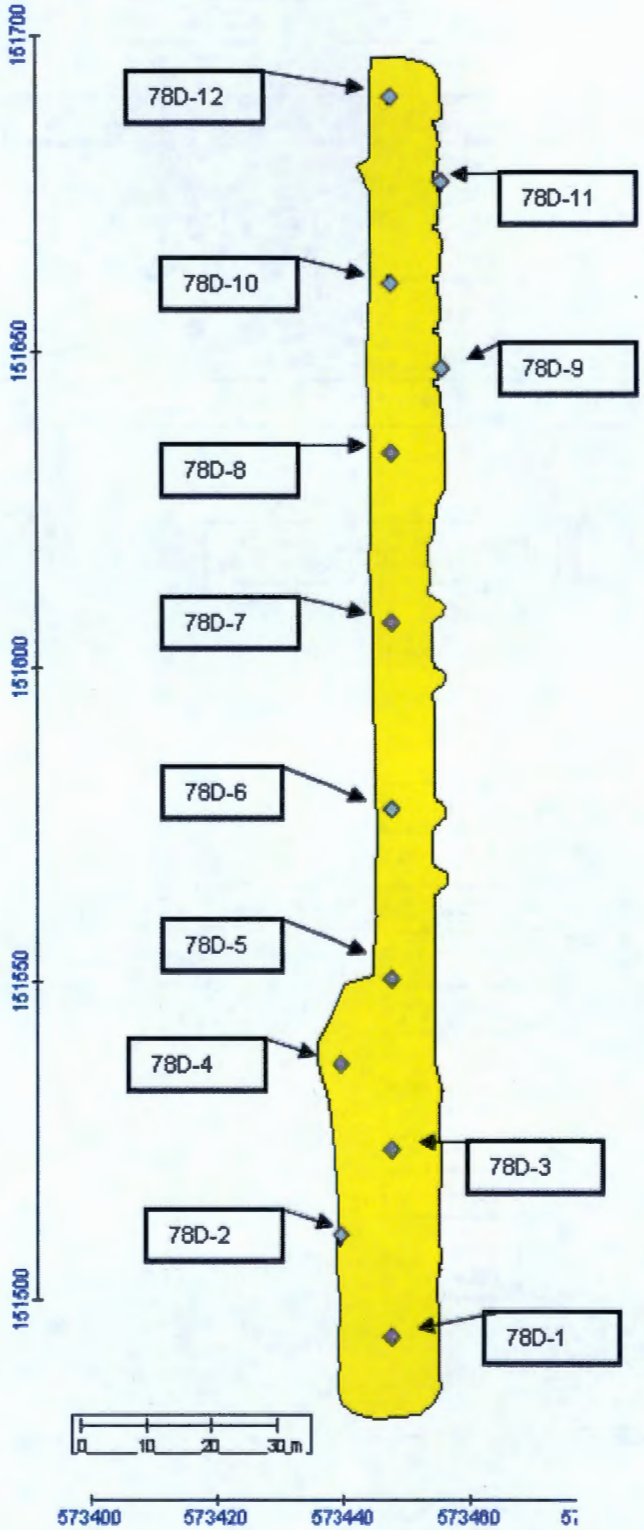
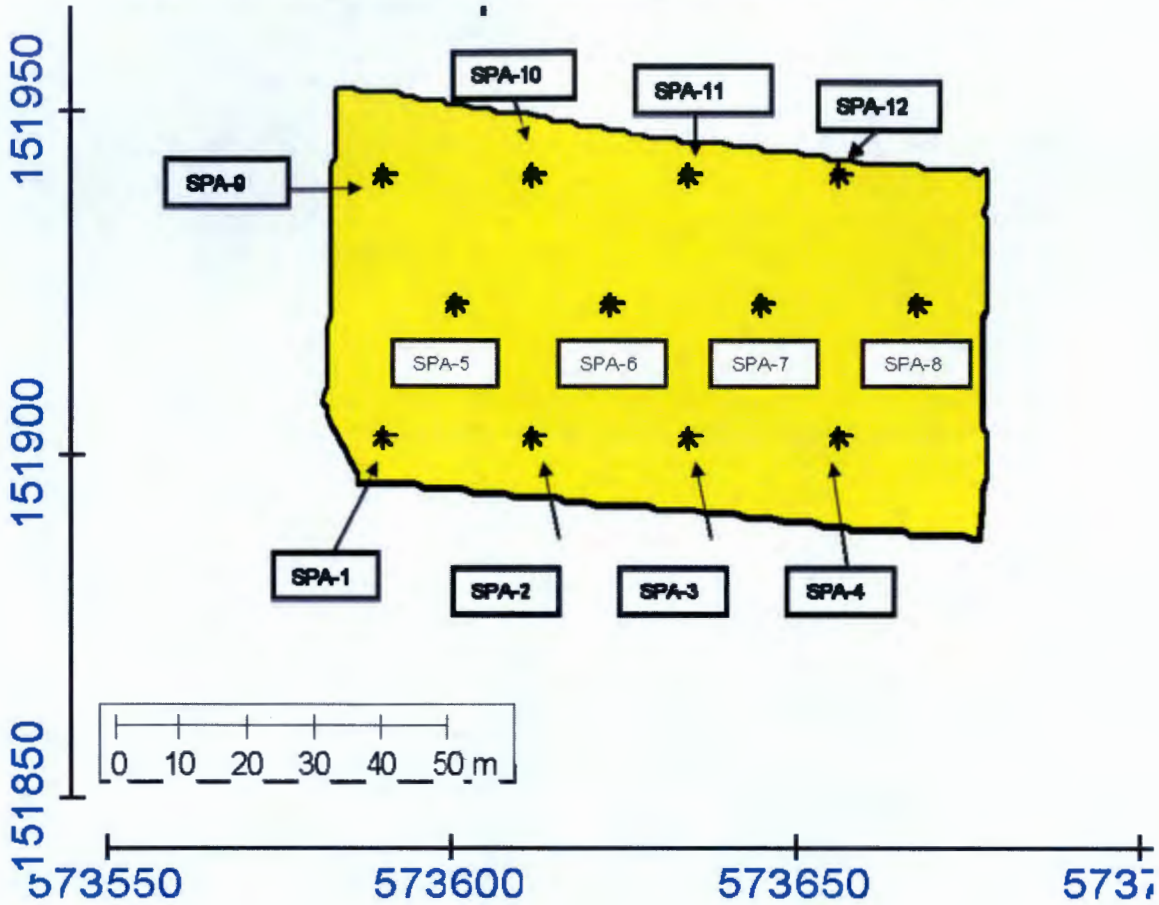


**Figure 12. Verification Sample Locations for the 100-D-78 SPA Area.**




## Verification Sample Results

All verification samples were analyzed using analytical methods approved by the U.S. Environmental Protection Agency (DOE-RL 2009b). Evaluation of the verification data from the 100-D-78 excavation and staging pile area was performed by direct comparison of the statistical or maximum sample results for each COPC against cleanup criteria.

The primary statistical calculation to evaluate compliance with cleanup standards is the 95% upper confidence limit (UCL) on the arithmetic mean of the data. The 95% UCL values for each detected COPC are computed for the 100-D-78 excavation area and SPA decision units as specified by the RDR/RAWP (DOE-RL 2009b). The calculations are provided in Appendix B. When a nonradionuclide COPC was detected in fewer than 50% of the verification samples collected for a decision unit, the maximum detected value was used for comparison to the RAGs. If no detections for a given COPC were reported in the data set, then no statistical calculation was performed for that COPC.

Comparisons of the results for the site COPC with the RAGs for each of the 100-D-78 decision units are summarized in Tables 7 and 8. 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 2012) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance for Superfund* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluation. 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 ENRE project-specific database prior to submitting to the HEIS for archiving and are provided in Appendix B.

**Table 7. Comparison of the Statistical or Maximum Contaminant Concentrations to the Remedial Action Goals for the 100-D-78 Excavation Sampling Data. (2 Pages)**

| COPC | Statistical or Maximum Result[a] (mg/kg) | Remedial Action Goals[b] (mg/kg) | | | Does the Statistical Result Exceed RAGs? | Does the Statistical Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Soil Cleanup Level for Groundwater Protection | Soil Cleanup Level for River Protection | | |
| Arsenic | 3.1 (<BG) | 20[c] | 20[c] | 20[c] | No | -- |
| Barium | 67.6 (<BG) | 5,600 | 200 | 400 | No | -- |
| Boron[d] | 1.2 | 7,200 | 320 | --[e] | No | -- |
| Cadmium | 0.18 (<BG) | 13.9[f] | 0.81[c] | 0.81[c] | No | -- |
| Chromium (total) | 6.9 (<BG) | 80,000 | 18.5[c] | 18.5[c] | No | -- |
| Chromium (hexavalent)[d] | 0.341 | 2.1[f] | 4.8 | 2 | No | |
| Cobalt | 9.4 (<BG) | 24 | 15.7[c] | --[e] | No | -- |
| Copper | 16.2 (<BG) | 2,960 | 59.2 | 22.0[c] | No | -- |
| Lead | 6.1 (<BG) | 353 | 10.2[c] | 10.2[c] | No | -- |
| Manganese | 321 (<BG) | 3,760 | 512[c] | 512[c] | No | -- |
| Mercury | 0.16 (<BG) | 24 | 0.33[c] | 0.33[c] | No | -- |
| Molybdenum[d] | 0.32 | 400 | 8 | --[e] | No | -- |
| Nickel | 8.5 (<BG) | 1,600 | 19.1[c] | 27.4 | No | -- |
| Vanadium | 74.9 (<BG) | 560 | 85.1[c] | --[e] | No | -- |
| Zinc | 52.2 (<BG) | 24,000 | 480 | 67.8[c] | No | -- |
| Chloride | 7.5 (<BG) | -- | 25,000 | --[e] | No | -- |
| Fluoride | 1.2 (<BG) | 4,800 | 96 | 400 | No | -- |
| Nitrogen as nitrate | 1.4 (<BG) | 128,000 | 1,000 | 2,000 | No | -- |
| Nitrogen in nitrate/nitrite | 0.56 (<BG) | 128,000 | 1,000 | 2,000 | No | -- |

## Table 7. Comparison of the Statistical or Maximum Contaminant Concentrations to the Remedial Action Goals for the 100-D-78 Excavation Sampling Data. (2 Pages)

| COPC | Statistical or Maximum Result[a] (mg/kg) | Remedial Action Goals[b] (mg/kg) | | | Does the Statistical Result Exceed RAGs? | Does the Statistical Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Soil Cleanup Level for Groundwater Protection | Soil Cleanup Level for River Protection | | |
| Nitrogen as nitrite | 0.82 | 8,000 | 100 | 200 | No | -- |
| Sulfate | 652 | -- | 25,000 | --[e] | No | -- |

[a] Maximum or 95% UCL result, depending on data censorship, as described in the 130-D-1 Waste Site Cleanup Verification 95% UCL Calculations (Appendix B).
[b] RAGs obtained from the RDR/RAWP (DOE-RL 2009b).
[c] Where cleanup levels are less than background, cleanup levels default to background ("Model Toxics Control Act – Cleanup," WAC 173-340-700[4][d]) (1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Section 2.1.2.1 of the RDR/RAWP (DOE-RL 2009b).
[d] No Hanford Site-specific or Washington State background value available.
[e] 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 2012) or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).
[f] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3], 1996) (Method B for air quality) and an airborne particulate mass loading rate of 0.0001 g/m$^3$ (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).

-- = not applicable
BG = background (Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes [DOE-RL 2001], unless otherwise stated)
COPC = contaminant of potential concern
RAG = remedial action goal
RDR/RAWP = *Remedial Design Report/Remedial Action Work Plan for the 100 Area*
RESRAD = RESidual RADioactivity (dose model)
UCL = upper confidence limit
WAC = *Washington Administrative Code*

## Table 8. Comparison of the Statistical or Maximum Contaminant Concentrations to the Remedial Action Goals for the 100-D-78 Staging Pile Area Sampling Data. (2 Pages)

| COPC | Statistical or Maximum Result[a] (mg/kg) | Remedial Action Goals[b] (mg/kg) | | | Does the Statistical Result Exceed RAGs? | Does the Statistical Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Soil Cleanup Level for Groundwater Protection | Soil Cleanup Level for River Protection | | |
| Arsenic | 2.6 (<BG) | 20[c] | 20[c] | 20[c] | No | -- |
| Barium | 87.7 (<BG) | 5,600 | 200 | 400 | No | -- |
| Boron[d] | 3.3 | 7,200 | 320 | --[e] | No | -- |
| Cadmium | 0.10 (<BG) | 13.9[f] | 0.81[c] | 0.81[c] | No | -- |
| Chromium (total) | 10.2 (<BG) | 80,000 | 18.5[c] | 18.5[c] | No | -- |
| Chromium (hexavalent)[d] | 0.383 | 2.1[f] | 4.8 | 2 | No | |
| Cobalt | 8.1 (<BG) | 24 | 15.7[c] | --[e] | No | -- |
| Copper | 18.1 (<BG) | 2,960 | 59.2 | 22.0[c] | No | -- |
| Lead | 4.7 (<BG) | 353 | 10.2[c] | 10.2[c] | No | -- |
| Manganese | 342 (<BG) | 3,760 | 512[c] | 512[c] | No | -- |

**Table 8. Comparison of the Statistical or Maximum Contaminant Concentrations to the Remedial Action Goals for the 100-D-78 Staging Pile Area Sampling Data. (2 Pages)**

| COPC | Statistical or Maximum Result[a] (mg/kg) | Remedial Action Goals[b] (mg/kg) | | | Does the Statistical Result Exceed RAGs? | Does the Statistical Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Soil Cleanup Level for Groundwater Protection | Soil Cleanup Level for River Protection | | |
| Mercury | 0.015 (<BG) | 24 | 0.33[c] | 0.33[c] | No | -- |
| Molybdenum[d] | 0.36 | 400 | 8 | --[e] | No | -- |
| Nickel | 11.3 (<BG) | 1,600 | 19.1[c] | 27.4 | No | -- |
| Vanadium | 50.7 (<BG) | 560 | 85.1[c] | --[e] | No | -- |
| Zinc | 58.8 (<BG) | 24,000 | 480 | 67.8[c] | No | -- |
| Chloride | 8.6 (<BG) | -- | 25,000 | --[e] | No | -- |
| Fluoride | 1.1 (<BG) | 4,800 | 96 | 400 | No | -- |
| Nitrogen as nitrate | 26.5 | 128,000 | 1,000 | 2,000 | No | -- |
| Nitrogen in nitrate/nitrite | 79.3 | 128,000 | 1,000 | 2,000 | No | -- |
| Nitrogen as nitrite | 1.2 | 8,000 | 100 | 200 | No | -- |
| Sulfate | 472 | -- | 25,000 | --[e] | No | -- |

[a] Maximum or 95% UCL result, depending on data censorship, as described in the 130-D-1 Waste site Cleanup Verification 95% UCL Calculations (Appendix B).
[b] RAGs obtained from the RDR/RAWP (DOE-RL 2009b).
[c] Where cleanup levels are less than background, cleanup levels default to background ("Model Toxics Control Act – Cleanup," WAC 173-340-700[4][d]) (1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Sect. 2.1.2.1 of the RDR/RAWP (DOE-RL 2009b).
[d] No Hanford Site-specific or Washington State background value available.
[e] 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 2012) or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).
[f] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3], 1996) (Method B for air quality) and an airborne particulate mass loading rate of 0.0001 g/m$^3$ (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).

-- = not applicable
BG = background (*Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes* [DOE-RL 2001], unless otherwise stated)
COPC = contaminant of potential concern
RAG = remedial action goal
RDR/RAWP = *Remedial Design Report/Remedial Action Work Plan for the 100 Area*
RESRAD = RESidual RADioactivity (dose model)
UCL = upper confidence limit
WAC = *Washington Administrative Code*

## DATA EVALUATION

This section demonstrates that remedial actions at the 100-D-78 waste site 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 RDR/RAWP (DOE-RL 2009). Evaluation of the results listed in Tables 2 and 3 from verification sampling at the 100-D-78 waste site indicates that residual concentrations of all site COPCs are below the direct exposure, groundwater, and river protection soil RAGs.

**Attainment of Radionuclide RAGS**

Radionuclides are not COPCs for the 100-D-78 waste site.

**Attainment of Nonradionuclide RAGS**

Inspection of Tables 7 and 8 shows that all nonradionuclide COPCs for both sampling areas were quantified below their respective direct exposure, groundwater, and river protection soil RAGs. Therefore, residual concentrations of all constituents are protective of human health, groundwater, and the Columbia River.

**Three-Part Test for Nonradionuclides**

A RAG requirement for nonradionuclides is the WAC 173-340-740(7)(e) three-part test, which consists of the following criteria: (1) the cleanup verification 95% UCL value must be less than the cleanup level, (2) no single detection shall exceed two times the cleanup criteria, and (3) the percentage of samples exceeding the cleanup criteria must be less than 10% of the data set.

The application of the three-part test for the 100-D-78 waste site is included in the statistical calculations (Appendix B). The results of this evaluation indicate that all residual COPC concentrations for the 100-D-78 waste site pass the three-part test in comparison to direct exposure, groundwater, and river protection RAGs.

An additional application of the three-part test is included for the statistical data sets that default to the maximum because less than half of the data set was detected. The results of this evaluation indicate that all residual COPC concentrations pass the three-part test in comparison to direct exposure, groundwater, and river protection RAGs.

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

The WAC 173-340-740(7)(e) 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-78 waste site, 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 detected above background, or for which there are no background values, is $4.6 \times 10^{-3}$. The calculated excess cancer risk for hexavalent chromium, the only carcinogenic constituent detected above background levels, is $1.8 \times 10^{-7}$, which is less than the individual and cumulative excess cancer risk limits of $1 \times 10^{-6}$ and $1 \times 10^{-5}$, respectively. The 100-D-78 waste site meets the requirements for the direct contact hazard quotient and excess carcinogenic risk as identified in the RDR/RAWP (DOE-RL 2009b).

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

Assessment of the risk requirements for the 100-D-78 waste site 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 waste site using the highest 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. Based on RESidual RADioactivity (RESRAD) modeling, constituents are eliminated from a groundwater calculation if their distribution coefficient ($K_d$) value is sufficiently high that the constituent will not migrate to groundwater in less than 1,000 years. Based on a vadose zone of approximately 24 m (79 ft) at the 100-D-78 waste site any constituent with a $K_d$ of 3.1 mL/g or greater is protective of groundwater. Of the constituents detected at this site, only boron, hexavalent chromium, and nitrate are subject to the groundwater hazard quotient calculation.

The individual hazard quotients are all less than one. The cumulative hazard quotient ($1.7 \times 10^{-1}$) is less than one. The 100-D-78 waste site does not have carcinogenic constituents subject to 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 and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WCH 2012). This DQA was performed in accordance with data quality objectives found in the *100 Area Remedial Action Sampling and Analysis Plan* (DOE-RL 2009a). A review of the sample design (WCH 2012), the field logbook (WCH 2013), and applicable analytical data packages has been performed as part of this DQA. This review determined the data are of the right type, quality, and quantity to support the intended use (i.e., closeout decisions). The detailed DQA is presented in Appendix C.

## SUMMARY FOR NO ACTION

The 100-D-78 waste site has been evaluated in accordance with the Remaining Sites ROD (EPA 1999) and the RDR/RAWP (DOE-RL 2009b). Confirmatory sampling results indicate that the residual concentrations of COPCs at this site meet the RAGs for direct exposure, groundwater protection, and river protection. In accordance with this evaluation, the verification results support a reclassification of the 100-D-78 waste site to Interim Closed Out. The 100-D-78 waste site contamination did not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the site are not required.

## REFERENCES

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# APPENDIX A

# ECOLOGICAL SCREENING EVALUATION

## Table A-1. Ecological Screening Levels [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 | | | | | | | | |
| Boron | -- | 0.5 | -- | -- | -- | -- | -- | -- | 3.3 |
| Manganese | 512 | 1,100[d] | -- | 1,500 | 220 | 450 | 4,300 | 4,000 | 342 (<BG) |
| Mercury | 0.33 | 0.3 | 0.1 | 5.5 | -- | -- | -- | -- | 0.16 (<BG) |
| Vanadium | 85.1 | 2 | -- | -- | -- | -- | 7.8 | 280 | 74.9 (<BG) |
| Zinc | 67.8 | 86[d] | 200 | 360 | 160 | 120 | 46 | 79 | 58.8 (<BG) |

NOTE: Highlighted values indicate exceedances of ecological screening levels for individual hazardous substances.

[a] Per WAC 173-340-7490(4)(b) (Ecology 2007), soil concentrations deeper than the standard point of compliance of 4.6 m (15 ft) are not considered in evaluation of risk to ecological receptors because this represents a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of site development activities, resulting in exposure by ecological receptors. 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] 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.

-- = no value exists
BG = background
EPA = U.S. Environmental Protection Agency
WAC = *Washington Administrative Code*

# APPENDIX B

# CALCULATIONS

# APPENDIX B

## CALCULATION BRIEFS

The calculations in this appendix 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 Calculations," Washington Closure Hanford, Richland, Washington. The following calculations are provided in this appendix:

*100-D-78 Waste Site Cleanup Verification 95% UCL Calculation,* 0100D-CA-V0499, Rev. 0, Washington Closure Hanford, Richland, Washington.

*100-D-78 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations,* 0100D-CA-V0500, Rev. 0, Washington Closure Hanford, Richland, Washington.

*100-D-78 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater,* 0100D-CA-V0501, 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 Field Remediation **Job No. 14655**

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0499

Subject: 100-D-78 Waste Site Cleanup Verification 95% UCL Calculation

Computer Program: Excel Program No: Excel 2003

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 = 17<br>Attm. 1 = 14<br>Total = 32 | J. D. Skoglie | N. K. Schiffern | I. B. Berezovskiy | D. F. Obenauer | 6/12/13 |
| | | | | | | |
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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** J. D. Skoglie | **Date** 06/12/13 | **Calc. No.** 0100D-CA-V0499 | **Rev. No.** 0 |
| **Project** 100-D Field Remediation | **Job No.** 14655 | **Checked** N. K. Schiffern | **Date** 06/12/13 |
| **Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations | | | **Sheet No.** 1 of 17 |

**Summary**

**Purpose:**
Calculate the 95% upper confidence limit (UCL) values to evaluate compliance with cleanup standards for the subject site. Also, perform the *Washington Administrative Code* (WAC) 173-340-740(7)(e) Model Toxics Control Act (MTCA) 3-part test for nonradionuclide analytes and calculate the relative percent difference (RPD) for primary-duplicate sample pairs for each contaminant of concern (COC) and contaminant of potential concern (COPC), as necessary.

**Table of Contents:**
Sheets 1 to 4 - Calculation Sheet Summary
Sheets 5 to 10 - Calculation Sheet Verification Data Results- Excavation Area and Staging Pile Area.
Sheets 11 to 14 - Ecology Software (MTCAStat) Results
Sheets 15 and 17 - Calculation Sheet - Duplicate Analysis
Attachment 1 - 100-D-78, Verification and Confirmatory Sampling Results (14 pages)

**Given/References:**
1) Sample Results (Attachment 1).
2) DOE-RL, 2009a, *100 Area Remedial Action Sampling and Analysis Plan* (SAP), DOE/RL-96-22, Rev.5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) DOE-RL, 2009b, *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) Ecology, 1992, *Statistical Guidance for Ecology Site Managers*, Publication #92-54, Washington Department of Ecology, Olympia, Washington.
5) Ecology, 1993, *Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-detection Limit or Below-PQL Values (Censored Data Sets),* Publication #92-54, Washington Department of Ecology, Olympia, Washington.
6) Ecology, 2011, Cleanup Levels and Risk Calculations (CLARC) Database, Washington State Department of Ecology, Olympia, Washington, <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.
7) EPA, 1989, *Risk Assessment Guidance for Superfund:* Volume 1, *Human Health Evaluation Manual, Part A; Interim Final,* EPA/540/1-89/002, U.S. Environmental Protection Agency, Washington, D. C.
8) WAC 173-340, 1996, "Model Toxic Control Act - Cleanup," *Washington Administrative Code.*

**Solution:**
Calculation methodology is described in Ecology Pub. #92-54 (Ecology 1992, 1993), below, and in the RDR/RAWP (DOE-RL 2009b). Use data from attached worksheets to perform the 95% UCL calculation for each analyte, the WAC 173-340-740(7)(e) 3-part test for nonradionuclides, and the RPD calculations for each COC/COPC. The hazard quotient and carcinogenic risk calculations are located in a separate calculation brief as an appendix to the Remaining Sites Verification Package (RSVP).

**Calculation Description:**
The subject calculations were performed on statistical data from soil verification samples (Attachment 1) from the 100-D-78 waste site. The data were entered into an EXCEL 2003 spreadsheet and calculations performed by using the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2009b) is documented by this calculation. Duplicate RPD results are used in evaluation of data quality within the RSVP for this site.

**Methodology:**
The 100-D-78 waste site underwent statistical sampling that consists of two decision units for verification sampling; the excavation area and the staging pile area. In addition, focused sampling was performed at two decision units; stained soil areas 3 and 4. Besides stained soil areas 3 and 4, all other confirmatory focused samples are for information only as discussed in the RSVP.

Analytical results for all sampling locations are summarized in the tables provided on sheet 4. Further information of the sample data quality is presented in the data quality assessment section of the associated RSVP.

***Washington Closure Hanford*** **CALCULATION SHEET**

| | | | |
|---|---|---|---|
| **Originator** J. D. Skoglie | **Date** 06/12/13 | **Calc. No.** 0100D-CA-V0499 | **Rev. No.** 0 |
| **Project** 100-D Field Remediation | **Job No.** 14655 | **Checked** N. K. Schiffern | **Date** 06/12/13 |
| **Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations | | | **Sheet No.** 2 of 17 |

**Summary (continued)**

**Methodology, continued:**

For nonradioactive analytes with ≤50% of the data below detection limits, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For nonradioactive analytes with >50% of the data below detection limits, as determined by direct inspection of the sample results (Attachment 1), the maximum detected value for the data set is used instead of the 95% UCL, and no further calculations are performed for those data sets. For convenience, these maximum detected values are included in the summary tables that follow. The 95% UCL was not calculated for data sets with no reported detections. Calculated cleanup levels are not available in Ecology (2011) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance* for Superfund (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 COCs/COPCs and are also not included in these calculations.

All nonradionuclide data reported as being undetected are set to ½ the detection limit value for calculation of the statistics (Ecology 1993). For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above. For radionuclide data, calculation of the statistics is done using the reported value. In cases where the laboratory does not report a value below the minimum detectable activity (MDA), half of the MDA is used in the calculation. For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above.

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For nonradionuclide small data sets (n<10), the calculations are performed assuming nonparametric distribution, so no tests for distribution are performed. For nonradionuclide data sets of ten or greater, as for the subject site, distributional testing is done using Ecology's MTCAStat software (Ecology 1993). Due to differences in addressing censored data between the RDR/RAWP (DOE-RL 2009b) and MTCAStat coding and due to a limitation in the MTCAStat coding (no direct capability to address variable quantitation limits within a data set), substitutions for censored data are performed before software input and the resulting data set treated as uncensored.

The WAC 173-340-740(7)(e) 3-part test is performed for nonradionuclide analytes only and determines if:
1) the 95% UCL exceeds the most stringent cleanup limit for each COPC/COC,
2) greater than 10% of the raw data exceed the most stringent cleanup limit for each COPC/COC,
3) the maximum value of the raw data set exceeds two times the most stringent cleanup limit for each COPC/COC.

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 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:

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

where, M = Main Sample Value S = Split (or duplicate) Sample Value

For quality assurance/quality control (QA/QC) split and duplicate RPD calculations, a value less than 30% indicates the data compare favorably. If the RPD is greater than 30%, further investigation regarding the usability of the data is performed. To assist in the identification of anomalous sample pairs, 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. Additional discussion as necessary is provided in the data quality assessment section of the applicable RSVP.

***Washington Closure Hanford*** **CALCULATION SHEET**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Originator** | J. D. Skoglie | **Date** | 06/12/13 | **Calc. No.** | 0100D-CA-V0499 | **Rev. No.** | 0 |
| **Project** | 100-D Field Remediation | **Job No.** | 14655 | **Checked** | N. K. Schiffern | **Date** | 06/12/13 |
| **Subject** | 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations | | | | | **Sheet No.** | 3 of 17 |

**Summary (continued)**

**QUALIFIER LIST**

B = blank contamination
D = dilution
J = estimate
M = sample duplicate precision not met
N = MS/MSD or LCS recovery is outside control limits
U = undetected
X = serial dilution in the analytical batch indicates that physical and chemical interferences are present

**ACRONYM LIST**

-- = not applicable
DE = direct exposure
EXC = excavation
GW = groundwater
MTCA = *Model Toxics Control Act*
PQL = practical quantitation limit
Q = qualifier
QA/QC = quality assurance/quality control
RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)
RPD = relative percent difference
RSVP = remaining sites verification package
SAP = sampling and analysis plan
SPA = staging pile area
TDL = target detection limit
UCL = upper confidence limit
WAC = Washington Administrative Code

*Washington Closure Hanford* **CALCULATION SHEET**

| | | | |
|---|---|---|---|
| **Originator** J. D. Skoglie | **Date** 06/12/13 | **Calc. No.** 0100D-CA-V0499 | **Rev. No.** 0 |
| **Project** 100-D Field Remediation | **Job No.** 14655 | **Checked** N. K. Schiffern | **Date** 06/12/13 |
| **Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations | | | **Sheet No.** 4 of 17 |

**Results:**
The results presented in the tables that follow include the summary of the results of the 95% UCL calculations and/or maximum for the excavation, staging pile area, stained soil area 3, stained soil area 4, the WAC 173-340-740(7)(e) 3-part test evaluation, and the RPD calculations, and are for use in risk analysis and the RSVP for this site.

**Results Summary [a]**

| Analyte | Excavation | | SPA | | Area 3 | Area 4 | Units |
|---|---|---|---|---|---|---|---|
| | 95% UCL Result | Maximum Result | 95% UCL Result | Maximum Result | Maximum Result | Maximum Result | |
| Arsenic | 3.1 | -- | 2.6 | -- | 3.1 | 3.5 | mg/kg |
| Barium | 67.6 | -- | 87.7 | -- | 72.0 | 84.8 | mg/kg |
| Beryllium | -- | -- | -- | -- | 0.34 | 0.38 | mg/kg |
| Boron | -- | 1.2 | 3.3 | -- | 1.7 | 2.8 | mg/kg |
| Cadmium | 0.18 | -- | 0.10 | -- | -- | -- | mg/kg |
| Chromium | 6.9 | -- | 10.2 | -- | 12.9 | 15.6 | mg/kg |
| Cobalt | 9.4 | -- | 8.1 | -- | 9.8 | 8.1 | mg/kg |
| Copper | 16.2 | -- | 18.1 | -- | 15.4 | 16.4 | mg/kg |
| Hexavalent chromium | 0.341 | -- | -- | 0.383 | -- | -- | mg/kg |
| Lead | 6.1 | -- | 4.7 | -- | 8.8 | 7.3 | mg/kg |
| Manganese | 321 | -- | 342 | -- | 333 | 329 | mg/kg |
| Mercury | 0.16 | -- | 0.015 | -- | 0.05 | 0.009 | mg/kg |
| Molybdenum | 0.32 | -- | -- | 0.36 | 0.69 | 0.48 | mg/kg |
| Nickel | 8.5 | -- | 11.3 | -- | 12.2 | 12.1 | mg/kg |
| Vanadium | 74.9 | -- | 50.7 | -- | 71.1 | 76.9 | mg/kg |
| Zinc | 52.2 | -- | 58.8 | -- | 50.4 | 42.6 | mg/kg |
| Chloride | -- | 7.5 | 8.6 | -- | -- | -- | mg/kg |
| Fluoride | 1.2 | -- | -- | 1.1 | -- | -- | mg/kg |
| Nitrate | -- | -- | -- | -- | 4.7 | 6.1 | mg/kg |
| Nitrogen as nitrate | -- | 1.4 | 26.5 | -- | -- | -- | mg/kg |
| Nitrogen in nitrate and nitrite | -- | 0.56 | 79.3 | -- | -- | -- | mg/kg |
| Nitrogen as nitrite | -- | 0.82 | -- | 1.2 | 0.89 | 1.8 | mg/kg |
| Sulfate | 652 | -- | 472 | -- | 720 | 15000 | mg/kg |

**WAC 173-340-740(7)(e) Evaluation:**

| WAC 173-340 3-Part Test for most stringent RAG: | EXC | | SPA | |
|---|---|---|---|---|
| 95% UCL or maximum> Cleanup Limit? | NO | NO | NO | NO |
| > 10% above Cleanup Limit? | NO | NO | NO | NO |
| Any sample > 2x Cleanup Limit? | NO | NO | NO | NO |

[a] The 95% UCL result or maximum value, depending on data censorship, as described in the methodology section.

**Relative Percent Difference Results and QA/QC Analysis[a]**

| Analyte | Duplicate Analysis | | |
|---|---|---|---|
| | Excavation | SPA | Area 2 |
| Aluminum | 6.4% | 2.5% | 6.1% |
| Barium | 10.7% | 5.7% | 3.0% |
| Calcium | 14.1% | 0.5% | 7.8% |
| Chromium | 1.9% | 9.4% | 13.3% |
| Cobalt | 6.7% | -- | -- |
| Copper | 3.7% | 10.9% | 9.3% |
| Iron | 3.6% | 2.3% | 2.0% |
| Magnesium | 4.6% | 2.0% | 3.1% |
| Manganese | 7.4% | 2.1% | 2.8% |
| Silicon | 4.2% | ***34.9%*** | 5.6% |
| Sodium | 7.1% | 9.4% | -- |
| Vanadium | 2.8% | 3.9% | 5.2% |
| Zinc | 1.1% | 2.5% | 1.7% |
| Sulfate | -- | 5.5% | ***46.3%*** |

[a]RPD listed where result produced, based on criteria. If RPD not required, no value is listed. The significance of the reported RPD values, including values greater than 30%, is addressed in the data quality assessment section of the RSVP.

**CALCULATION SHEET**

***Washington Closure Hanford***

Originator J. D. Skoglie
Project 100-D Field Remediation
Subject 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations

Date 06/12/13
Job No. 14655

Calc. No. 0100D-CA-V0499
Checked N. K. Schiffern

Rev. No. 0
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**100-D-78 Statistical Calculations**

**Verification Data - Excavation**

| 1 | Sample | Sample | Sample | Arsenic | | | Barium | | | Cadmium | | | Chromium | | | Cobalt | | | Copper | | | Hexavalent Chromium | | | Lead | | | Manganese | | | Mercury | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Area | Number | Date | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 3 | 78D-4 | J1R684 | 1/16/13 | 2.3 | | 0.61 | 65.1 | X | 0.071 | 0.16 | B | 0.038 | 5.2 | X | 0.054 | 10.8 | X | 0.46 | 16.5 | X | 1.0 | 0.208 | | 0.155 | 3.8 | | 1.3 | 324 | X | 0.093 | 0.0058 | U | 0.0058 |
| 4 | Duplicate of J1R684 | J1R693 | 1/16/13 | 2.6 | | 0.67 | 58.5 | X | 0.077 | 0.16 | B | 0.042 | 5.1 | X | 0.059 | 10.1 | X | 0.51 | 15.9 | X | 1.1 | 0.155 | U | 0.155 | 3.8 | | 1.4 | 301 | X | 0.10 | 0.0052 | U | 0.0052 |
| 5 | 78D-1 | J1R681 | 1/16/13 | 2.8 | | 0.62 | 61.5 | X | 0.072 | 0.18 | B | 0.039 | 6.4 | X | 0.055 | 7.9 | X | 0.094 | 14.7 | X | 0.2 | 0.256 | | 0.155 | 5.3 | | 0.25 | 280 | X | 0.094 | 0.0053 | B | 0.0050 |
| 6 | 78D-2 | J1R682 | 1/16/13 | 3.7 | | 0.67 | 66.0 | X | 0.077 | 0.17 | B | 0.042 | 8.3 | X | 0.059 | 7.7 | X | 0.10 | 15.7 | X | 0.22 | 0.273 | | 0.155 | 7.8 | | 0.28 | 296 | X | 0.10 | 0.0071 | B | 0.0056 |
| 7 | 78D-3 | J1R683 | 1/16/13 | 2.7 | | 0.60 | 51.3 | X | 0.070 | 0.14 | B | 0.038 | 6.0 | X | 0.053 | 7.3 | X | 0.091 | 13.3 | X | 0.20 | 0.209 | | 0.155 | 3.4 | | 0.25 | 270 | X | 0.091 | 0.0055 | B | 0.0052 |
| 8 | 78D-5 | J1R685 | 1/16/13 | 3.0 | | 0.64 | 62.5 | X | 0.074 | 0.16 | B | 0.040 | 6.5 | X | 0.056 | 8.3 | X | 0.097 | 16.1 | X | 0.21 | 0.211 | | 0.155 | 3.5 | | 0.26 | 299 | X | 0.097 | 0.0056 | U | 0.0056 |
| 9 | 78D-6 | J1R686 | 1/16/13 | 2.8 | | 0.64 | 60.2 | X | 0.074 | 0.16 | B | 0.040 | 6.1 | X | 0.056 | 7.8 | X | 0.097 | 14.3 | X | 0.21 | 0.298 | | 0.155 | 4.8 | | 0.26 | 285 | X | 0.097 | 0.045 | | 0.0058 |
| 10 | 78D-7 | J1R687 | 1/16/13 | 3.7 | | 0.66 | 98.2 | X | 0.076 | 0.22 | | 0.041 | 8.6 | X | 0.058 | 8.1 | X | 0.10 | 16.7 | X | 0.22 | 0.439 | | 0.155 | 8.6 | | 0.27 | 405 | X | 0.10 | 0.64 | | 0.0056 |
| 11 | 78D-8 | J1R688 | 1/16/13 | 3.1 | | 0.67 | 62.4 | X | 0.077 | 0.19 | B | 0.042 | 6.3 | X | 0.059 | 8.4 | X | 0.10 | 16.8 | X | 0.22 | 0.342 | | 0.155 | 5.0 | | 0.27 | 332 | X | 0.10 | 0.012 | B | 0.0056 |
| 12 | 78D-9 | J1R689 | 1/16/13 | 2.6 | | 0.69 | 55.1 | X | 0.079 | 0.16 | B | 0.043 | 4.6 | X | 0.061 | 10.9 | X | 0.52 | 16.8 | X | 1.1 | 0.155 | U | 0.155 | 5.2 | | 1.4 | 296 | X | 0.10 | 0.0057 | B | 0.0054 |
| 13 | 78D-10 | J1R690 | 1/16/13 | 2.6 | | 0.67 | 57.3 | X | 0.077 | 0.17 | B | 0.041 | 6.2 | X | 0.058 | 8.5 | X | 0.10 | 15.5 | X | 0.22 | 0.212 | | 0.155 | 3.9 | | 0.27 | 295 | X | 0.10 | 0.0060 | U | 0.0060 |
| 14 | 78D-11 | J1R691 | 1/16/13 | 2.7 | | 0.60 | 48.5 | X | 0.070 | 0.14 | B | 0.038 | 3.8 | X | 0.053 | 9.4 | X | 0.46 | 15.5 | X | 0.99 | 0.155 | U | 0.155 | 5.7 | | 1.2 | 266 | X | 0.092 | 0.0053 | U | 0.0053 |
| 15 | 78D-12 | J1R692 | 1/16/13 | 2.4 | | 0.61 | 54.6 | X | 0.070 | 0.16 | B | 0.038 | 4.7 | X | 0.053 | 9.9 | X | 0.46 | 15.9 | X | 1.0 | 0.155 | U | 0.155 | 4.8 | | 1.2 | 301 | X | 0.092 | 0.14 | | 0.0053 |

16 **Statistical Computation Input Data**

| 17 | Sample | Sample | Sample | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper | Hexavalent Chromium | Lead | Manganese | Mercury |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | Area | Number | Date | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| 19 | 78D-4 | J1R684/ J1R693 | 1/16/13 | 2.5 | 61.8 | 0.16 | 5.2 | 10.5 | 16.2 | 0.143 | 3.8 | 313 | 0.0028 |
| 20 | 78D-1 | J1R681 | 1/16/13 | 2.8 | 61.5 | 0.18 | 6.4 | 7.9 | 14.7 | 0.256 | 5.3 | 280 | 0.0053 |
| 21 | 78D-2 | J1R682 | 1/16/13 | 3.7 | 66.0 | 0.17 | 8.3 | 7.7 | 15.7 | 0.273 | 7.8 | 296 | 0.0071 |
| 22 | 78D-3 | J1R683 | 1/16/13 | 2.7 | 51.3 | 0.14 | 6.0 | 7.3 | 13.3 | 0.209 | 3.4 | 270 | 0.0055 |
| 23 | 78D-5 | J1R685 | 1/16/13 | 3.0 | 62.5 | 0.16 | 6.5 | 8.3 | 16.1 | 0.211 | 3.5 | 299 | 0.0028 |
| 24 | 78D-6 | J1R686 | 1/16/13 | 2.8 | 60.2 | 0.16 | 6.1 | 7.8 | 14.3 | 0.298 | 4.8 | 285 | 0.045 |
| 25 | 78D-7 | J1R687 | 1/16/13 | 3.7 | 98.2 | 0.22 | 8.6 | 8.1 | 16.7 | 0.439 | 8.6 | 405 | 0.64 |
| 26 | 78D-8 | J1R688 | 1/16/13 | 3.1 | 62.4 | 0.19 | 6.3 | 8.4 | 16.8 | 0.342 | 5.0 | 332 | 0.012 |
| 27 | 78D-9 | J1R689 | 1/16/13 | 2.6 | 55.1 | 0.16 | 4.6 | 10.9 | 16.8 | 0.078 | 5.2 | 296 | 0.0057 |
| 28 | 78D-10 | J1R690 | 1/16/13 | 2.6 | 57.3 | 0.17 | 6.2 | 8.5 | 15.5 | 0.212 | 3.9 | 295 | 0.0030 |
| 29 | 78D-11 | J1R691 | 1/16/13 | 2.7 | 48.5 | 0.14 | 3.8 | 9.4 | 15.5 | 0.078 | 5.7 | 266 | 0.0027 |
| 30 | 78D-12 | J1R692 | 1/16/13 | 2.4 | 54.6 | 0.16 | 4.7 | 9.9 | 15.9 | 0.078 | 4.8 | 301 | 0.14 |

31 **Statistical Computations**

| 32 | | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper | Hexavalent Chromium | Lead | Manganese | Mercury |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 95% UCL based on | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), use MTCAStat normal distribution. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. |
| 34 | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 35 | % < Detection limit | 0% | 0% | 0% | 0% | 0% | 0% | 25% | 0% | 0% | 33% |
| 36 | Mean | 2.9 | 61.6 | 0.17 | 6.1 | 8.7 | 15.6 | 0.218 | 5.2 | 303 | 0.073 |
| 37 | Standard deviation | 0.43 | 12.6 | 0.022 | 1.4 | 1.2 | 1.07 | 0.113 | 1.6 | 36.7 | 0.18 |
| 38 | 95% UCL on mean | 3.1 | 67.6 | 0.18 | 6.9 | 9.4 | 16.2 | 0.341 | 6.1 | 321 | 0.16 |
| 39 | Maximum value | 3.7 | 98.2 | 0.22 | 8.6 | 10.9 | 16.8 | 0.439 | 8.6 | 405 | 0.64 |
| 40 | **Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)** | 20 DE, GW & River Protection | 200 GW Protection | 0.81 GW & River Protection | 18.5 GW & River Protection | 15.7 GW Protection | 22.0 River Protection | 2 River Protection | 10.2 GW & River Protection | 512 GW & River Protection | 0.33 GW & River Protection |
| 41 | **WAC 173-340 3-PART TEST** | | | | | | | | | | |
| 42 | 95% UCL > Cleanup Limit? | NA | NA | NA | NA | NA | NA | NO | NA | NA | NO |
| 43 | > 10% above Cleanup Limit? | NA | NA | NA | NA | NA | NA | NO | NA | NA | NO |
| 44 | Any sample > 2X Cleanup Limit? | NA | NA | NA | NA | NA | NA | NO | NA | NA | NO |
| 45 | **WAC 173-340 Compliance?** | Because all values are below background (6.5 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (132 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (0.81 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (18.5 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (15.7 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (22.0 mg/kg) the WAC 173-340 3-part test is not required. | The data set meets the 3-part test criteria when compared to the most stringent RAG. | Because all values are below background (10.2 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (512 mg/kg) the WAC 173-340 3-part test is not required. | The data set meets the 3-part test criteria when compared to the most stringent RAG. |

**Acronyms and qualifiers are defined on sheet 3.**

**CALCULATION SHEET**

***Washington Closure Hanford***

**Originator** J. D. Skoglie **Date** 06/12/13 **Calc. No.** 0100D-CA-V0499 **Rev. No.** 0
**Project** 100-D Field Remediation **Job No.** 14655 **Checked** N. K. Schiffern **Date** 06/12/13
**Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 6 of 17

**100-D-78 Statistical Calculations**
**Verification Data - Excavation**

| 1 | Sample | Sample | Sample | Molybdenum | | | Nickel | | | Vanadium | | | Zinc | | | Fluoride | | | Sulfate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Area | Number | Date | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 3 | 78D-4 | J1R684 | 1/16/13 | 0.32 | B | 0.24 | 7.6 | X | 0.11 | 80.3 | X | 0.44 | 45.8 | X | 0.37 | 1.0 | JB | 0.86 | 7.5 | | 1.8 |
| 4 | Duplicate of J1R684 | J1R693 | 1/16/13 | 0.28 | B | 0.26 | 8.3 | X | 0.13 | 78.1 | X | 0.48 | 45.3 | X | 0.40 | 1.0 | JB | 0.84 | 6.9 | | 1.8 |
| 5 | 78D-1 | J1R681 | 1/16/13 | 0.28 | B | 0.24 | 8.4 | X | 0.12 | 66.0 | X | 0.089 | 43.5 | X | 0.37 | 1.1 | JB | 0.85 | 81.2 | | 1.8 |
| 6 | 78D-2 | J1R682 | 1/16/13 | 0.30 | B | 0.26 | 9.4 | X | 0.13 | 60.2 | X | 0.096 | 49.7 | X | 0.41 | 1.0 | JBN | 0.91 | 8.4 | | 1.9 |
| 7 | 78D-3 | J1R683 | 1/16/13 | 0.24 | U | 0.24 | 8.6 | X | 0.11 | 60.9 | X | 0.086 | 39.5 | X | 0.36 | 0.96 | JB | 0.89 | 362 | | 1.9 |
| 8 | 78D-5 | J1R685 | 1/16/13 | 0.26 | B | 0.25 | 8.6 | X | 0.12 | 66.8 | X | 0.092 | 44.5 | X | 0.39 | 1.2 | JB | 0.87 | 11.3 | | 1.8 |
| 9 | 78D-6 | J1R686 | 1/16/13 | 0.29 | B | 0.25 | 7.4 | X | 0.12 | 67.4 | X | 0.092 | 45.3 | X | 0.39 | 0.96 | JB | 0.90 | 7.0 | | 1.9 |
| 10 | 78D-7 | J1R687 | 1/16/13 | 0.35 | B | 0.26 | 8.8 | X | 0.12 | 59.9 | X | 0.094 | 50.7 | X | 0.40 | 1.3 | JB | 0.88 | 2710 | D | 18.4 |
| 11 | 78D-8 | J1R688 | 1/16/13 | 0.38 | B | 0.26 | 7.8 | X | 0.13 | 67.7 | X | 0.096 | 49.9 | X | 0.41 | 1.8 | JB | 0.87 | 205 | | 1.8 |
| 12 | 78D-9 | J1R689 | 1/16/13 | 0.30 | B | 0.27 | 8.2 | X | 0.13 | 83.4 | X | 0.49 | 73.4 | X | 0.42 | 0.83 | UJ | 0.83 | 7.0 | | 1.8 |
| 13 | 78D-10 | J1R690 | 1/16/13 | 0.26 | B | 0.26 | 8.1 | X | 0.12 | 69.6 | X | 0.095 | 45.1 | X | 0.40 | 0.97 | JB | 0.83 | 8.4 | | 1.7 |
| 14 | 78D-11 | J1R691 | 1/16/13 | 0.27 | B | 0.24 | 5.9 | X | 0.11 | 76.5 | X | 0.43 | 43.2 | X | 0.36 | 0.91 | JB | 0.88 | 6.2 | | 1.8 |
| 15 | 78D-12 | J1R692 | 1/16/13 | 0.32 | B | 0.24 | 6.3 | X | 0.11 | 83.8 | X | 0.43 | 47.8 | X | 0.37 | 0.89 | JB | 0.83 | 8.9 | | 1.7 |

16 **Statistical Computation Input Data**

| 17 | Sample | Sample | Sample | Molybdenum | Nickel | Vanadium | Zinc | Fluoride | Sulfate |
|---|---|---|---|---|---|---|---|---|---|
| 18 | Area | Number | Date | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| 19 | 78D-4 | J1R684/ J1R693 | 1/16/13 | 0.30 | 8.0 | 79.2 | 45.6 | 1.0 | 7.2 |
| 20 | 78D-1 | J1R681 | 1/16/13 | 0.28 | 8.4 | 66.0 | 43.5 | 1.1 | 81.2 |
| 21 | 78D-2 | J1R682 | 1/16/13 | 0.30 | 9.4 | 60.2 | 49.7 | 1.0 | 8.4 |
| 22 | 78D-3 | J1R683 | 1/16/13 | 0.12 | 8.6 | 60.9 | 39.5 | 0.96 | 362 |
| 23 | 78D-5 | J1R685 | 1/16/13 | 0.26 | 8.6 | 66.8 | 44.5 | 1.2 | 11.3 |
| 24 | 78D-6 | J1R686 | 1/16/13 | 0.29 | 7.4 | 67.4 | 45.3 | 0.96 | 7.0 |
| 25 | 78D-7 | J1R687 | 1/16/13 | 0.35 | 8.8 | 59.9 | 50.7 | 1.3 | 2710 |
| 26 | 78D-8 | J1R688 | 1/16/13 | 0.38 | 7.8 | 67.7 | 49.9 | 1.8 | 205 |
| 27 | 78D-9 | J1R689 | 1/16/13 | 0.30 | 8.2 | 83.4 | 73.4 | 0.42 | 7.0 |
| 28 | 78D-10 | J1R690 | 1/16/13 | 0.26 | 8.1 | 69.6 | 45.1 | 0.97 | 8.4 |
| 29 | 78D-11 | J1R691 | 1/16/13 | 0.27 | 5.9 | 76.5 | 43.2 | 0.91 | 6.2 |
| 30 | 78D-12 | J1R692 | 1/16/13 | 0.32 | 6.3 | 83.8 | 47.8 | 0.89 | 8.9 |

31 **Statistical Computations**

| 32 | | Molybdenum | Nickel | Vanadium | Zinc | Fluoride | Sulfate |
|---|---|---|---|---|---|---|---|
| 33 | 95% UCL based on | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), use MTCAStat normal distribution. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. |
| 34 | N | 12 | 12 | 12 | 12 | 12 | 12 |
| 35 | % < Detection limit | 8% | 0% | 0% | 0% | 8% | 0% |
| 36 | Mean | 0.29 | 8.0 | 70.1 | 48.2 | 1.0 | 285 |
| 37 | Standard deviation | 0.063 | 1.0 | 8.6 | 8.6 | 0.32 | 772 |
| 38 | 95% UCL on mean | 0.32 | 8.5 | 74.9 | 52.2 | 1.2 | 652 |
| 39 | Maximum value | 0.38 | 9.4 | 83.8 | 73.4 | 1.8 | 2710 |
| 40 | **Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)** | 8 GW Protection | 19.1 GW Protection | 85.1 GW Protection | 67.8 River Protection | 96 GW Protection | 25000 GW Protection |
| 41 | **WAC 173-340 3-PART TEST** | | | | | | |
| 42 | 95% UCL > Cleanup Limit? | NO | NA | NA | NO | NA | NO |
| 43 | > 10% above Cleanup Limit? | NO | NA | NA | NO | NA | NO |
| 44 | Any sample > 2X Cleanup Limit? | NO | NA | NA | NO | NA | NO |
| 45 | **WAC 173-340 Compliance?** | The data set meets the 3-part test criteria when compared to the most stringent RAG. | Because all values are below background (19.1 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (85.1 mg/kg) the WAC 173-340 3-part test is not required. | The data set meets the 3-part test criteria when compared to the most stringent RAG. | Because all values are below background (2.81 mg/kg) the WAC 173-340 3-part test is not required. | The data set meets the 3-part test criteria when compared to the most stringent RAG. |

**Acronyms and qualifiers are defined on sheet 3.**

## MAXIMUM VALUE 3-PART TEST CALCULATION SHEET

***Washington Closure Hanford***

**Originator** J. D. Skoglie
**Project** 100-D Field Remediation
**Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations

**Date** 06/12/13
**Job No.** 14655

**Calc. No.** 0100D-CA-V0499
**Checked** N. K. Schiffern

**Rev. No.** 0
**Date** 06/12/13
**Sheet No.** 7 of 17

1 **100-D-78 Maximum Calculations**

2 **Verification Data - Excavation**

| 3 | Sample | Sample | Sample | Boron | | | Chloride | | | Nitrogen in Nitrate | | | Nitrogen in Nitrate and Nitrite | | | Nitrogen in Nitrite | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Area | Number | Date | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 5 | 78D-4 | J1R684 | 1/16/13 | 0.91 | U | 0.91 | 3.7 | B | 2.1 | 0.93 | JB | 0.33 | 0.31 | U | 0.31 | 0.35 | UR | 0.35 |
| 6 | Duplicate of J1R684 | J1R693 | 1/16/13 | 1.0 | U | 1.0 | 3.8 | B | 2.0 | 0.95 | JB | 0.32 | 0.31 | U | 0.31 | 0.34 | UR | 0.34 |
| 7 | 78D-1 | J1R681 | 1/16/13 | 0.92 | U | 0.92 | 3.5 | B | 2.0 | 0.93 | JB | 0.32 | 0.31 | U | 0.31 | 0.82 | JB | 0.35 |
| 8 | 78D-2 | J1R682 | 1/16/13 | 1.2 | B | 1.0 | 2.2 | U | 2.2 | 1.0 | JB | 0.35 | 0.33 | U | 0.33 | 0.37 | UR | 0.37 |
| 9 | 78D-3 | J1R683 | 1/16/13 | 0.90 | U | 0.90 | 3.8 | B | 2.1 | 0.95 | JB | 0.34 | 0.32 | U | 0.32 | 0.36 | UR | 0.36 |
| 10 | 78D-5 | J1R685 | 1/16/13 | 0.95 | U | 0.95 | 7.5 | | 2.1 | 0.33 | UR | 0.33 | 0.32 | U | 0.32 | 0.36 | UR | 0.36 |
| 11 | 78D-6 | J1R686 | 1/16/13 | 0.95 | U | 0.95 | 2.2 | U | 2.2 | 1.3 | JB | 0.34 | 0.33 | U | 0.33 | 0.37 | UR | 0.37 |
| 12 | 78D-7 | J1R687 | 1/16/13 | 0.98 | U | 0.98 | 4.9 | B | 2.1 | 1.4 | JB | 0.33 | 0.56 | B | 0.32 | 0.36 | UR | 0.36 |
| 13 | 78D-8 | J1R688 | 1/16/13 | 1.0 | U | 1.0 | 2.1 | U | 2.1 | 0.33 | UR | 0.33 | 0.32 | U | 0.32 | 0.36 | UR | 0.36 |
| 14 | 78D-9 | J1R689 | 1/16/13 | 1.0 | U | 1.0 | 2.0 | U | 2.0 | 0.89 | JB | 0.32 | 0.30 | U | 0.30 | 0.34 | UR | 0.34 |
| 15 | 78D-10 | J1R690 | 1/16/13 | 0.99 | U | 0.99 | 2.0 | U | 2.0 | 0.32 | UR | 0.32 | 0.30 | U | 0.30 | 0.34 | UR | 0.34 |
| 16 | 78D-11 | J1R691 | 1/16/13 | 0.90 | U | 0.90 | 2.1 | U | 2.1 | 1.1 | JB | 0.33 | 0.32 | U | 0.32 | 0.36 | UR | 0.36 |
| 17 | 78D-12 | J1R692 | 1/16/13 | 0.90 | U | 0.90 | 2.0 | U | 2.0 | 0.92 | JB | 0.32 | 0.30 | U | 0.30 | 0.34 | UR | 0.34 |

18 **Statistical Computations**

| 19 | | Boron | Chloride | Nitrogen in Nitrate | Nitrogen in Nitrate and Nitrite | Nitrogen in Nitrite |
|---|---|---|---|---|---|---|
| 20 | % < Detection limit | 92% | 58% | 0% | 92% | 0% |
| 21 | Maximum value | 1.2 | 7.5 | 1.4 | 0.56 | 0.82 |
| 22 | **Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)** | 320 GW Protection | 25000 GW Protection | 1000 GW Protection | 1000 GW Protection | 1000 GW Protection |
| 23 | **3-PART TEST** | | | | | |
| 24 | Maximum > Cleanup Limit? | NO | NA | NA | NA | NA |
| 25 | > 10% above Cleanup Limit? | NO | NA | NA | NA | NA |
| 26 | Any sample > 2X Cleanup Limit? | NO | NA | NA | NA | NA |
| 27 | **3-Part Test Compliance?** | The data set meets the 3-part test criteria when compared to the most stringent RAG. | Because all values are below background (100 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (11.8 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (11.8 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (11.8 mg/kg) the WAC 173-340 3-part test is not required. |

**Acronyms and qualifiers are defined on sheet 3.**

**CALCULATION SHEET**

***Washington Closure Hanford***

**Originator** J. D. Skoglie
**Project** 100-D Field Remediation
**Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations

**Date** 06/12/13
**Job No.** 14655

**Calc. No.** 0100D-CA-V0499
**Checked** N. K. Schiffern

**Rev. No.** 0
**Date** 06/12/13
**Sheet No.** 8 of 17

**100-D-78 Statistical Calculations**

**Verification Data - Staging Pile Area (SPA)**

| 1 | Sample | Sample | Sample | Arsenic | | | Barium | | | Boron | | | Cadmium | | | Chromium | | | Cobalt | | | Copper | | | Lead | | | Manganese | | | Mercury | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Area | Number | Date | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 3 | SPA-1 | J1R695 | 4/1/13 | 2.8 | | 0.62 | 103 | | 0.071 | 3.4 | | 0.92 | 0.085 | B | 0.038 | 10.0 | X | 0.054 | 8.1 | X | 0.094 | 17.4 | | 0.20 | 4.8 | | 0.25 | 323 | X | 0.094 | 0.019 | | 0.0055 |
| 4 | Duplicate of J1R695 | J1R6C7 | 4/1/13 | 2.8 | | 0.64 | 109 | | 0.073 | 3.4 | | 0.95 | 0.11 | B | 0.040 | 9.1 | X | 0.056 | 8.3 | X | 0.096 | 15.6 | | 0.21 | 4.7 | | 0.26 | 330 | X | 0.096 | 0.017 | B | 0.0060 |
| 5 | SPA-2 | J1R696 | 4/1/13 | 2.3 | | 0.56 | 96.8 | | 0.065 | 4.9 | | 0.84 | 0.092 | B | 0.035 | 8.5 | X | 0.050 | 7.9 | X | 0.085 | 31.9 | | 0.19 | 5.4 | | 0.23 | 308 | X | 0.085 | 0.014 | B | 0.0048 |
| 6 | SPA-3 | J1R697 | 4/1/13 | 1.9 | | 0.64 | 61.9 | | 0.074 | 1.5 | B | 0.96 | 0.077 | B | 0.040 | 7.6 | X | 0.057 | 7.8 | X | 0.098 | 13.2 | | 0.21 | 2.8 | | 0.26 | 290 | X | 0.098 | 0.013 | B | 0.0048 |
| 7 | SPA-4 | J1R698 | 4/1/13 | 2.4 | | 0.62 | 79.7 | | 0.072 | 2.0 | | 0.93 | 0.078 | B | 0.039 | 12.1 | X | 0.055 | 7.8 | X | 0.095 | 13.8 | | 0.21 | 4.3 | | 0.26 | 325 | X | 0.095 | 0.0094 | B | 0.0059 |
| 8 | SPA-5 | J1R699 | 4/1/13 | 2.7 | | 0.65 | 78.3 | | 0.075 | 2.1 | | 0.97 | 0.085 | B | 0.041 | 10.5 | X | 0.058 | 7.9 | X | 0.099 | 14.1 | | 0.22 | 3.9 | | 0.27 | 343 | X | 0.099 | 0.0088 | B | 0.0064 |
| 9 | SPA-6 | J1R6C0 | 4/1/13 | 3.0 | | 0.62 | 80.7 | | 0.072 | 2.1 | | 0.92 | 0.12 | B | 0.039 | 10.0 | X | 0.055 | 7.8 | X | 0.094 | 12.5 | | 0.20 | 4.4 | | 0.25 | 352 | X | 0.094 | 0.011 | B | 0.0065 |
| 10 | SPA-7 | J1R6C1 | 4/1/13 | 1.9 | | 0.59 | 64.0 | | 0.068 | 2.0 | | 0.88 | 0.079 | B | 0.037 | 7.8 | X | 0.052 | 7.1 | X | 0.089 | 12.7 | | 0.19 | 3.7 | | 0.24 | 274 | X | 0.089 | 0.021 | | 0.0055 |
| 11 | SPA-8 | J1R6C2 | 4/1/13 | 2.5 | | 0.69 | 84.3 | | 0.079 | 2.8 | | 1.0 | 0.11 | B | 0.043 | 9.5 | X | 0.061 | 7.6 | X | 0.10 | 18.2 | | 0.23 | 5.5 | | 0.28 | 325 | X | 0.10 | 0.010 | B | 0.0056 |
| 12 | SPA-9 | J1R6C3 | 4/1/13 | 2.4 | | 0.63 | 86.9 | | 0.073 | 5.3 | | 0.94 | 0.12 | B | 0.039 | 9.9 | X | 0.055 | 9.0 | X | 0.095 | 13.1 | | 0.21 | 4.2 | | 0.26 | 384 | X | 0.095 | 0.0093 | B | 0.0056 |
| 13 | SPA-10 | J1R6C4 | 4/1/13 | 2.1 | | 0.68 | 65.0 | | 0.078 | 2.2 | | 1.0 | 0.082 | B | 0.042 | 7.2 | X | 0.059 | 8.3 | X | 0.10 | 13.5 | | 0.22 | 3.3 | | 0.28 | 324 | X | 0.10 | 0.014 | B | 0.0051 |
| 14 | SPA-11 | J1R6C5 | 4/1/13 | 2.5 | | 0.67 | 77.3 | | 0.077 | 2.7 | | 0.99 | 0.088 | B | 0.042 | 9.7 | X | 0.059 | 7.9 | X | 0.10 | 13.7 | | 0.22 | 4.3 | | 0.27 | 329 | X | 0.10 | 0.011 | B | 0.0065 |
| 15 | SPA-12 | J1R6C6 | 4/1/13 | 2.6 | | 0.64 | 81.6 | | 0.074 | 2.2 | | 0.95 | 0.10 | B | 0.040 | 10.1 | X | 0.056 | 7.8 | X | 0.097 | 12.8 | | 0.21 | 4.2 | | 0.26 | 333 | X | 0.097 | 0.0082 | B | 0.0059 |

16 **Statistical Computation Input Data**

| 17 | Sample | Sample | Sample | Arsenic | Barium | Boron | Cadmium | Chromium | Cobalt | Copper | Lead | Manganese | Mercury |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | Area | Number | Date | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| 19 | SPA-1 | J1R695/ J1R6C7 | 4/1/13 | 2.8 | 106 | 3.4 | 0.098 | 9.6 | 8.2 | 16.5 | 4.8 | 327 | 0.018 |
| 20 | SPA-2 | J1R696 | 4/1/13 | 2.3 | 96.8 | 4.9 | 0.092 | 8.5 | 7.9 | 31.9 | 5.4 | 308 | 0.014 |
| 21 | SPA-3 | J1R697 | 4/1/13 | 1.9 | 61.9 | 1.5 | 0.077 | 7.6 | 7.8 | 13.2 | 2.8 | 290 | 0.013 |
| 22 | SPA-4 | J1R698 | 4/1/13 | 2.4 | 79.7 | 2.0 | 0.078 | 12.1 | 7.8 | 13.8 | 4.3 | 325 | 0.0094 |
| 23 | SPA-5 | J1R699 | 4/1/13 | 2.7 | 78.3 | 2.1 | 0.085 | 10.5 | 7.9 | 14.1 | 3.9 | 343 | 0.0088 |
| 24 | SPA-6 | J1R6C0 | 4/1/13 | 3.0 | 80.7 | 2.1 | 0.12 | 10.0 | 7.8 | 12.5 | 4.4 | 352 | 0.011 |
| 25 | SPA-7 | J1R6C1 | 4/1/13 | 1.9 | 64.0 | 2.0 | 0.079 | 7.8 | 7.1 | 12.7 | 3.7 | 274 | 0.021 |
| 26 | SPA-8 | J1R6C2 | 4/1/13 | 2.5 | 84.3 | 2.8 | 0.11 | 9.5 | 7.6 | 18.2 | 5.5 | 325 | 0.010 |
| 27 | SPA-9 | J1R6C3 | 4/1/13 | 2.4 | 86.9 | 5.3 | 0.12 | 9.9 | 9.0 | 13.1 | 4.2 | 384 | 0.0093 |
| 28 | SPA-10 | J1R6C4 | 4/1/13 | 2.1 | 65.0 | 2.2 | 0.082 | 7.2 | 8.3 | 13.5 | 3.3 | 324 | 0.014 |
| 29 | SPA-11 | J1R6C5 | 4/1/13 | 2.5 | 77.3 | 2.7 | 0.088 | 9.7 | 7.9 | 13.7 | 4.3 | 329 | 0.011 |
| 30 | SPA-12 | J1R6C6 | 4/1/13 | 2.6 | 81.6 | 2.2 | 0.10 | 10.1 | 7.8 | 12.8 | 4.2 | 333 | 0.0082 |

31 **Statistical Computations**

| 32 | | Arsenic | Barium | Boron | Cadmium | Chromium | Cobalt | Copper | Lead | Manganese | Mercury |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 95% UCL based on | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. |
| 34 | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 35 | % < Detection limit | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 36 | Mean | 2.4 | 80.2 | 2.8 | 0.094 | 9.4 | 7.9 | 15.5 | 4.2 | 326 | 0.012 |
| 37 | Standard deviation | 0.34 | 13.0 | 1.2 | 0.016 | 1.4 | 0.45 | 5.4 | 0.77 | 28.2 | 0.0039 |
| 38 | 95% UCL on mean | 2.6 | 87.7 | 3.3 | 0.10 | 10.2 | 8.1 | 18.1 | 4.7 | 342 | 0.015 |
| 39 | Maximum value | 3.0 | 109 | 5.3 | 0.12 | 12.1 | 9.0 | 31.9 | 5.5 | 384 | 0.021 |
| 40 | **Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)** | 20 DE, GW & River Protection | 200 GW Protection | 320 GW Protection | 0.81 GW & River Protection | 18.5 GW & River Protection | 15.7 GW Protection | 22.0 River Protection | 10.2 GW & River Protection | 512 GW & River Protection | 0.33 GW & River Protection |
| 41 | **WAC 173-340 3-PART TEST** | | | | | | | | | | |
| 42 | 95% UCL > Cleanup Limit? | NA | NA | NO | NA | NA | NA | NO | NA | NA | NA |
| 43 | > 10% above Cleanup Limit? | NA | NA | NO | NA | NA | NA | NO | NA | NA | NA |
| 44 | Any sample > 2X Cleanup Limit? | NA | NA | NO | NA | NA | NA | NO | NA | NA | NA |
| 45 | **WAC 173-340 Compliance?** | Because all values are below background (6.5 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (132 mg/kg) the WAC 173-340 3-part test is not required. | The data set meets the 3-part test criteria when compared to the most stringent RAG. | Because all values are below background (0.81 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (18.5 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (15.7 mg/kg) the WAC 173-340 3-part test is not required. | The data set meets the 3-part test criteria when compared to the most stringent RAG. | Because all values are below background (10.2 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (512 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (0.33 mg/kg) the WAC 173-340 3-part test is not required. |

46 **Acronyms and qualifiers are defined on sheet 3.**

**CALCULATION SHEET**

***Washington Closure Hanford***

**Originator** J. D. Skoglie
**Project** 100-D Field Remediation
**Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations

**Date** 06/12/13
**Job No.** 14655

**Calc. No.** 0100D-CA-V0499
**Checked** N. K. Schiffern NKS

**Rev. No.** 0
**Date** 06/12/13
**Sheet No.** 9 of 17

**100-D-78 Statistical Calculations**
**Verification Data - Staging Pile Area (SPA)**

| 1 | Sample | Sample | Sample | Nickel | | | Vanadium | | | Zinc | | | Chloride | | | Nitrogen in Nitrate | | | Nitrogen in Nitrate and Nitrite | | | Sulfate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Area | Number | Date | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 3 | SPA-1 | J1R695 | 4/1/13 | 11.4 | X | 0.12 | 50.2 | | 0.088 | 43.4 | X | 0.37 | 3.8 | B | 2.0 | 3.4 | | 0.33 | 3.7 | M | 0.31 | 42.9 | | 1.8 |
| 4 | Duplicate of J1R695 | J1R6C7 | 4/1/13 | 11.8 | X | 0.12 | 52.2 | | 0.091 | 44.5 | X | 0.38 | 3.9 | B | 2.1 | 2.8 | | 0.33 | 3.7 | | 0.32 | 40.6 | | 1.8 |
| 5 | SPA-2 | J1R696 | 4/1/13 | 11.0 | X | 0.11 | 47.7 | | 0.080 | 43.5 | X | 0.34 | 3.8 | B | 1.9 | 3.0 | | 0.31 | 3.5 | | 0.30 | 374 | | 1.7 |
| 6 | SPA-3 | J1R697 | 4/1/13 | 8.9 | X | 0.12 | 55.4 | | 0.092 | 41.1 | X | 0.39 | 3.0 | B | 2.0 | 1.4 | B | 0.31 | 1.2 | | 0.30 | 13.1 | | 1.7 |
| 7 | SPA-4 | J1R698 | 4/1/13 | 11.8 | X | 0.12 | 47.0 | | 0.089 | 40.9 | X | 0.38 | 3.4 | B | 2.0 | 2.0 | B | 0.32 | 2.3 | | 0.31 | 39.8 | | 1.8 |
| 8 | SPA-5 | J1R699 | 4/1/13 | 11.4 | X | 0.12 | 46.3 | | 0.093 | 42.8 | X | 0.39 | 3.0 | B | 2.0 | 1.2 | B | 0.32 | 0.91 | | 0.31 | 15.2 | | 1.8 |
| 9 | SPA-6 | J1R6C0 | 4/1/13 | 10.5 | X | 0.12 | 46.9 | | 0.089 | 44.0 | X | 0.37 | 3.0 | B | 2.0 | 1.2 | B | 0.32 | 1.2 | | 0.31 | 12.5 | | 1.8 |
| 10 | SPA-7 | J1R6C1 | 4/1/13 | 9.7 | X | 0.11 | 49.8 | | 0.084 | 39.3 | X | 0.36 | 5.4 | | 2.0 | 1.3 | B | 0.32 | 1.3 | | 0.31 | 97.3 | | 1.8 |
| 11 | SPA-8 | J1R6C2 | 4/1/13 | 11.8 | X | 0.13 | 46.9 | | 0.098 | 114 | X | 0.42 | 2.8 | B | 2.0 | 1.0 | B | 0.32 | 0.67 | B | 0.30 | 298 | | 1.8 |
| 12 | SPA-9 | J1R6C3 | 4/1/13 | 10.7 | X | 0.12 | 50.5 | | 0.090 | 46.6 | X | 0.38 | 24.4 | | 2.1 | 100 | | 0.33 | 101 | | 0.31 | 172 | | 1.8 |
| 13 | SPA-10 | J1R6C4 | 4/1/13 | 9.2 | X | 0.13 | 54.4 | | 0.096 | 43.8 | X | 0.41 | 6.8 | | 2.0 | 12.1 | | 0.32 | 14.8 | M | 0.30 | 189 | N | 1.8 |
| 14 | SPA-11 | J1R6C5 | 4/1/13 | 11.6 | X | 0.12 | 47.8 | | 0.095 | 45.5 | X | 0.40 | 5.9 | | 2.0 | 5.4 | | 0.32 | 6.6 | | 0.30 | 35.9 | | 1.7 |
| 15 | SPA-12 | J1R6C6 | 4/1/13 | 10.6 | X | 0.12 | 46.3 | | 0.091 | 42.5 | X | 0.39 | 2.8 | B | 2.0 | 0.32 | UR | 0.32 | 0.31 | U | 0.31 | 12.6 | | 1.8 |

16 **Statistical Computation Input Data**

| 17 | Sample | Sample | Sample | Nickel | Vanadium | Zinc | Chloride | Nitrogen in Nitrate | Nitrogen in Nitrate and Nitrite | Sulfate |
|---|---|---|---|---|---|---|---|---|---|---|
| 18 | Area | Number | Date | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| 19 | SPA-1 | J1R695/ J1R6C7 | 4/1/13 | 11.6 | 51.2 | 44.0 | 3.9 | 3.1 | 3.7 | 41.8 |
| 20 | SPA-2 | J1R696 | 4/1/13 | 11.0 | 47.7 | 43.5 | 3.8 | 3.0 | 3.5 | 374 |
| 21 | SPA-3 | J1R697 | 4/1/13 | 8.9 | 55.4 | 41.1 | 3.0 | 1.4 | 1.2 | 13.1 |
| 22 | SPA-4 | J1R698 | 4/1/13 | 11.8 | 47.0 | 40.9 | 3.4 | 2.0 | 2.3 | 39.8 |
| 23 | SPA-5 | J1R699 | 4/1/13 | 11.4 | 46.3 | 42.8 | 3.0 | 1.2 | 0.9 | 15.2 |
| 24 | SPA-6 | J1R6C0 | 4/1/13 | 10.5 | 46.9 | 44.0 | 3.0 | 1.2 | 1.2 | 12.5 |
| 25 | SPA-7 | J1R6C1 | 4/1/13 | 9.7 | 49.8 | 39.3 | 5.4 | 1.3 | 1.3 | 97.3 |
| 26 | SPA-8 | J1R6C2 | 4/1/13 | 11.8 | 46.9 | 114 | 2.8 | 1.0 | 0.67 | 298 |
| 27 | SPA-9 | J1R6C3 | 4/1/13 | 10.7 | 50.5 | 46.6 | 24.4 | 100 | 101 | 172 |
| 28 | SPA-10 | J1R6C4 | 4/1/13 | 9.2 | 54.4 | 43.8 | 6.8 | 12.1 | 14.8 | 189 |
| 29 | SPA-11 | J1R6C5 | 4/1/13 | 11.6 | 47.8 | 45.5 | 5.9 | 5.4 | 6.6 | 35.9 |
| 30 | SPA-12 | J1R6C6 | 4/1/13 | 10.6 | 46.3 | 42.5 | 2.8 | | 0.16 | 12.6 |

31 **Statistical Computations**

| 32 | | Nickel | Vanadium | Zinc | Chloride | Nitrogen in Nitrate | Nitrogen in Nitrate and Nitrite | Sulfate |
|---|---|---|---|---|---|---|---|---|
| 33 | 95% UCL based on | Large data set (n ≥ 10), use MTCAStat normal distribution. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. |
| 34 | N | 12 | 12 | 12 | 12 | 11 | 12 | 12 |
| 35 | % < Detection limit | 0% | 0% | 0% | 0% | 9% | 8% | 0% |
| 36 | Mean | 10.7 | 49.2 | 49.0 | 5.7 | 12.0 | 11.4 | 108 |
| 37 | Standard deviation | 1.0 | 3.1 | 20.6 | 6.0 | 29.4 | 28.5 | 123 |
| 38 | 95% UCL on mean | 11.3 | 50.7 | 58.8 | 8.6 | 26.5 | 79.3 | 472 |
| 39 | Maximum value | 11.8 | 55.4 | 114 | 24.4 | 100 | 101 | 374 |
| 40 | **Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)** | 19.1 GW Protection | 85.1 GW Protection | 67.8 River Protection | 25,000 GW Protection | 1000 GW Protection | 1000 GW Protection | 25,000 GW Protection |
| 41 | **WAC 173-340 3-PART TEST** | | | | | | | |
| 42 | 95% UCL > Cleanup Limit? | NA | NA | NO | NA | NO | NO | NO |
| 43 | > 10% above Cleanup Limit? | NA | NA | NO | NA | NO | NO | NO |
| 44 | Any sample > 2X Cleanup Limit? | NA | NA | NO | NA | NO | NO | NO |
| 45 | **WAC 173-340 Compliance?** | Because all values are below background (19.1 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (85.1 mg/kg) the WAC 173-340 3-part test is not required. | The data set meets the 3-part test criteria when compared to the most stringent RAG. | Because all values are below background (100 mg/kg) the WAC 173-340 3-part test is not required. | The data set meets the 3-part test criteria when compared to the most stringent RAG. | The data set meets the 3-part test criteria when compared to the most stringent RAG. | The data set meets the 3-part test criteria when compared to the most stringent RAG. |

**Acronyms and qualifiers are defined on sheet 3.**

## MAXIMUM VALUE 3-PART TEST CALCULATION SHEET

***Washington Closure Hanford***

**Originator** J. D. Skoglie **Date** 06/12/13 **Calc. No.** 0100D-CA-V0499 **Rev. No.** 0
**Project** 100-D Field Remediation **Job No.** 14655 **Checked** N. K. Schiffern **Date** 06/12/13
**Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 10 of 17

1 **100-D-78 Maximum Calculations**

2 **Verification Data - Staging Pile Area (SPA)**

| 3 | Sample | Sample | Sample | Hexavalent Chromium | | | Molybdenum | | | Fluoride | | | Nitrogen in Nitrite | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Area | Number | Date | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 5 | SPA-1 | J1R695 | 4/1/13 | 0.155 | U | 0.155 | 0.35 | B | 0.24 | 0.96 | BN | 0.86 | 0.89 | B | 0.35 |
| 6 | Duplicate of J1R695 | J1R6C7 | 4/1/13 | 0.155 | U | 0.155 | 0.25 | U | 0.25 | 0.97 | B | 0.86 | 0.90 | B | 0.35 |
| 7 | SPA-2 | J1R696 | 4/1/13 | 0.155 | U | 0.155 | 0.36 | B | 0.22 | 0.86 | B | 0.81 | 0.86 | B | 0.33 |
| 8 | SPA-3 | J1R697 | 4/1/13 | 0.217 | | 0.155 | 0.25 | U | 0.25 | 0.89 | B | 0.82 | 0.84 | B | 0.33 |
| 9 | SPA-4 | J1R698 | 4/1/13 | 0.383 | | 0.155 | 0.25 | U | 0.25 | 0.85 | U | 0.85 | 0.90 | B | 0.35 |
| 10 | SPA-5 | J1R699 | 4/1/13 | 0.155 | U | 0.155 | 0.26 | U | 0.26 | 0.85 | U | 0.85 | 0.35 | UR | 0.35 |
| 11 | SPA-6 | J1R6C0 | 4/1/13 | 0.155 | U | 0.155 | 0.24 | U | 0.24 | 0.84 | U | 0.84 | 0.34 | UR | 0.34 |
| 12 | SPA-7 | J1R6C1 | 4/1/13 | 0.155 | U | 0.155 | 0.23 | U | 0.23 | 0.84 | U | 0.84 | 0.34 | UR | 0.34 |
| 13 | SPA-8 | J1R6C2 | 4/1/13 | 0.155 | U | 0.155 | 0.27 | U | 0.27 | 0.83 | U | 0.83 | 0.34 | UR | 0.34 |
| 14 | SPA-9 | J1R6C3 | 4/1/13 | 0.155 | U | 0.155 | 0.25 | U | 0.25 | 0.97 | B | 0.86 | 0.98 | B | 0.35 |
| 15 | SPA-10 | J1R6C4 | 4/1/13 | 0.155 | U | 0.155 | 0.27 | U | 0.27 | 0.83 | UN | 0.83 | 0.96 | B | 0.34 |
| 16 | SPA-11 | J1R6C5 | 4/1/13 | 0.155 | U | 0.155 | 0.26 | U | 0.26 | 1.1 | B | 0.83 | 1.2 | B | 0.34 |
| 17 | SPA-12 | J1R6C6 | 4/1/13 | 0.155 | U | 0.155 | 0.25 | U | 0.25 | 0.85 | U | 0.85 | 0.35 | UR | 0.35 |

18 **Statistical Computations**

| 19 | | Hexavalent Chromium | Molybdenum | Fluoride | Nitrogen in Nitrite |
|---|---|---|---|---|---|
| 20 | % < Detection limit | 83% | 83% | 58% | 42% |
| 21 | Maximum value | 0.383 | 0.36 | 1.1 | 1.2 |
| 22 | **Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)** | 2 River Protection | 8 GW Protection | 96 GW Protection | 100 GW Protection |
| 23 | **3-PART TEST** | | | | |
| 24 | Maximum > Cleanup Limit? | NO | NO | NA | NO |
| 25 | > 10% above Cleanup Limit? | NO | NO | NA | NO |
| 26 | Any sample > 2X Cleanup Limit? | NO | NO | NA | NO |
| 27 | **3-Part Test Compliance?** | The data set meets the 3-part test criteria when compared to the most stringent RAG. | The data set meets the 3-part test criteria when compared to the most stringent RAG. | Because all values are below background (2.81 mg/kg) the WAC 173-340 3-part test is not required. | The data set meets the 3-part test criteria when compared to the most stringent RAG. |

**Acronyms and qualifiers are defined on sheet 3.**

**CALCULATION SHEET**

***Washington Closure Hanford***

**Originator** J. D. Skoglie

**Project** 100-D Field Remediation

**Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations

**Date** 06/12/13

**Job No.** 14655

**Calc. No.** 0100D-CA-V0499

**Checked** N. K. Schiffern

**Rev. No.** 0

**Date** 06/12/13

**Sheet No.** 11 of 17

**Ecology Software (MTCAStat) Results, 100-D-78 Waste Site Excavation**

| DATA | ID | Arsenic 95% UCL Calculation | | | |
|---|---|---|---|---|---|
| 2.5 | J1R684/ J1R693 | | | | |
| 2.8 | J1R681 | | | | |
| 3.7 | J1R682 | Number of samples | | Uncensored values | |
| 2.7 | J1R683 | Uncensored | 12 | Mean | 2.9 |
| 3.0 | J1R685 | Censored | | Lognormal mean | 2.9 |
| 2.8 | J1R686 | Detection limit or PQL | | Std. devn. | 0.43 |
| 3.7 | J1R687 | Method detection limit | | Median | 2.8 |
| 3.1 | J1R688 | TOTAL | 12 | Min. | 2.4 |
| 2.6 | J1R689 | | | Max. | 3.7 |
| 2.6 | J1R690 | | | | |
| 2.7 | J1R691 | | | | |
| 2.4 | J1R692 | | | | |

Lognormal distribution? r-squared is: 0.893
Normal distribution? r-squared is: 0.856
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 3.1

| DATA | ID | Barium 95% UCL Calculation | | | |
|---|---|---|---|---|---|
| 61.8 | J1R684/ J1R693 | | | | |
| 61.5 | J1R681 | | | | |
| 66.0 | J1R682 | Number of samples | | Uncensored values | |
| 51.3 | J1R683 | Uncensored | 12 | Mean | 61.6 |
| 62.5 | J1R685 | Censored | | Lognormal mean | 61.6 |
| 60.2 | J1R686 | Detection limit or PQL | | Std. devn. | 12.6 |
| 98.2 | J1R687 | Method detection limit | | Median | 60.9 |
| 62.4 | J1R688 | TOTAL | 12 | Min. | 48.5 |
| 55.1 | J1R689 | | | Max. | 98.2 |
| 57.3 | J1R690 | | | | |
| 48.5 | J1R691 | | | | |
| 54.6 | J1R692 | | | | |

Lognormal distribution? r-squared is: 0.788
Normal distribution? r-squared is: 0.692
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 67.6

| DATA | ID | Cadmium 95% UCL Calculation | | | |
|---|---|---|---|---|---|
| 0.16 | J1R684/ J1R693 | | | | |
| 0.18 | J1R681 | | | | |
| 0.17 | J1R682 | Number of samples | | Uncensored values | |
| 0.14 | J1R683 | Uncensored | 12 | Mean | 0.17 |
| 0.16 | J1R685 | Censored | | Lognormal mean | 0.17 |
| 0.16 | J1R686 | Detection limit or PQL | | Std. devn. | 0.022 |
| 0.22 | J1R687 | Method detection limit | | Median | 0.16 |
| 0.19 | J1R688 | TOTAL | 12 | Min. | 0.14 |
| 0.16 | J1R689 | | | Max. | 0.22 |
| 0.17 | J1R690 | | | | |
| 0.14 | J1R691 | | | | |
| 0.16 | J1R692 | | | | |

Lognormal distribution? r-squared is: 0.892
Normal distribution? r-squared is: 0.862
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.18

| DATA | ID | Chromium 95% UCL Calculation | | | |
|---|---|---|---|---|---|
| 5.2 | J1R684/ J1R693 | | | | |
| 6.4 | J1R681 | | | | |
| 8.3 | J1R682 | Number of samples | | Uncensored values | |
| 6.0 | J1R683 | Uncensored | 12 | Mean | 6.1 |
| 6.5 | J1R685 | Censored | | Lognormal mean | 6.1 |
| 6.1 | J1R686 | Detection limit or PQL | | Std. devn. | 1.4 |
| 8.6 | J1R687 | Method detection limit | | Median | 6.2 |
| 6.3 | J1R688 | TOTAL | 12 | Min. | 3.8 |
| 4.6 | J1R689 | | | Max. | 8.6 |
| 6.2 | J1R690 | | | | |
| 3.8 | J1R691 | | | | |
| 4.7 | J1R692 | | | | |

Lognormal distribution? r-squared is: 0.946
Normal distribution? r-squared is: 0.934
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 6.9

| DATA | ID | Cobalt 95% UCL Calculation | | | |
|---|---|---|---|---|---|
| 10.5 | J1R684/ J1R693 | | | | |
| 7.9 | J1R681 | | | | |
| 7.7 | J1R682 | Number of samples | | Uncensored values | |
| 7.3 | J1R683 | Uncensored | 12 | Mean | 8.7 |
| 8.3 | J1R685 | Censored | | Lognormal mean | 8.7 |
| 7.8 | J1R686 | Detection limit or PQL | | Std. devn. | 1.2 |
| 8.1 | J1R687 | Method detection limit | | Median | 8.4 |
| 8.4 | J1R688 | TOTAL | 12 | Min. | 7.3 |
| 10.9 | J1R689 | | | Max. | 10.9 |
| 8.5 | J1R690 | | | | |
| 9.4 | J1R691 | | | | |
| 9.9 | J1R692 | | | | |

Lognormal distribution? r-squared is: 0.928
Normal distribution? r-squared is: 0.908
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 9.4

| DATA | ID | Copper 95% UCL Calculation | | | |
|---|---|---|---|---|---|
| 16.2 | J1R684/ J1R693 | | | | |
| 14.7 | J1R681 | | | | |
| 15.7 | J1R682 | Number of samples | | Uncensored values | |
| 13.3 | J1R683 | Uncensored | 12 | Mean | 15.6 |
| 16.1 | J1R685 | Censored | | Lognormal mean | 15.6 |
| 14.3 | J1R686 | Detection limit or PQL | | Std. devn. | 1.1 |
| 16.7 | J1R687 | Method detection limit | | Median | 15.8 |
| 16.8 | J1R688 | TOTAL | 12 | Min. | 13.3 |
| 16.8 | J1R689 | | | Max. | 16.8 |
| 15.5 | J1R690 | | | | |
| 15.5 | J1R691 | | | | |
| 15.9 | J1R692 | | | | |

Lognormal distribution? r-squared is: 0.899
Normal distribution? r-squared is: 0.916
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 16.2

| DATA | ID | Hexavalent chromium 95% UCL Calculation | | | |
|---|---|---|---|---|---|
| 0.143 | J1R684/ J1R693 | | | | |
| 0.256 | J1R681 | | | | |
| 0.273 | J1R682 | Number of samples | | Uncensored values | |
| 0.209 | J1R683 | Uncensored | 12 | Mean | 0.218 |
| 0.211 | J1R685 | Censored | | Lognormal mean | 0.225 |
| 0.298 | J1R686 | Detection limit or PQL | | Std. devn. | 0.113 |
| 0.439 | J1R687 | Method detection limit | | Median | 0.212 |
| 0.342 | J1R688 | TOTAL | 12 | Min. | 0.0775 |
| 0.0775 | J1R689 | | | Max. | 0.439 |
| 0.212 | J1R690 | | | | |
| 0.0775 | J1R691 | | | | |
| 0.0775 | J1R692 | | | | |

Lognormal distribution? r-squared is: 0.903
Normal distribution? r-squared is: 0.947
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.341

| DATA | ID | Lead 95% UCL Calculation | | | |
|---|---|---|---|---|---|
| 3.8 | J1R684/ J1R693 | | | | |
| 5.3 | J1R681 | | | | |
| 7.8 | J1R682 | Number of samples | | Uncensored values | |
| 3.4 | J1R683 | Uncensored | 12 | Mean | 5.2 |
| 3.5 | J1R685 | Censored | | Lognormal mean | 5.2 |
| 4.8 | J1R686 | Detection limit or PQL | | Std. devn. | 1.6 |
| 8.6 | J1R687 | Method detection limit | | Median | 4.9 |
| 5.0 | J1R688 | TOTAL | 12 | Min. | 3.4 |
| 5.2 | J1R689 | | | Max. | 8.6 |
| 3.9 | J1R690 | | | | |
| 5.7 | J1R691 | | | | |
| 4.8 | J1R692 | | | | |

Lognormal distribution? r-squared is: 0.933
Normal distribution? r-squared is: 0.869
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 6.1

| DATA | ID | Manganese 95% UCL Calculation | | | |
|---|---|---|---|---|---|
| 313 | J1R684/ J1R693 | | | | |
| 280 | J1R681 | | | | |
| 296 | J1R682 | Number of samples | | Uncensored values | |
| 270 | J1R683 | Uncensored | 12 | Mean | 303 |
| 299 | J1R685 | Censored | | Lognormal mean | 303 |
| 285 | J1R686 | Detection limit or PQL | | Std. devn. | 36.7 |
| 405 | J1R687 | Method detection limit | | Median | 296 |
| 332 | J1R688 | TOTAL | 12 | Min. | 266 |
| 296 | J1R689 | | | Max. | 405 |
| 295 | J1R690 | | | | |
| 266 | J1R691 | | | | |
| 301 | J1R692 | | | | |

Lognormal distribution? r-squared is: 0.806
Normal distribution? r-squared is: 0.752
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 321

**Acronyms and qualifiers are defined on sheet 3.**

**CALCULATION SHEET**

***Washington Closure Hanford***

**Originator** J. D. Skoglie
**Project** 100-D Field Remediation
**Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations

**Date** 06/12/13
**Job No.** 14655

**Calc. No.** 0100D-CA-V0499
**Checked** N. K. Schiffern

**Rev. No.** 0
**Date** 06/12/13
**Sheet No.** 12 of 17

**Ecology Software (MTCAStat) Results, 100-D-78 Waste Site Excavation**

**Mercury 95% UCL Calculation**

| DATA | ID |
|---|---|
| 0.0028 | J1R684/ J1R693 |
| 0.0053 | J1R681 |
| 0.0071 | J1R682 |
| 0.0055 | J1R683 |
| 0.0028 | J1R685 |
| 0.045 | J1R686 |
| 0.64 | J1R687 |
| 0.012 | J1R688 |
| 0.0057 | J1R689 |
| 0.0030 | J1R690 |
| 0.0027 | J1R691 |
| 0.14 | J1R692 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 0.073 |
| Censored | | Lognormal mean | 0.052 |
| Detection limit or PQL | | Std. devn. | 0.18 |
| Method detection limit | | Median | 0.0056 |
| TOTAL | 12 | Min. | 0.0027 |
| | | Max. | 0.64 |

Lognormal distribution? r-squared is: 0.797
Normal distribution? r-squared is: 0.419
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.16

**Molybdenum 95% UCL Calculation**

| DATA | ID |
|---|---|
| 0.30 | J1R684/ J1R693 |
| 0.28 | J1R681 |
| 0.30 | J1R682 |
| 0.12 | J1R683 |
| 0.26 | J1R685 |
| 0.29 | J1R686 |
| 0.35 | J1R687 |
| 0.38 | J1R688 |
| 0.30 | J1R689 |
| 0.26 | J1R690 |
| 0.27 | J1R691 |
| 0.32 | J1R692 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 0.29 |
| Censored | | Lognormal mean | 0.29 |
| Detection limit or PQL | | Std. devn. | 0.063 |
| Method detection limit | | Median | 0.30 |
| TOTAL | 12 | Min. | 0.12 |
| | | Max. | 0.38 |

Lognormal distribution? r-squared is: 0.678
Normal distribution? r-squared is: 0.820
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.32

**Nickel 95% UCL Calculation**

| DATA | ID |
|---|---|
| 8.0 | J1R684/ J1R693 |
| 8.4 | J1R681 |
| 9.4 | J1R682 |
| 8.6 | J1R683 |
| 8.6 | J1R685 |
| 7.4 | J1R686 |
| 8.8 | J1R687 |
| 7.8 | J1R688 |
| 8.2 | J1R689 |
| 8.1 | J1R690 |
| 5.9 | J1R691 |
| 6.3 | J1R692 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 8.0 |
| Censored | | Lognormal mean | 8.0 |
| Detection limit or PQL | | Std. devn. | 1.0 |
| Method detection limit | | Median | 8.2 |
| TOTAL | 12 | Min. | 5.9 |
| | | Max. | 9.4 |

Lognormal distribution? r-squared is: 0.874
Normal distribution? r-squared is: 0.911
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 8.5

**Vanadium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 79.2 | J1R684/ J1R693 |
| 66.0 | J1R681 |
| 60.2 | J1R682 |
| 60.9 | J1R683 |
| 66.8 | J1R685 |
| 67.4 | J1R686 |
| 59.9 | J1R687 |
| 67.7 | J1R688 |
| 83.4 | J1R689 |
| 69.6 | J1R690 |
| 76.5 | J1R691 |
| 83.8 | J1R692 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 70.1 |
| Censored | | Lognormal mean | 70.2 |
| Detection limit or PQL | | Std. devn. | 8.61 |
| Method detection limit | | Median | 67.6 |
| TOTAL | 12 | Min. | 59.9 |
| | | Max. | 83.8 |

Lognormal distribution? r-squared is: 0.928
Normal distribution? r-squared is: 0.917
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 74.9

**Zinc 95% UCL Calculation**

| DATA | ID |
|---|---|
| 45.6 | J1R684/ J1R693 |
| 43.5 | J1R681 |
| 49.7 | J1R682 |
| 39.5 | J1R683 |
| 44.5 | J1R685 |
| 45.3 | J1R686 |
| 50.7 | J1R687 |
| 49.9 | J1R688 |
| 73.4 | J1R689 |
| 45.1 | J1R690 |
| 43.2 | J1R691 |
| 47.8 | J1R692 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 48.2 |
| Censored | | Lognormal mean | 48.2 |
| Detection limit or PQL | | Std. devn. | 8.57 |
| Method detection limit | | Median | 45.4 |
| TOTAL | 12 | Min. | 39.5 |
| | | Max. | 73.4 |

Lognormal distribution? r-squared is: 0.740
Normal distribution? r-squared is: 0.659
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 52.2

**Fluoride 95% UCL Calculation**

| DATA | ID |
|---|---|
| 1.0 | J1R684/ J1R693 |
| 1.1 | J1R681 |
| 1.0 | J1R682 |
| 0.96 | J1R683 |
| 1.2 | J1R685 |
| 0.96 | J1R686 |
| 1.3 | J1R687 |
| 1.8 | J1R688 |
| 0.42 | J1R689 |
| 0.97 | J1R690 |
| 0.91 | J1R691 |
| 0.89 | J1R692 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 1.0 |
| Censored | | Lognormal mean | 1.1 |
| Detection limit or PQL | | Std. devn. | 0.32 |
| Method detection limit | | Median | 0.99 |
| TOTAL | 12 | Min. | 0.42 |
| | | Max. | 1.8 |

Lognormal distribution? r-squared is: 0.789
Normal distribution? r-squared is: 0.833
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 1.2

**Sulfate 95% UCL Calculation**

| DATA | ID |
|---|---|
| 7.2 | J1R684/ J1R693 |
| 81.2 | J1R681 |
| 8.4 | J1R682 |
| 362 | J1R683 |
| 11.3 | J1R685 |
| 7.0 | J1R686 |
| 2710 | J1R687 |
| 205 | J1R688 |
| 7.0 | J1R689 |
| 8.4 | J1R690 |
| 6.2 | J1R691 |
| 8.9 | J1R692 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 285 |
| Censored | | Lognormal mean | 224 |
| Detection limit or PQL | | Std. devn. | 772 |
| Method detection limit | | Median | 8.7 |
| TOTAL | 12 | Min. | 6.2 |
| | | Max. | 2710 |

Lognormal distribution? r-squared is: 0.753
Normal distribution? r-squared is: 0.389
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 652

**Acronyms and qualifiers are defined on sheet 3.**

**CALCULATION SHEET**

***Washington Closure Hanford***

**Originator** J. D. Skoglie
**Project** 100-D Field Remediation
**Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations

**Date** 06/12/13
**Job No.** 14655

**Calc. No.** 0100D-CA-V0499
**Checked** N. K. Schiffern

**Rev. No.** 0
**Date** 06/12/13
**Sheet No.** 13 of 17

**Ecology Software (MTCAStat) Results, 100-D-78 Waste Site Staging Pile Area**

**Arsenic 95% UCL Calculation**

| DATA | ID |
|---|---|
| 2.8 | J1R695/ J1R6C7 |
| 2.3 | J1R696 |
| 1.9 | J1R697 |
| 2.4 | J1R698 |
| 2.7 | J1R699 |
| 3.0 | J1R6C0 |
| 1.9 | J1R6C1 |
| 2.5 | J1R6C2 |
| 2.4 | J1R6C3 |
| 2.1 | J1R6C4 |
| 2.5 | J1R6C5 |
| 2.6 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 2.4 |
| Censored | | Lognormal mean | 2.4 |
| Detection limit or PQL | | Std. devn. | 0.34 |
| Method detection limit | | Median | 2.5 |
| TOTAL | 12 | Min. | 1.9 |
| | | Max. | 3.0 |

Lognormal distribution? r-squared is: 0.956
Normal distribution? r-squared is: 0.971
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 2.6

**Barium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 106 | J1R695/ J1R6C7 |
| 96.8 | J1R696 |
| 61.9 | J1R697 |
| 79.7 | J1R698 |
| 78.3 | J1R699 |
| 80.7 | J1R6C0 |
| 64.0 | J1R6C1 |
| 84.3 | J1R6C2 |
| 86.9 | J1R6C3 |
| 65.0 | J1R6C4 |
| 77.3 | J1R6C5 |
| 81.6 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 80.2 |
| Censored | | Lognormal mean | 80.3 |
| Detection limit or PQL | | Std. devn. | 13.0 |
| Method detection limit | | Median | 80.2 |
| TOTAL | 12 | Min. | 61.9 |
| | | Max. | 106 |

Lognormal distribution? r-squared is: 0.946
Normal distribution? r-squared is: 0.940
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 87.7

**Boron 95% UCL Calculation**

| DATA | ID |
|---|---|
| 3.4 | J1R695/ J1R6C7 |
| 4.9 | J1R696 |
| 1.5 | J1R697 |
| 2.0 | J1R698 |
| 2.1 | J1R699 |
| 2.1 | J1R6C0 |
| 2.0 | J1R6C1 |
| 2.8 | J1R6C2 |
| 5.3 | J1R6C3 |
| 2.2 | J1R6C4 |
| 2.7 | J1R6C5 |
| 2.2 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 2.8 |
| Censored | | Lognormal mean | 2.8 |
| Detection limit or PQL | | Std. devn. | 1.2 |
| Method detection limit | | Median | 2.2 |
| TOTAL | 12 | Min. | 1.5 |
| | | Max. | 5.3 |

Lognormal distribution? r-squared is: 0.888
Normal distribution? r-squared is: 0.798
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 3.3

**Cadmium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 0.098 | J1R695/ J1R6C7 |
| 0.092 | J1R696 |
| 0.077 | J1R697 |
| 0.078 | J1R698 |
| 0.085 | J1R699 |
| 0.12 | J1R6C0 |
| 0.079 | J1R6C1 |
| 0.11 | J1R6C2 |
| 0.12 | J1R6C3 |
| 0.082 | J1R6C4 |
| 0.088 | J1R6C5 |
| 0.10 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 0.094 |
| Censored | | Lognormal mean | 0.094 |
| Detection limit or PQL | | Std. devn. | 0.016 |
| Method detection limit | | Median | 0.090 |
| TOTAL | 12 | Min. | 0.077 |
| | | Max. | 0.12 |

Lognormal distribution? r-squared is: 0.931
Normal distribution? r-squared is: 0.911
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.10

**Chromium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 9.6 | J1R695/ J1R6C7 |
| 8.5 | J1R696 |
| 7.6 | J1R697 |
| 12.1 | J1R698 |
| 10.5 | J1R699 |
| 10.0 | J1R6C0 |
| 7.8 | J1R6C1 |
| 9.5 | J1R6C2 |
| 9.9 | J1R6C3 |
| 7.2 | J1R6C4 |
| 9.7 | J1R6C5 |
| 10.1 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 9.4 |
| Censored | | Lognormal mean | 9.4 |
| Detection limit or PQL | | Std. devn. | 1.4 |
| Method detection limit | | Median | 9.6 |
| TOTAL | 12 | Min. | 7.2 |
| | | Max. | 12.1 |

Lognormal distribution? r-squared is: 0.937
Normal distribution? r-squared is: 0.939
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 10.2

**Cobalt 95% UCL Calculation**

| DATA | ID |
|---|---|
| 8.2 | J1R695/ J1R6C7 |
| 7.9 | J1R696 |
| 7.8 | J1R697 |
| 7.8 | J1R698 |
| 7.9 | J1R699 |
| 7.8 | J1R6C0 |
| 7.1 | J1R6C1 |
| 7.6 | J1R6C2 |
| 9.0 | J1R6C3 |
| 8.3 | J1R6C4 |
| 7.9 | J1R6C5 |
| 7.8 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 7.9 |
| Censored | | Lognormal mean | 7.9 |
| Detection limit or PQL | | Std. devn. | 0.45 |
| Method detection limit | | Median | 7.9 |
| TOTAL | 12 | Min. | 7.1 |
| | | Max. | 9.0 |

Lognormal distribution? r-squared is: 0.853
Normal distribution? r-squared is: 0.842
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 8.1

**Copper 95% UCL Calculation**

| DATA | ID |
|---|---|
| 16.5 | J1R695/ J1R6C7 |
| 31.9 | J1R696 |
| 13.2 | J1R697 |
| 13.8 | J1R698 |
| 14.1 | J1R699 |
| 12.5 | J1R6C0 |
| 12.7 | J1R6C1 |
| 18.2 | J1R6C2 |
| 13.1 | J1R6C3 |
| 13.5 | J1R6C4 |
| 13.7 | J1R6C5 |
| 12.8 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 15.5 |
| Censored | | Lognormal mean | 15.4 |
| Detection limit or PQL | | Std. devn. | 5.4 |
| Method detection limit | | Median | 13.6 |
| TOTAL | 12 | Min. | 12.5 |
| | | Max. | 31.9 |

Lognormal distribution? r-squared is: 0.633
Normal distribution? r-squared is: 0.538
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 18.1

**Lead 95% UCL Calculation**

| DATA | ID |
|---|---|
| 4.8 | J1R695/ J1R6C7 |
| 5.4 | J1R696 |
| 2.8 | J1R697 |
| 4.3 | J1R698 |
| 3.9 | J1R699 |
| 4.4 | J1R6C0 |
| 3.7 | J1R6C1 |
| 5.5 | J1R6C2 |
| 4.2 | J1R6C3 |
| 3.3 | J1R6C4 |
| 4.3 | J1R6C5 |
| 4.2 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 4.2 |
| Censored | | Lognormal mean | 4.2 |
| Detection limit or PQL | | Std. devn. | 0.77 |
| Method detection limit | | Median | 4.3 |
| TOTAL | 12 | Min. | 2.8 |
| | | Max. | 5.5 |

Lognormal distribution? r-squared is: 0.944
Normal distribution? r-squared is: 0.958
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 4.7

**Manganese 95% UCL Calculation**

| DATA | ID |
|---|---|
| 327 | J1R695/ J1R6C7 |
| 308 | J1R696 |
| 290 | J1R697 |
| 325 | J1R698 |
| 343 | J1R699 |
| 352 | J1R6C0 |
| 274 | J1R6C1 |
| 325 | J1R6C2 |
| 384 | J1R6C3 |
| 324 | J1R6C4 |
| 329 | J1R6C5 |
| 333 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 326 |
| Censored | | Lognormal mean | 326 |
| Detection limit or PQL | | Std. devn. | 28.2 |
| Method detection limit | | Median | 326 |
| TOTAL | 12 | Min. | 274 |
| | | Max. | 384 |

Lognormal distribution? r-squared is: 0.929
Normal distribution? r-squared is: 0.930
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 342

**Acronyms and qualifiers are defined on sheet 3.**

**CALCULATION SHEET**

***Washington Closure Hanford***

**Originator** J. D. Skoglie
**Project** 100-D Field Remediation
**Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations

**Date** 06/12/13
**Job No.** 14655

**Calc. No.** 0100D-CA-V0499
**Checked** N. K. Schiffern

**Rev. No.** 0
**Date** 06/12/13
**Sheet No.** 14 of 17

**Ecology Software (MTCAStat) Results, 100-D-78 Waste Site Staging Pile Area**

### Mercury 95% UCL Calculation

| DATA | ID |
|---|---|
| 0.018 | J1R695/ J1R6C7 |
| 0.014 | J1R696 |
| 0.013 | J1R697 |
| 0.0094 | J1R698 |
| 0.0088 | J1R699 |
| 0.011 | J1R6C0 |
| 0.021 | J1R6C1 |
| 0.010 | J1R6C2 |
| 0.0093 | J1R6C3 |
| 0.014 | J1R6C4 |
| 0.011 | J1R6C5 |
| 0.0082 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 0.012 |
| Censored | | Lognormal mean | 0.012 |
| Detection limit or PQL | | Std. devn. | 0.0039 |
| Method detection limit | | Median | 0.011 |
| TOTAL | 12 | Min. | 0.0082 |
| | | Max. | 0.021 |

Lognormal distribution? r-squared is: 0.938
Normal distribution? r-squared is: 0.876
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.015

### Nickel 95% UCL Calculation

| DATA | ID |
|---|---|
| 11.6 | J1R695/ J1R6C7 |
| 11.0 | J1R696 |
| 8.9 | J1R697 |
| 11.8 | J1R698 |
| 11.4 | J1R699 |
| 10.5 | J1R6C0 |
| 9.7 | J1R6C1 |
| 11.8 | J1R6C2 |
| 10.7 | J1R6C3 |
| 9.2 | J1R6C4 |
| 11.6 | J1R6C5 |
| 10.6 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 10.7 |
| Censored | | Lognormal mean | 10.7 |
| Detection limit or PQL | | Std. devn. | 1.0 |
| Method detection limit | | Median | 10.9 |
| TOTAL | 12 | Min. | 8.9 |
| | | Max. | 11.8 |

Lognormal distribution? r-squared is: 0.898
Normal distribution? r-squared is: 0.911
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 11.3

### Vanadium 95% UCL Calculation

| DATA | ID |
|---|---|
| 51.2 | J1R695/ J1R6C7 |
| 47.7 | J1R696 |
| 55.4 | J1R697 |
| 47.0 | J1R698 |
| 46.3 | J1R699 |
| 46.9 | J1R6C0 |
| 49.8 | J1R6C1 |
| 46.9 | J1R6C2 |
| 50.5 | J1R6C3 |
| 54.4 | J1R6C4 |
| 47.8 | J1R6C5 |
| 46.3 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 49.2 |
| Censored | | Lognormal mean | 49.2 |
| Detection limit or PQL | | Std. devn. | 3.1 |
| Method detection limit | | Median | 47.8 |
| TOTAL | 12 | Min. | 46.3 |
| | | Max. | 55.4 |

Lognormal distribution? r-squared is: 0.861
Normal distribution? r-squared is: 0.851
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 50.7

### Zinc 95% UCL Calculation

| DATA | ID |
|---|---|
| 44.0 | J1R695/ J1R6C7 |
| 43.5 | J1R696 |
| 41.1 | J1R697 |
| 40.9 | J1R698 |
| 42.8 | J1R699 |
| 44.0 | J1R6C0 |
| 39.3 | J1R6C1 |
| 114 | J1R6C2 |
| 46.6 | J1R6C3 |
| 43.8 | J1R6C4 |
| 45.5 | J1R6C5 |
| 42.5 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 49.0 |
| Censored | | Lognormal mean | 48.6 |
| Detection limit or PQL | | Std. devn. | 20.6 |
| Method detection limit | | Median | 43.7 |
| TOTAL | 12 | Min. | 39.3 |
| | | Max. | 114 |

Lognormal distribution? r-squared is: 0.451
Normal distribution? r-squared is: 0.386
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 58.8

### Chloride 95% UCL Calculation

| DATA | ID |
|---|---|
| 3.9 | J1R695/ J1R6C7 |
| 3.8 | J1R696 |
| 3.0 | J1R697 |
| 3.4 | J1R698 |
| 3.0 | J1R699 |
| 3.0 | J1R6C0 |
| 5.4 | J1R6C1 |
| 2.8 | J1R6C2 |
| 24.4 | J1R6C3 |
| 6.8 | J1R6C4 |
| 5.9 | J1R6C5 |
| 2.8 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 5.7 |
| Censored | | Lognormal mean | 5.4 |
| Detection limit or PQL | | Std. devn. | 6.0 |
| Method detection limit | | Median | 3.6 |
| TOTAL | 12 | Min. | 2.8 |
| | | Max. | 24.4 |

Lognormal distribution? r-squared is: 0.720
Normal distribution? r-squared is: 0.480
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 8.6

### Nitrogen in Nitrate 95% UCL Calculation

| DATA | ID |
|---|---|
| 3.1 | J1R695/ J1R6C7 |
| 3.0 | J1R696 |
| 1.4 | J1R697 |
| 2.0 | J1R698 |
| 1.2 | J1R699 |
| 1.2 | J1R6C0 |
| 1.3 | J1R6C1 |
| 1.0 | J1R6C2 |
| 100 | J1R6C3 |
| 12.1 | J1R6C4 |
| 5.4 | J1R6C5 |
| | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 11 | Mean | 12.0 |
| Censored | | Lognormal mean | 8.1 |
| Detection limit or PQL | | Std. devn. | 29.4 |
| Method detection limit | | Median | 2.0 |
| TOTAL | 11 | Min. | 1.0 |
| | | Max. | 100 |

Lognormal distribution? r-squared is: 0.779
Normal distribution? r-squared is: 0.392
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 26.5

### Nitrogen in Nitrate and Nitrite 95% UCL Calculation

| DATA | ID |
|---|---|
| 3.7 | J1R695/ J1R6C7 |
| 3.5 | J1R696 |
| 1.2 | J1R697 |
| 2.3 | J1R698 |
| 0.91 | J1R699 |
| 1.2 | J1R6C0 |
| 1.3 | J1R6C1 |
| 0.67 | J1R6C2 |
| 101 | J1R6C3 |
| 14.8 | J1R6C4 |
| 6.6 | J1R6C5 |
| 0.16 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 11.4 |
| Censored | | Lognormal mean | 9.7 |
| Detection limit or PQL | | Std. devn. | 28.5 |
| Method detection limit | | Median | 1.8 |
| TOTAL | 12 | Min. | 0.16 |
| | | Max. | 101 |

Lognormal distribution? r-squared is: 0.930
Normal distribution? r-squared is: 0.398
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 79.3

### Sulfate 95% UCL Calculation

| DATA | ID |
|---|---|
| 41.8 | J1R695/ J1R6C7 |
| 374 | J1R696 |
| 13.1 | J1R697 |
| 39.8 | J1R698 |
| 15.2 | J1R699 |
| 12.5 | J1R6C0 |
| 97.3 | J1R6C1 |
| 298 | J1R6C2 |
| 172 | J1R6C3 |
| 189 | J1R6C4 |
| 35.9 | J1R6C5 |
| 12.6 | J1R6C6 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 108 |
| Censored | | Lognormal mean | 124 |
| Detection limit or PQL | | Std. devn. | 123 |
| Method detection limit | | Median | 40.8 |
| TOTAL | 12 | Min. | 12.5 |
| | | Max. | 374 |

Lognormal distribution? r-squared is: 0.917
Normal distribution? r-squared is: 0.801
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 472

**Acronyms and qualifiers are defined on sheet 3.**

CALCULATION SHEET

***Washington Closure Hanford***

**Originator** J. D. Skoglie **Date** 06/12/13 **Calc. No.** 0100D-CA-V0499 **Rev. No.** 0
**Project** 100-D Field Remediation **Job No.** 14655 **Checked** N. K. Schiffern **Date** 06/12/13
**Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 15 of 17

**Duplicate Analysis - 100-D-78 Waste Site Excavation**

| Sampling Area | Sample Number | Sample Date | Aluminum | | | Arsenic | | | Barium | | | 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 | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 78D-4 | J1R684 | 1/16/13 | 4840 | X | 1.4 | 2.3 | | 0.61 | 65.1 | JX | 0.071 | 0.16 | B | 0.038 | 6510 | JX | 13.1 | 5.2 | X | 0.054 | 10.8 | X | 0.46 | 16.5 | X | 1.0 | 25500 | X | 3.5 |
| Duplicate of J1R684 | J1R693 | 1/16/13 | 4540 | X | 1.6 | 2.6 | | 0.67 | 58.5 | JX | 0.077 | 0.16 | B | 0.042 | 5650 | JX | 14.3 | 5.1 | X | 0.059 | 10.1 | X | 0.51 | 15.9 | X | 1.1 | 24600 | X | 3.9 |

**Analysis:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **TDL** | | 5 | 10 | 2 | 0.2 | 100 | 1 | 2 | 1 | 5 |
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | Yes (calc RPD) | No-Stop (acceptable) | Yes (calc RPD) | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) | Yes (calc RPD) | Yes (calc RPD) | Yes (calc RPD) |
| | RPD | 6.4% | | 10.7% | | 14.1% | 1.9% | 6.7% | 3.7% | 3.6% |
| | Difference > 2 TDL? | Not applicable | No - acceptable | Not applicable | No - acceptable | Not applicable | Not applicable | Not applicable | Not applicable | Not applicable |

**Duplicate Analysis - 100-D-78 Waste Site Excavation**

| Sampling Area | Sample Number | Sample Date | Lead | | | Magnesium | | | Manganese | | | Molybdenum | | | Nickel | | | Potassium | | | Silicon | | | 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 | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 78D-4 | J1R684 | 1/16/13 | 3.8 | | 1.3 | 4850 | X | 17.2 | 324 | X | 0.093 | 0.32 | B | 0.24 | 7.6 | X | 0.11 | 754 | | 38.1 | 254 | JX | 5.3 | 290 | | 54.8 | 80.3 | X | 0.44 |
| Duplicate of J1R684 | J1R693 | 1/16/13 | 3.8 | | 1.4 | 4630 | X | 18.8 | 301 | X | 0.10 | 0.28 | B | 0.26 | 8.3 | X | 0.13 | 720 | | 41.7 | 265 | JX | 5.8 | 270 | | 60.0 | 78.1 | X | 0.48 |

**Analysis:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **TDL** | | 5 | 75 | 5 | 2 | 4 | 400 | 2 | 50 | 2.5 |
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) | No-Stop (acceptable) | No-Stop (acceptable) | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) | Yes (calc RPD) |
| | RPD | | 4.6% | 7.4% | | | | 4.2% | 7.1% | 2.8% |
| | Difference > 2 TDL? | No - acceptable | Not applicable | Not applicable | No - acceptable | No - acceptable | No - acceptable | Not applicable | Not applicable | Not applicable |

**Duplicate Analysis - 100-D-78 Waste Site Excavation**

| Sampling Area | Sample Number | Sample Date | Zinc | | | Chloride | | | Fluoride | | | Sulfate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 78D-4 | J1R684 | 1/16/13 | 45.8 | X | 0.37 | 3.7 | B | 2.1 | 1.0 | JB | 0.86 | 7.5 | | 1.8 |
| Duplicate of J1R684 | J1R693 | 1/16/13 | 45.3 | X | 0.40 | 3.8 | B | 2.0 | 1.0 | JB | 0.84 | 6.9 | | 1.8 |

**Analysis:**

| | | | | | |
|---|---|---|---|---|---|
| **TDL** | | 1 | 2 | 5 | 5 |
| 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 | 1.1% | | | |
| | Difference > 2 TDL? | Not applicable | No - acceptable | No - acceptable | No - acceptable |

**CALCULATION SHEET**

***Washington Closure Hanford***

**Originator** J. D. Skoglie **Date** 06/12/13 **Calc. No.** 0100D-CA-V0499 **Rev. No.** 0
**Project** 100-D Field Remediation **Job No.** 14655 **Checked** N. K. Schiffern **Date** 06/12/13
**Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 16 of 17

**Duplicate Analysis - 100-D-78 Waste Site Staging Pile Area**

| Sampling Area | Sample Number | Sample Date | Aluminum | | | Arsenic | | | Barium | | | Boron | | | Cadmium | | | Calcium | | | Chromium | | | Cobalt | | | Copper | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1R695 | 4/1/13 | 7560 | X | 1.5 | 2.8 | | 0.62 | 103 | | 0.071 | 3.4 | | 0.92 | 0.085 | B | 0.038 | 5510 | X | 13.2 | 10.0 | X | 0.054 | 8.1 | X | 0.094 | 17.4 | | 0.20 |
| Duplicate of J1R695 | J1R6C7 | 4/1/13 | 7370 | X | 1.5 | 2.8 | | 0.64 | 109 | | 0.073 | 3.4 | | 0.95 | 0.11 | B | 0.040 | 5480 | X | 13.6 | 9.1 | X | 0.056 | 8.3 | X | 0.096 | 15.6 | | 0.21 |

**Analysis:**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TDL | | | 5 | | | 10 | | | 2 | | | 2 | | | 0.2 | | | 100 | | | 1 | | | 2 | | | 1 | | |
| Duplicate Analysis | Both > PQL? | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | |
| | Both >5xTDL? | | Yes (calc RPD) | | | No-Stop (acceptable) | | | Yes (calc RPD) | | | No-Stop (acceptable) | | | No-Stop (acceptable) | | | Yes (calc RPD) | | | Yes (calc RPD) | | | No-Stop (acceptable) | | | Yes (calc RPD) | | |
| | RPD | | 2.5% | | | | | | 5.7% | | | | | | | | | 0.5% | | | 9.4% | | | | | | 10.9% | | |
| | Difference > 2 TDL? | | Not applicable | | | No - acceptable | | | Not applicable | | | No - acceptable | | | No - acceptable | | | Not applicable | | | Not applicable | | | No - acceptable | | | Not applicable | | |

**Duplicate Analysis - 100-D-78 Waste Site Staging Pile Area**

| Sampling Area | Sample Number | Sample Date | Iron | | | Lead | | | Magnesium | | | Manganese | | | Mercury | | | Nickel | | | Potassium | | | Silicon | | | Sodium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1R695 | 4/1/13 | 21100 | X | 3.6 | 4.8 | | 0.25 | 4890 | X | 3.5 | 323 | X | 0.094 | 0.019 | | 0.0055 | 11.4 | X | 0.12 | 1430 | | 38.5 | 495 | NX | 5.3 | 294 | | 55.4 |
| Duplicate of J1R695 | J1R6C7 | 4/1/13 | 21600 | X | 3.7 | 4.7 | | 0.26 | 4990 | X | 3.6 | 330 | X | 0.096 | 0.017 | B | 0.0060 | 11.8 | X | 0.12 | 1390 | | 39.6 | 348 | X | 5.5 | 323 | | 56.9 |

**Analysis:**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TDL | | | 5 | | | 5 | | | 75 | | | 5 | | | 0.2 | | | 4 | | | 400 | | | 2 | | | 50 | | |
| Duplicate Analysis | Both > PQL? | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | |
| | Both >5xTDL? | | Yes (calc RPD) | | | No-Stop (acceptable) | | | Yes (calc RPD) | | | Yes (calc RPD) | | | No-Stop (acceptable) | | | No-Stop (acceptable) | | | No-Stop (acceptable) | | | Yes (calc RPD) | | | Yes (calc RPD) | | |
| | RPD | | 2.3% | | | | | | 2.0% | | | 2.1% | | | | | | | | | | | | 34.9% | | | 9.4% | | |
| | Difference > 2 TDL? | | Not applicable | | | No - acceptable | | | Not applicable | | | Not applicable | | | No - acceptable | | | No - acceptable | | | No - acceptable | | | Not applicable | | | Not applicable | | |

**Duplicate Analysis - 100-D-78 Waste Site Staging Pile Area**

| Sampling Area | Sample Number | Sample Date | Vanadium | | | Zinc | | | Chloride | | | Fluoride | | | Nitrogen in Nitrite and Nitrate | | | Sulfate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1R695 | 4/1/13 | 50.2 | | 0.088 | 43.4 | X | 0.37 | 3.8 | B | 2.0 | 0.96 | BN | 0.86 | 3.7 | M | 0.31 | 42.9 | | 1.8 |
| Duplicate of J1R695 | J1R6C7 | 4/1/13 | 52.2 | | 0.091 | 44.5 | X | 0.38 | 3.9 | B | 2.1 | 0.97 | B | 0.86 | 3.7 | | 0.32 | 40.6 | | 1.8 |

**Analysis:**

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TDL | | | 2.5 | | | 1 | | | 2 | | | 5 | | | 0.75 | | | 5 | | |
| Duplicate Analysis | Both > PQL? | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | | Yes (continue) | | |
| | Both >5xTDL? | | Yes (calc RPD) | | | Yes (calc RPD) | | | No-Stop (acceptable) | | | No-Stop (acceptable) | | | No-Stop (acceptable) | | | Yes (calc RPD) | | |
| | RPD | | 3.9% | | | 2.5% | | | | | | | | | | | | 5.5% | | |
| | Difference > 2 TDL? | | Not applicable | | | Not applicable | | | No - acceptable | | | No - acceptable | | | No - acceptable | | | Not applicable | | |

**CALCULATION SHEET**

***Washington Closure Hanford***

**Originator** J. D. Skoglie **Date** 06/12/13 **Calc. No.** 0100D-CA-V0499 **Rev. No.** 0
**Project** 100-D Field Remediation **Job No.** 14655 **Checked** N. K. Schiffern **Date** 06/12/13
**Subject** 100-D-78 Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 17 of 17

**Duplicate Analysis - 100-D-78 Waste Site Area 2**

| Sampling Area | Sample Number | Sample Date | Aluminum | | | Arsenic | | | Barium | | | Boron | | | 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 | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 2E, 1.2 m | J17FK2 | 9/11/08 | 5380 | C | 9.7 | 1.9 | | 1.2 | 55.1 | | 0.24 | 1.3 | | 1.2 | 6250 | C | 9.78 | 7.0 | C | 0.49 | 8.7 | | 0.49 | 13.3 | | 0.49 | 24700 | | 10.9 |
| Duplicate of J17FK2 | J17FK3 | 9/11/08 | 5720 | C | 9.4 | 1.6 | | 1.2 | 56.8 | | 0.23 | 1.2 | | 1.2 | 6760 | C | 9.4 | 8.0 | C | 0.47 | 9.4 | | 0.47 | 14.6 | | 0.47 | 25200 | | 10.5 |

**Analysis:**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TDL | | 5 | 10 | 2 | 2 | 100 | 1 | 2 | 1 | 5 |
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) | No-Stop (acceptable) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | Yes (calc RPD) | No-Stop (acceptable) | Yes (calc RPD) | | Yes (calc RPD) | Yes (calc RPD) | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) |
| | RPD | 6.1% | | 3.0% | | 7.8% | 13.3% | | 9.3% | 2.0% |
| | Difference > 2 TDL? | Not applicable | No - acceptable | Not applicable | No - acceptable | Not applicable | Not applicable | No - acceptable | Not applicable | Not applicable |

**Duplicate Analysis - 100-D-78 Waste Site Area 2**

| Sampling Area | Sample Number | Sample Date | Lead | | | Magnesium | | | Manganese | | | Nickel | | | Potassium | | | Silicon | | | Sodium | | | Vanadium | | | Zinc | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 2E, 1.2 m | J17FK2 | 9/11/08 | 4.1 | | 0.73 | 4660 | | 6.1 | 312 | C | 0.10 | 10.0 | | 0.49 | 733 | | 9.7 | 553 | | 9.7 | 229 | C | 4.9 | 60.1 | | 0.34 | 46.7 | C | 1.5 |
| Duplicate of J17FK2 | J17FK3 | 9/11/08 | 6.1 | | 0.70 | 4520 | | 5.9 | 321 | C | 0.09 | 14.4 | | 0.47 | 752 | | 9.4 | 523 | | 9.4 | 240 | C | 4.7 | 63.3 | | 0.33 | 47.5 | C | 1.4 |

**Analysis:**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TDL | | 5 | 75 | 5 | 4 | 400 | 2 | 50 | 2.5 | 1 |
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) | No-Stop (acceptable) | No-Stop (acceptable) | Yes (calc RPD) | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) |
| | RPD | | 3.1% | 2.8% | | | 5.6% | | 5.2% | 1.7% |
| | Difference > 2 TDL? | No - acceptable | Not applicable | Not applicable | No - acceptable | No - acceptable | Not applicable | No - acceptable | Not applicable | Not applicable |

**Duplicate Analysis - 100-D-78 Waste Site Area 2**

| Sampling Area | Sample Number | Sample Date | Nitrate | | | Nitrogen as nitrite | | | Sulfate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 2E, 1.2 m | J17FK2 | 9/11/08 | 2.5 | | 2.53 | 0.46 | | 0.21 | 867 | D | 50.5 |
| Duplicate of J17FK2 | J17FK3 | 9/11/08 | 2.8 | | 2.31 | 0.53 | | 0.2 | 1390 | D | 115 |

**Analysis:**

| | | | | |
|---|---|---|---|---|
| TDL | | 2.5 | 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 | | | *46.3%* |
| | Difference > 2 TDL? | No - acceptable | No - acceptable | Not applicable |

**Attachment 1. 100-D-78 Waste Site Verification Sample Results (Metals).**

| 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 |
| 78D-4 | J1R684 | 1/16/13 | 4840 | X | 1.4 | 0.35 | UJ | 0.35 | 2.3 | | 0.61 | 65.1 | X | 0.071 | 0.15 | U | 0.15 | 0.91 | U | 0.91 |
| Duplicate of J1R684 | J1R693 | 1/16/13 | 4540 | X | 1.6 | 0.39 | UJ | 0.39 | 2.6 | | 0.67 | 58.5 | X | 0.077 | 0.17 | U | 0.17 | 1.0 | U | 1.0 |
| 78D-1 | J1R681 | 1/16/13 | 5260 | X | 1.5 | 0.36 | UJ | 0.36 | 2.8 | | 0.62 | 61.5 | X | 0.072 | 0.031 | U | 0.031 | 0.92 | U | 0.92 |
| 78D-2 | J1R682 | 1/16/13 | 6440 | X | 1.6 | 0.39 | UJ | 0.39 | 3.7 | | 0.67 | 66.0 | X | 0.077 | 0.034 | U | 0.034 | 1.2 | B | 1.0 |
| 78D-3 | J1R683 | 1/16/13 | 4830 | X | 1.4 | 0.35 | UJ | 0.35 | 2.7 | | 0.60 | 51.3 | X | 0.070 | 0.030 | U | 0.030 | 0.90 | U | 0.90 |
| 78D-5 | J1R685 | 1/16/13 | 5860 | X | 1.5 | 0.37 | UJ | 0.37 | 3.0 | | 0.64 | 62.5 | X | 0.074 | 0.032 | U | 0.032 | 0.95 | U | 0.95 |
| 78D-6 | J1R686 | 1/16/13 | 4920 | X | 1.5 | 0.37 | UJ | 0.37 | 2.8 | | 0.64 | 60.2 | X | 0.074 | 0.032 | U | 0.032 | 0.95 | U | 0.95 |
| 78D-7 | J1R687 | 1/16/13 | 6090 | X | 1.6 | 0.38 | UJ | 0.38 | 3.7 | | 0.66 | 98.2 | X | 0.076 | 0.033 | U | 0.033 | 0.98 | U | 0.98 |
| 78D-8 | J1R688 | 1/16/13 | 5870 | X | 1.6 | 0.39 | UJ | 0.39 | 3.1 | | 0.67 | 62.4 | X | 0.077 | 0.034 | U | 0.034 | 1.0 | U | 1.0 |
| 78D-9 | J1R689 | 1/16/13 | 4460 | X | 1.6 | 0.40 | UJ | 0.40 | 2.6 | | 0.69 | 55.1 | X | 0.079 | 0.17 | U | 0.17 | 1.0 | U | 1.0 |
| 78D-10 | J1R690 | 1/16/13 | 5590 | X | 1.6 | 0.38 | UJ | 0.38 | 2.6 | | 0.67 | 57.3 | X | 0.077 | 0.033 | U | 0.033 | 0.99 | U | 0.99 |
| 78D-11 | J1R691 | 1/16/13 | 3900 | X | 1.4 | 0.35 | UJ | 0.35 | 2.7 | | 0.60 | 48.5 | X | 0.070 | 0.15 | U | 0.15 | 0.90 | U | 0.90 |
| 78D-12 | J1R692 | 1/16/13 | 4290 | X | 1.4 | 0.35 | UJ | 0.35 | 2.4 | | 0.61 | 54.6 | X | 0.070 | 0.15 | U | 0.15 | 0.90 | U | 0.90 |
| Equipment Blank | J1R694 | 1/16/13 | 203 | X | 1.5 | 0.36 | UJ | 0.36 | 0.62 | U | 0.62 | 1.9 | X | 0.072 | 0.038 | B | 0.031 | 0.93 | U | 0.93 |

| LOCATION | HEIS Number | Sample Date | Cadmium | | | Calcium | | | Chromium | | | Cobalt | | | Copper | | | Hexavalent Chromium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 78D-4 | J1R684 | 1/16/13 | 0.16 | B | 0.038 | 6510 | JX | 13.1 | 5.2 | X | 0.054 | 10.8 | X | 0.46 | 16.5 | X | 1.0 | 0.208 | | 0.155 |
| Duplicate of J1R684 | J1R693 | 1/16/13 | 0.16 | B | 0.042 | 5650 | JX | 14.3 | 5.1 | X | 0.059 | 10.1 | X | 0.51 | 15.9 | X | 1.1 | 0.155 | U | 0.155 |
| 78D-1 | J1R681 | 1/16/13 | 0.18 | B | 0.039 | 6330 | JX | 13.3 | 6.4 | X | 0.055 | 7.9 | X | 0.094 | 14.7 | X | 0.2 | 0.256 | | 0.155 |
| 78D-2 | J1R682 | 1/16/13 | 0.17 | B | 0.042 | 9830 | JX | 14.4 | 8.3 | X | 0.059 | 7.7 | X | 0.10 | 15.7 | X | 0.22 | 0.273 | | 0.155 |
| 78D-3 | J1R683 | 1/16/13 | 0.14 | B | 0.038 | 5980 | JX | 12.9 | 6.0 | X | 0.053 | 7.3 | X | 0.091 | 13.3 | X | 0.20 | 0.209 | | 0.155 |
| 78D-5 | J1R685 | 1/16/13 | 0.16 | B | 0.040 | 7240 | JX | 13.7 | 6.5 | X | 0.056 | 8.3 | X | 0.097 | 16.1 | X | 0.21 | 0.211 | | 0.155 |
| 78D-6 | J1R686 | 1/16/13 | 0.16 | B | 0.040 | 6470 | JX | 13.7 | 6.1 | X | 0.056 | 7.8 | X | 0.097 | 14.3 | X | 0.21 | 0.298 | | 0.155 |
| 78D-7 | J1R687 | 1/16/13 | 0.22 | | 0.041 | 10400 | JX | 14.2 | 8.6 | X | 0.058 | 8.1 | X | 0.10 | 16.7 | X | 0.22 | 0.439 | | 0.155 |
| 78D-8 | J1R688 | 1/16/13 | 0.19 | B | 0.042 | 6630 | JX | 14.4 | 6.3 | X | 0.059 | 8.4 | X | 0.10 | 16.8 | X | 0.22 | 0.342 | | 0.155 |
| 78D-9 | J1R689 | 1/16/13 | 0.16 | B | 0.043 | 6720 | JX | 14.7 | 4.6 | X | 0.061 | 10.9 | X | 0.52 | 16.8 | X | 1.1 | 0.155 | U | 0.155 |
| 78D-10 | J1R690 | 1/16/13 | 0.17 | B | 0.041 | 6880 | JX | 14.2 | 6.2 | X | 0.058 | 8.5 | X | 0.10 | 15.5 | X | 0.22 | 0.212 | | 0.155 |
| 78D-11 | J1R691 | 1/16/13 | 0.14 | B | 0.038 | 5950 | JX | 12.9 | 3.8 | X | 0.053 | 9.4 | X | 0.46 | 15.5 | X | 0.99 | 0.155 | U | 0.155 |
| 78D-12 | J1R692 | 1/16/13 | 0.16 | B | 0.038 | 5550 | JX | 13.0 | 4.7 | X | 0.053 | 9.9 | X | 0.46 | 15.9 | X | 1.0 | 0.155 | U | 0.155 |
| Equipment Blank | J1R694 | 1/16/13 | 0.039 | U | 0.039 | 38.9 | JBX | 13.4 | 0.12 | BX | 0.055 | 0.095 | UX | 0.095 | 0.25 | BX | 0.21 | | | |

| LOCATION | HEIS Number | Sample Date | Iron | | | Lead | | | Magnesium | | | Manganese | | | Mercury | | | Molybdenum | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 78D-4 | J1R684 | 1/16/13 | 25500 | X | 3.5 | 3.8 | | 1.3 | 4850 | X | 17.2 | 324 | X | 0.093 | 0.0058 | U | 0.0058 | 0.32 | B | 0.24 |
| Duplicate of J1R684 | J1R693 | 1/16/13 | 24600 | X | 3.9 | 3.8 | | 1.4 | 4630 | X | 18.8 | 301 | X | 0.10 | 0.0052 | U | 0.0052 | 0.28 | B | 0.26 |
| 78D-1 | J1R681 | 1/16/13 | 22700 | X | 3.6 | 5.3 | | 0.25 | 3850 | X | 3.5 | 280 | X | 0.094 | 0.0053 | B | 0.0050 | 0.28 | B | 0.24 |
| 78D-2 | J1R682 | 1/16/13 | 21500 | X | 3.9 | 7.8 | | 0.28 | 4300 | X | 3.8 | 296 | X | 0.10 | 0.0071 | B | 0.0056 | 0.30 | B | 0.26 |
| 78D-3 | J1R683 | 1/16/13 | 21400 | X | 3.5 | 3.4 | | 0.25 | 3870 | X | 3.4 | 270 | X | 0.091 | 0.0055 | B | 0.0052 | 0.24 | U | 0.24 |
| 78D-5 | J1R685 | 1/16/13 | 23700 | X | 3.7 | 3.5 | | 0.26 | 4210 | X | 3.6 | 299 | X | 0.097 | 0.0056 | U | 0.0056 | 0.26 | B | 0.25 |
| 78D-6 | J1R686 | 1/16/13 | 22800 | X | 3.7 | 4.8 | | 0.26 | 3960 | X | 3.6 | 285 | X | 0.097 | 0.045 | | 0.0058 | 0.29 | B | 0.25 |
| 78D-7 | J1R687 | 1/16/13 | 21500 | X | 3.8 | 8.6 | | 0.27 | 3940 | X | 3.7 | 405 | X | 0.10 | 0.64 | | 0.0056 | 0.35 | B | 0.26 |
| 78D-8 | J1R688 | 1/16/13 | 23600 | X | 3.9 | 5.0 | | 0.27 | 3890 | X | 3.8 | 332 | X | 0.10 | 0.012 | B | 0.0056 | 0.38 | B | 0.26 |
| 78D-9 | J1R689 | 1/16/13 | 26000 | X | 4.0 | 5.2 | | 1.4 | 4820 | X | 19.3 | 296 | X | 0.10 | 0.0057 | B | 0.0054 | 0.30 | B | 0.27 |
| 78D-10 | J1R690 | 1/16/13 | 23500 | X | 3.8 | 3.9 | | 0.27 | 3980 | X | 3.7 | 295 | X | 0.10 | 0.0060 | U | 0.0060 | 0.26 | B | 0.26 |
| 78D-11 | J1R691 | 1/16/13 | 22500 | X | 3.5 | 5.7 | | 1.2 | 3860 | X | 16.9 | 266 | X | 0.092 | 0.0053 | U | 0.0053 | 0.27 | B | 0.24 |
| 78D-12 | J1R692 | 1/16/13 | 24700 | X | 3.5 | 4.8 | | 1.2 | 4350 | X | 17.0 | 301 | X | 0.092 | 0.14 | | 0.0053 | 0.32 | B | 0.24 |
| Equipment Blank | J1R694 | 1/16/13 | 401 | X | 3.6 | 0.41 | B | 0.26 | 20.8 | X | 3.5 | 5.1 | X | 0.095 | 0.0051 | U | 0.0051 | 0.25 | U | 0.25 |

[a] all confirmatory samples are for information only except stained soil areas 3 and 4.

**Grey cells indicate not applicable or data will not be used.**

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

Note: Data qualified with B, D, and/or J.

78D = 100-D-78 excavation decision unit

B = blank contamination (inorganic constituents)

C = sample concentration was ≤5x blank concentration.

D = identifies all compounds identified in an analysis at a secondary dilution factor.

HEIS = Hanford Environmental Information System

J = estimate

M = sample duplicate precision not met

N = recovery is outside control limits

NR = no result. The sample was not able to be analyzed due to precipitation formed during sample preparation.

PQL = practical quantitative limit

Q = qualifier

R = rejected

SPA = staging pile area

U = undetected

X (metals) = serial dilution in the analytical batch indicates that physical and chemical interferences are present.

X (organics) = >40% difference between primary and confirmation detector results.

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 1 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

**Attachment 1. 100-D-78 Waste Site Verification Sample Results (Metals).**

| LOCATION | HEIS Number | Sample Date | Nickel | | | Potassium | | | Selenium | | | Silicon | | | Silver | | | Sodium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 78D-4 | J1R684 | 1/16/13 | 7.6 | X | 0.11 | 754 | | 38.1 | 0.80 | U | 0.80 | 254 | JX | 5.3 | 0.15 | UJ | 0.15 | 290 | | 54.8 |
| Duplicate of J1R684 | J1R693 | 1/16/13 | 8.3 | X | 0.13 | 720 | | 41.7 | 0.87 | U | 0.87 | 265 | JX | 5.8 | 0.16 | UJ | 0.16 | 270 | | 60.0 |
| 78D-1 | J1R681 | 1/16/13 | 8.4 | X | 0.12 | 828 | | 38.6 | 0.81 | U | 0.81 | 290 | JXN | 5.3 | 0.15 | UJN | 0.15 | 258 | | 55.6 |
| 78D-2 | J1R682 | 1/16/13 | 9.4 | X | 0.13 | 1140 | | 41.8 | 0.88 | U | 0.88 | 372 | JX | 5.8 | 0.16 | UJ | 0.16 | 268 | | 60.1 |
| 78D-3 | J1R683 | 1/16/13 | 8.6 | X | 0.11 | 824 | | 37.5 | 0.79 | U | 0.79 | 268 | JX | 5.2 | 0.15 | UJ | 0.15 | 219 | | 54.0 |
| 78D-5 | J1R685 | 1/16/13 | 8.6 | X | 0.12 | 931 | | 39.9 | 0.84 | U | 0.84 | 256 | JX | 5.5 | 0.16 | UJ | 0.16 | 269 | | 57.5 |
| 78D-6 | J1R686 | 1/16/13 | 7.4 | X | 0.12 | 775 | | 39.9 | 0.84 | U | 0.84 | 271 | JX | 5.5 | 0.16 | UJ | 0.16 | 235 | | 57.5 |
| 78D-7 | J1R687 | 1/16/13 | 8.8 | X | 0.12 | 1330 | | 41.2 | 0.86 | U | 0.86 | 410 | JX | 5.7 | 0.16 | UJ | 0.16 | 280 | | 59.3 |
| 78D-8 | J1R688 | 1/16/13 | 7.8 | X | 0.13 | 904 | | 41.7 | 0.88 | U | 0.88 | 317 | JX | 5.8 | 0.16 | UJ | 0.16 | 264 | | 60.1 |
| 78D-9 | J1R689 | 1/16/13 | 8.2 | X | 0.13 | 603 | | 42.8 | 0.90 | U | 0.90 | 277 | JX | 5.9 | 0.17 | UJ | 0.17 | 313 | | 61.7 |
| 78D-10 | J1R690 | 1/16/13 | 8.1 | X | 0.12 | 897 | | 41.3 | 0.87 | U | 0.87 | 415 | JX | 5.7 | 0.16 | UJ | 0.16 | 304 | | 59.5 |
| 78D-11 | J1R691 | 1/16/13 | 5.9 | X | 0.11 | 548 | | 37.5 | 0.79 | U | 0.79 | 204 | JX | 5.2 | 0.15 | UJ | 0.15 | 243 | | 54.0 |
| 78D-12 | J1R692 | 1/16/13 | 6.3 | X | 0.11 | 601 | | 37.7 | 0.79 | U | 0.79 | 185 | JX | 5.2 | 0.15 | UJ | 0.15 | 250 | | 54.2 |
| Equipment Blank | J1R694 | 1/16/13 | 0.15 | BX | 0.12 | 47.4 | B | 38.8 | 0.81 | U | 0.81 | 161 | JX | 5.4 | 0.15 | UJ | 0.15 | 55.9 | U | 55.9 |

| LOCATION | HEIS Number | Sample Date | Vanadium | | | Zinc | | |
|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 78D-4 | J1R684 | 1/16/13 | 80.3 | X | 0.44 | 45.8 | X | 0.37 |
| Duplicate of J1R684 | J1R693 | 1/16/13 | 78.1 | X | 0.48 | 45.3 | X | 0.40 |
| 78D-1 | J1R681 | 1/16/13 | 66.0 | X | 0.089 | 43.5 | X | 0.37 |
| 78D-2 | J1R682 | 1/16/13 | 60.2 | X | 0.096 | 49.7 | X | 0.41 |
| 78D-3 | J1R683 | 1/16/13 | 60.9 | X | 0.086 | 39.5 | X | 0.36 |
| 78D-5 | J1R685 | 1/16/13 | 66.8 | X | 0.092 | 44.5 | X | 0.39 |
| 78D-6 | J1R686 | 1/16/13 | 67.4 | X | 0.092 | 45.3 | X | 0.39 |
| 78D-7 | J1R687 | 1/16/13 | 59.9 | X | 0.094 | 50.7 | X | 0.40 |
| 78D-8 | J1R688 | 1/16/13 | 67.7 | X | 0.096 | 49.9 | X | 0.41 |
| 78D-9 | J1R689 | 1/16/13 | 83.4 | X | 0.49 | 73.4 | X | 0.42 |
| 78D-10 | J1R690 | 1/16/13 | 69.6 | X | 0.095 | 45.1 | X | 0.40 |
| 78D-11 | J1R691 | 1/16/13 | 76.5 | X | 0.43 | 43.2 | X | 0.36 |
| 78D-12 | J1R692 | 1/16/13 | 83.8 | X | 0.43 | 47.8 | X | 0.37 |
| Equipment Blank | J1R694 | 1/16/13 | 0.37 | BX | 0.089 | 1.8 | UJXC | 0.38 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 2 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

**Attachment 1. 100-D-78 Waste Site Verification Sample Results (Metals).**

| 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 |
| SPA-1 | J1R695 | 4/1/13 | 7560 | X | 1.5 | 0.36 | U | 0.36 | 2.8 | | 0.62 | 103 | | 0.071 | 0.031 | U | 0.031 | 3.4 | | 0.92 |
| Duplicate of J1R695 | J1R6C7 | 4/1/13 | 7370 | X | 1.5 | 0.37 | U | 0.37 | 2.8 | | 0.64 | 109 | | 0.073 | 0.032 | U | 0.032 | 3.4 | | 0.95 |
| SPA-2 | J1R696 | 4/1/13 | 6630 | X | 1.3 | 0.32 | U | 0.32 | 2.3 | | 0.56 | 96.8 | | 0.065 | 0.028 | U | 0.028 | 4.9 | | 0.84 |
| SPA-3 | J1R697 | 4/1/13 | 5570 | X | 1.5 | 0.37 | U | 0.37 | 1.9 | | 0.64 | 61.9 | | 0.074 | 0.032 | U | 0.032 | 1.5 | B | 0.96 |
| SPA-4 | J1R698 | 4/1/13 | 7390 | X | 1.5 | 0.36 | U | 0.36 | 2.4 | | 0.62 | 79.7 | | 0.072 | 0.031 | U | 0.031 | 2.0 | | 0.93 |
| SPA-5 | J1R699 | 4/1/13 | 7670 | X | 1.5 | 0.38 | U | 0.38 | 2.7 | | 0.65 | 78.3 | | 0.075 | 0.033 | U | 0.033 | 2.1 | | 0.97 |
| SPA-6 | J1R6C0 | 4/1/13 | 7430 | X | 1.5 | 0.36 | U | 0.36 | 3.0 | | 0.62 | 80.7 | | 0.072 | 0.031 | U | 0.031 | 2.1 | | 0.92 |
| SPA-7 | J1R6C1 | 4/1/13 | 5750 | X | 1.4 | 0.34 | U | 0.34 | 1.9 | | 0.59 | 64.0 | | 0.068 | 0.029 | U | 0.029 | 2.0 | | 0.88 |
| SPA-8 | J1R6C2 | 4/1/13 | 7280 | X | 1.6 | 0.40 | U | 0.40 | 2.5 | | 0.69 | 84.3 | | 0.079 | 0.035 | U | 0.035 | 2.8 | | 1.0 |
| SPA-9 | J1R6C3 | 4/1/13 | 8380 | X | 1.5 | 0.36 | U | 0.36 | 2.4 | | 0.63 | 86.9 | | 0.073 | 0.031 | U | 0.031 | 5.3 | | 0.94 |
| SPA-10 | J1R6C4 | 4/1/13 | 6080 | X | 1.6 | 0.39 | U | 0.39 | 2.1 | | 0.68 | 65.0 | | 0.078 | 0.034 | U | 0.034 | 2.2 | | 1.0 |
| SPA-11 | J1R6C5 | 4/1/13 | 7340 | X | 1.6 | 0.39 | U | 0.39 | 2.5 | | 0.67 | 77.3 | | 0.077 | 0.033 | U | 0.033 | 2.7 | | 0.99 |
| SPA-12 | J1R6C6 | 4/1/13 | 8020 | X | 1.5 | 0.37 | U | 0.37 | 2.6 | | 0.64 | 81.6 | | 0.074 | 0.032 | U | 0.032 | 2.2 | | 0.95 |
| Equipment Blank | J1R6C8 | 4/1/13 | 189 | X | 1.4 | 0.33 | U | 0.33 | 0.58 | U | 0.58 | 1.8 | | 0.067 | 0.062 | B | 0.029 | 0.86 | U | 0.86 |

| Location | HEIS Number | Sample Date | Cadmium | | | Calcium | | | Chromium | | | Cobalt | | | Copper | | | Hexavalent Chromium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1R695 | 4/1/13 | 0.085 | B | 0.038 | 5510 | X | 13.2 | 10.0 | X | 0.054 | 8.1 | X | 0.094 | 17.4 | | 0.20 | 0.155 | U | 0.155 |
| Duplicate of J1R695 | J1R6C7 | 4/1/13 | 0.11 | B | 0.040 | 5480 | X | 13.6 | 9.1 | X | 0.056 | 8.3 | X | 0.096 | 15.6 | | 0.21 | 0.155 | U | 0.155 |
| SPA-2 | J1R696 | 4/1/13 | 0.092 | B | 0.035 | 5190 | X | 12.0 | 8.5 | X | 0.050 | 7.9 | X | 0.085 | 31.9 | | 0.19 | 0.155 | U | 0.155 |
| SPA-3 | J1R697 | 4/1/13 | 0.077 | B | 0.040 | 6380 | X | 13.8 | 7.6 | X | 0.057 | 7.8 | X | 0.098 | 13.2 | | 0.21 | 0.217 | | 0.155 |
| SPA-4 | J1R698 | 4/1/13 | 0.078 | B | 0.039 | 3950 | X | 13.3 | 12.1 | X | 0.055 | 7.8 | X | 0.095 | 13.8 | | 0.21 | 0.383 | | 0.155 |
| SPA-5 | J1R699 | 4/1/13 | 0.085 | B | 0.041 | 4870 | X | 14.0 | 10.5 | X | 0.058 | 7.9 | X | 0.099 | 14.1 | | 0.22 | 0.155 | U | 0.155 |
| SPA-6 | J1R6C0 | 4/1/13 | 0.12 | B | 0.039 | 4050 | X | 13.3 | 10.0 | X | 0.055 | 7.8 | X | 0.094 | 12.5 | | 0.20 | 0.155 | U | 0.155 |
| SPA-7 | J1R6C1 | 4/1/13 | 0.079 | B | 0.037 | 4380 | X | 12.6 | 7.8 | X | 0.052 | 7.1 | X | 0.089 | 12.7 | | 0.19 | 0.155 | U | 0.155 |
| SPA-8 | J1R6C2 | 4/1/13 | 0.11 | B | 0.043 | 4390 | X | 14.7 | 9.5 | X | 0.061 | 7.6 | X | 0.10 | 18.2 | | 0.23 | 0.155 | U | 0.155 |
| SPA-9 | J1R6C3 | 4/1/13 | 0.12 | B | 0.039 | 4330 | X | 13.5 | 9.9 | X | 0.055 | 9.0 | X | 0.095 | 13.1 | | 0.21 | 0.155 | U | 0.155 |
| SPA-10 | J1R6C4 | 4/1/13 | 0.082 | B | 0.042 | 6220 | X | 14.4 | 7.2 | X | 0.059 | 8.3 | X | 0.10 | 13.5 | | 0.22 | 0.155 | U | 0.155 |
| SPA-11 | J1R6C5 | 4/1/13 | 0.088 | B | 0.042 | 4860 | X | 14.3 | 9.7 | X | 0.059 | 7.9 | X | 0.10 | 13.7 | | 0.22 | 0.155 | U | 0.155 |
| SPA-12 | J1R6C6 | 4/1/13 | 0.10 | B | 0.040 | 3690 | X | 13.7 | 10.1 | X | 0.056 | 7.8 | X | 0.097 | 12.8 | | 0.21 | 0.155 | U | 0.155 |
| Equipment Blank | J1R6C8 | 4/1/13 | 0.036 | U | 0.036 | 31.8 | BX | 12.4 | 0.32 | XC | 0.051 | 0.18 | BX | 0.088 | 0.39 | B | 0.19 | | | |

| Location | HEIS Number | Sample Date | Iron | | | Lead | | | Magnesium | | | Manganese | | | Mercury | | | Molybdenum | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1R695 | 4/1/13 | 21100 | X | 3.6 | 4.8 | | 0.25 | 4890 | X | 3.5 | 323 | X | 0.094 | 0.019 | | 0.0055 | 0.35 | B | 0.24 |
| Duplicate of J1R695 | J1R6C7 | 4/1/13 | 21600 | X | 3.7 | 4.7 | | 0.26 | 4990 | X | 3.6 | 330 | X | 0.096 | 0.017 | B | 0.0060 | 0.25 | U | 0.25 |
| SPA-2 | J1R696 | 4/1/13 | 20200 | X | 3.2 | 5.4 | | 0.23 | 4690 | X | 3.2 | 308 | X | 0.085 | 0.014 | B | 0.0048 | 0.36 | B | 0.22 |
| SPA-3 | J1R697 | 4/1/13 | 20900 | X | 3.7 | 2.8 | | 0.26 | 4490 | X | 3.6 | 290 | X | 0.098 | 0.013 | B | 0.0048 | 0.25 | U | 0.25 |
| SPA-4 | J1R698 | 4/1/13 | 19800 | X | 3.6 | 4.3 | | 0.26 | 4690 | X | 3.5 | 325 | X | 0.095 | 0.0094 | B | 0.0059 | 0.25 | U | 0.25 |
| SPA-5 | J1R699 | 4/1/13 | 20400 | X | 3.8 | 3.9 | | 0.27 | 4880 | X | 3.7 | 343 | X | 0.099 | 0.0088 | B | 0.0064 | 0.26 | U | 0.26 |
| SPA-6 | J1R6C0 | 4/1/13 | 20700 | X | 3.6 | 4.4 | | 0.25 | 4780 | X | 3.5 | 352 | X | 0.094 | 0.011 | B | 0.0065 | 0.24 | U | 0.24 |
| SPA-7 | J1R6C1 | 4/1/13 | 19300 | X | 3.4 | 3.7 | | 0.24 | 4020 | X | 3.3 | 274 | X | 0.089 | 0.021 | | 0.0055 | 0.23 | U | 0.23 |
| SPA-8 | J1R6C2 | 4/1/13 | 19900 | X | 4.0 | 5.5 | | 0.28 | 4760 | X | 3.9 | 325 | X | 0.10 | 0.010 | B | 0.0056 | 0.27 | U | 0.27 |
| SPA-9 | J1R6C3 | 4/1/13 | 22600 | X | 3.6 | 4.2 | | 0.26 | 4770 | X | 3.5 | 384 | X | 0.095 | 0.0093 | B | 0.0056 | 0.25 | U | 0.25 |
| SPA-10 | J1R6C4 | 4/1/13 | 22700 | X | 3.9 | 3.3 | | 0.28 | 4570 | X | 3.8 | 324 | X | 0.10 | 0.014 | B | 0.0051 | 0.27 | U | 0.27 |
| SPA-11 | J1R6C5 | 4/1/13 | 20500 | X | 3.9 | 4.3 | | 0.27 | 4760 | X | 3.8 | 329 | X | 0.10 | 0.011 | B | 0.0065 | 0.26 | U | 0.26 |
| SPA-12 | J1R6C6 | 4/1/13 | 20700 | X | 3.7 | 4.2 | | 0.26 | 4460 | X | 3.6 | 333 | X | 0.097 | 0.0082 | B | 0.0059 | 0.25 | U | 0.25 |
| Equipment Blank | J1R6C8 | 4/1/13 | 988 | X | 3.3 | 0.49 | | 0.24 | 28.2 | X | 3.3 | 8.4 | X | 0.088 | 0.0050 | U | 0.0050 | 0.23 | U | 0.23 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 3 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

Attachment 1. 100-D-78 Waste Site Verification Sample Results (Metals).

| Location | HEIS Number | Sample Date | Nickel | | | Potassium | | | Selenium | | | Silicon | | | Silver | | | Sodium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1R695 | 4/1/13 | 11.4 | X | 0.12 | 1430 | | 38.5 | 0.81 | U | 0.81 | 495 | NX | 5.3 | 0.15 | U | 0.15 | 294 | | 55.4 |
| Duplicate of J1R695 | J1R6C7 | 4/1/13 | 11.8 | X | 0.12 | 1390 | | 39.6 | 0.83 | U | 0.83 | 348 | X | 5.5 | 0.15 | U | 0.15 | 323 | | 56.9 |
| SPA-2 | J1R696 | 4/1/13 | 11.0 | X | 0.11 | 1110 | | 35.0 | 0.73 | U | 0.73 | 234 | X | 4.8 | 0.14 | U | 0.14 | 255 | | 50.4 |
| SPA-3 | J1R697 | 4/1/13 | 8.9 | X | 0.12 | 696 | | 40.1 | 0.84 | U | 0.84 | 234 | X | 5.5 | 0.16 | U | 0.16 | 253 | | 57.6 |
| SPA-4 | J1R698 | 4/1/13 | 11.8 | X | 0.12 | 1430 | | 38.8 | 0.81 | U | 0.81 | 265 | X | 5.4 | 0.15 | U | 0.15 | 198 | | 55.8 |
| SPA-5 | J1R699 | 4/1/13 | 11.4 | X | 0.12 | 1580 | | 40.7 | 0.85 | U | 0.85 | 305 | X | 5.6 | 0.16 | U | 0.16 | 196 | | 58.5 |
| SPA-6 | J1R6C0 | 4/1/13 | 10.5 | X | 0.12 | 1630 | | 38.6 | 0.81 | U | 0.81 | 298 | X | 5.3 | 0.15 | U | 0.15 | 187 | | 55.6 |
| SPA-7 | J1R6C1 | 4/1/13 | 9.7 | X | 0.11 | 877 | | 36.6 | 0.77 | U | 0.77 | 204 | X | 5.1 | 0.14 | U | 0.14 | 218 | | 52.7 |
| SPA-8 | J1R6C2 | 4/1/13 | 11.8 | X | 0.13 | 1340 | | 42.9 | 0.90 | U | 0.90 | 294 | X | 5.9 | 0.17 | U | 0.17 | 226 | | 61.7 |
| SPA-9 | J1R6C3 | 4/1/13 | 10.7 | X | 0.12 | 1860 | | 39.1 | 0.82 | U | 0.82 | 311 | X | 5.4 | 0.15 | U | 0.15 | 245 | | 56.3 |
| SPA-10 | J1R6C4 | 4/1/13 | 9.2 | X | 0.13 | 1050 | | 42.0 | 0.88 | U | 0.88 | 213 | X | 5.8 | 0.16 | U | 0.16 | 298 | | 60.4 |
| SPA-11 | J1R6C5 | 4/1/13 | 11.6 | X | 0.12 | 1340 | | 41.6 | 0.87 | U | 0.87 | 267 | X | 5.7 | 0.16 | U | 0.16 | 222 | | 59.9 |
| SPA-12 | J1R6C6 | 4/1/13 | 10.6 | X | 0.12 | 1750 | | 39.8 | 0.84 | U | 0.84 | 324 | X | 5.5 | 0.16 | U | 0.16 | 197 | | 57.3 |
| Equipment Blank | J1R6C8 | 4/1/13 | 0.35 | BX | 0.11 | 47.5 | B | 36.0 | 0.76 | U | 0.76 | 99.5 | X | 5.0 | 0.14 | U | 0.14 | 51.9 | U | 51.9 |

| Location | HEIS Number | Sample Date | Vanadium | | | Zinc | | |
|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1R695 | 4/1/13 | 50.2 | | 0.088 | 43.4 | X | 0.37 |
| Duplicate of J1R695 | J1R6C7 | 4/1/13 | 52.2 | | 0.091 | 44.5 | X | 0.38 |
| SPA-2 | J1R696 | 4/1/13 | 47.7 | | 0.080 | 43.5 | X | 0.34 |
| SPA-3 | J1R697 | 4/1/13 | 55.4 | | 0.092 | 41.1 | X | 0.39 |
| SPA-4 | J1R698 | 4/1/13 | 47.0 | | 0.089 | 40.9 | X | 0.38 |
| SPA-5 | J1R699 | 4/1/13 | 46.3 | | 0.093 | 42.8 | X | 0.39 |
| SPA-6 | J1R6C0 | 4/1/13 | 46.9 | | 0.089 | 44.0 | X | 0.37 |
| SPA-7 | J1R6C1 | 4/1/13 | 49.8 | | 0.084 | 39.3 | X | 0.36 |
| SPA-8 | J1R6C2 | 4/1/13 | 46.9 | | 0.098 | 114 | X | 0.42 |
| SPA-9 | J1R6C3 | 4/1/13 | 50.5 | | 0.090 | 46.6 | X | 0.38 |
| SPA-10 | J1R6C4 | 4/1/13 | 54.4 | | 0.096 | 43.8 | X | 0.41 |
| SPA-11 | J1R6C5 | 4/1/13 | 47.8 | | 0.095 | 45.5 | X | 0.40 |
| SPA-12 | J1R6C6 | 4/1/13 | 46.3 | | 0.091 | 42.5 | X | 0.39 |
| Equipment Blank | J1R6C8 | 4/1/13 | 1.2 | B | 0.083 | 2.5 | X | 0.35 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 4 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

**Attachment 1. 100-D-78 Waste Site Verification Sample Results (Anions and Physical).**

| LOCATION | HEIS Number | Sample Date | Bromide | | | Chloride | | | Fluoride | | | Nitrogen in Nitrate | | | Nitrogen in Nitrite | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 78D-4 | J1R684 | 1/16/13 | 0.40 | U | 0.40 | 3.7 | B | 2.1 | 1.0 | JB | 0.86 | 0.93 | JB | 0.33 | 0.35 | UR | 0.35 |
| Duplicate of J1R684 | J1R693 | 1/16/13 | 0.39 | U | 0.39 | 3.8 | B | 2.0 | 1.0 | JB | 0.84 | 0.95 | JB | 0.32 | 0.34 | UR | 0.34 |
| 78D-1 | J1R681 | 1/16/13 | 0.40 | U | 0.40 | 3.5 | B | 2.0 | 1.1 | JB | 0.85 | 0.93 | JB | 0.32 | 0.82 | JB | 0.35 |
| 78D-2 | J1R682 | 1/16/13 | 0.43 | U | 0.43 | 2.2 | U | 2.2 | 1.0 | JBN | 0.91 | 1.0 | JB | 0.35 | 0.37 | UR | 0.37 |
| 78D-3 | J1R683 | 1/16/13 | 0.42 | U | 0.42 | 3.8 | B | 2.1 | 0.96 | JB | 0.89 | 0.95 | JB | 0.34 | 0.36 | UR | 0.36 |
| 78D-5 | J1R685 | 1/16/13 | 0.41 | U | 0.41 | 7.5 | | 2.1 | 1.2 | JB | 0.87 | 0.33 | UR | 0.33 | 0.36 | UR | 0.36 |
| 78D-6 | J1R686 | 1/16/13 | 0.42 | U | 0.42 | 2.2 | U | 2.2 | 0.96 | JB | 0.90 | 1.3 | JB | 0.34 | 0.37 | UR | 0.37 |
| 78D-7 | J1R687 | 1/16/13 | 0.41 | U | 0.41 | 4.9 | B | 2.1 | 1.3 | JB | 0.88 | 1.4 | JB | 0.33 | 0.36 | UR | 0.36 |
| 78D-8 | J1R688 | 1/16/13 | 0.41 | U | 0.41 | 2.1 | U | 2.1 | 1.8 | JB | 0.87 | 0.33 | UR | 0.33 | 0.36 | UR | 0.36 |
| 78D-9 | J1R689 | 1/16/13 | 0.39 | U | 0.39 | 2.0 | U | 2.0 | 0.83 | UJ | 0.83 | 0.89 | JB | 0.32 | 0.34 | UR | 0.34 |
| 78D-10 | J1R690 | 1/16/13 | 0.39 | U | 0.39 | 2.0 | U | 2.0 | 0.97 | JB | 0.83 | 0.32 | UR | 0.32 | 0.34 | UR | 0.34 |
| 78D-11 | J1R691 | 1/16/13 | 0.41 | U | 0.41 | 2.1 | U | 2.1 | 0.91 | JB | 0.88 | 1.1 | JB | 0.33 | 0.36 | UR | 0.36 |
| 78D-12 | J1R692 | 1/16/13 | 0.39 | U | 0.39 | 2.0 | U | 2.0 | 0.89 | JB | 0.83 | 0.92 | JB | 0.32 | 0.34 | UR | 0.34 |
| Equipment Blank | J1R694 | 1/16/13 | | | | | | | | | | | | | | | |

| LOCATION | HEIS Number | Sample Date | Nitrogen in Nitrite and Nitrate | | | Phosphorous in phosphate | | | Sulfate | | | Percent moisture (wet sample) | | | pH Measurement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | % | Q | PQL | pH | Q | PQL |
| 78D-4 | J1R684 | 1/16/13 | 0.31 | U | 0.31 | 1.3 | UR | 1.3 | 7.5 | | 1.8 | 3.0 | | 0.10 | 8.97 | J | 0.100 |
| Duplicate of J1R684 | J1R693 | 1/16/13 | 0.31 | U | 0.31 | 1.3 | UR | 1.3 | 6.9 | | 1.8 | 2.6 | | 0.10 | 8.95 | J | 0.100 |
| 78D-1 | J1R681 | 1/16/13 | 0.31 | U | 0.31 | 1.3 | UR | 1.3 | 81.2 | | 1.8 | 5.2 | | 0.10 | 8.68 | J | 0.100 |
| 78D-2 | J1R682 | 1/16/13 | 0.33 | U | 0.33 | 1.4 | URN | 1.4 | 8.4 | | 1.9 | 5.6 | | 0.10 | 8.22 | J | 0.100 |
| 78D-3 | J1R683 | 1/16/13 | 0.32 | U | 0.32 | 1.3 | UR | 1.3 | 362 | | 1.9 | 3.3 | | 0.10 | 8.89 | J | 0.100 |
| 78D-5 | J1R685 | 1/16/13 | 0.32 | U | 0.32 | 1.3 | UR | 1.3 | 11.3 | | 1.8 | 4.9 | | 0.10 | 8.93 | J | 0.100 |
| 78D-6 | J1R686 | 1/16/13 | 0.33 | U | 0.33 | 1.4 | UR | 1.4 | 7.0 | | 1.9 | 5.8 | | 0.10 | 7.87 | J | 0.100 |
| 78D-7 | J1R687 | 1/16/13 | 0.56 | B | 0.32 | 1.3 | UR | 1.3 | 2710 | D | 18.4 | 6.1 | | 0.10 | 8.01 | J | 0.100 |
| 78D-8 | J1R688 | 1/16/13 | 0.32 | U | 0.32 | 1.3 | UR | 1.3 | 205 | | 1.8 | 6.5 | | 0.10 | 8.98 | J | 0.100 |
| 78D-9 | J1R689 | 1/16/13 | 0.30 | U | 0.30 | 1.3 | UR | 1.3 | 7.0 | | 1.8 | 4.3 | | 0.10 | 8.97 | J | 0.100 |
| 78D-10 | J1R690 | 1/16/13 | 0.30 | U | 0.30 | 1.2 | UR | 1.2 | 8.4 | | 1.7 | 3.7 | | 0.10 | 9.00 | J | 0.100 |
| 78D-11 | J1R691 | 1/16/13 | 0.32 | U | 0.32 | 1.3 | UR | 1.3 | 6.2 | | 1.8 | 3.3 | | 0.10 | 9.06 | J | 0.100 |
| 78D-12 | J1R692 | 1/16/13 | 0.30 | U | 0.30 | 1.2 | UR | 1.2 | 8.9 | | 1.7 | 4.6 | | 0.10 | 8.96 | J | 0.100 |
| Equipment Blank | J1R694 | 1/16/13 | | | | | | | | | | 0.38 | | 0.10 | | | |

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|---|---|---|---|
| Attachment | 1 | Sheet No. | 5 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

**Attachment 1. 100-D-78 Waste Site Verification Sample Results (Anions and Physical).**

| LOCATION | HEIS Number | Sample Date | Bromide | | | Chloride | | | Fluoride | | | Nitrogen in Nitrate | | | Nitrogen in Nitrite | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| SPA-1 | J1R695 | 4/1/13 | 0.40 | U | 0.40 | 3.8 | B | 2.0 | 0.96 | BN | 0.86 | 3.4 | | 0.33 | 0.89 | B | 0.35 |
| Duplicate of J1R695 | J1R6C7 | 4/1/13 | 0.41 | U | 0.41 | 3.9 | B | 2.1 | 0.97 | B | 0.86 | 2.8 | | 0.33 | 0.90 | B | 0.35 |
| SPA-2 | J1R696 | 4/1/13 | 0.38 | U | 0.38 | 3.8 | B | 1.9 | 0.86 | B | 0.81 | 3.0 | | 0.31 | 0.86 | B | 0.33 |
| SPA-3 | J1R697 | 4/1/13 | 0.39 | U | 0.39 | 3.0 | B | 2.0 | 0.89 | B | 0.82 | 1.4 | B | 0.31 | 0.84 | B | 0.33 |
| SPA-4 | J1R698 | 4/1/13 | 0.40 | U | 0.40 | 3.4 | B | 2.0 | 0.85 | U | 0.85 | 2.0 | B | 0.32 | 0.90 | B | 0.35 |
| SPA-5 | J1R699 | 4/1/13 | 0.40 | U | 0.40 | 3.0 | B | 2.0 | 0.85 | U | 0.85 | 1.2 | B | 0.32 | 0.35 | UR | 0.35 |
| SPA-6 | J1R6C0 | 4/1/13 | 0.40 | U | 0.40 | 3.0 | B | 2.0 | 0.84 | U | 0.84 | 1.2 | B | 0.32 | 0.34 | UR | 0.34 |
| SPA-7 | J1R6C1 | 4/1/13 | 0.40 | U | 0.40 | 5.4 | | 2.0 | 0.84 | U | 0.84 | 1.3 | B | 0.32 | 0.34 | UR | 0.34 |
| SPA-8 | J1R6C2 | 4/1/13 | 0.39 | U | 0.39 | 2.8 | B | 2.0 | 0.83 | U | 0.83 | 1.0 | B | 0.32 | 0.34 | UR | 0.34 |
| SPA-9 | J1R6C3 | 4/1/13 | 0.41 | U | 0.41 | 24.4 | | 2.1 | 0.97 | B | 0.86 | 100 | | 0.33 | 0.98 | B | 0.35 |
| SPA-10 | J1R6C4 | 4/1/13 | 0.39 | U | 0.39 | 6.8 | | 2.0 | 0.83 | UN | 0.83 | 12.1 | | 0.32 | 0.96 | B | 0.34 |
| SPA-11 | J1R6C5 | 4/1/13 | 1.0 | B | 0.39 | 5.9 | | 2.0 | 1.1 | B | 0.83 | 5.4 | | 0.32 | 1.2 | B | 0.34 |
| SPA-12 | J1R6C6 | 4/1/13 | 0.40 | U | 0.40 | 2.8 | B | 2.0 | 0.85 | U | 0.85 | 0.32 | UR | 0.32 | 0.35 | UR | 0.35 |
| Equipment Blank | J1R6C8 | 4/1/13 | | | | | | | | | | | | | | | |

| LOCATION | HEIS Number | Sample Date | Nitrogen in Nitrite and Nitrate | | | Phosphorous in phosphate | | | Sulfate | | | Percent moisture (wet sample) | | | pH Measurement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | % | Q | PQL | pH | Q | PQL |
| SPA-1 | J1R695 | 4/1/13 | 3.7 | M | 0.31 | 1.3 | URN | 1.3 | 42.9 | | 1.8 | 5.8 | | 0.10 | 8.02 | | 0.100 |
| Duplicate of J1R695 | J1R6C7 | 4/1/13 | 3.7 | | 0.32 | 1.3 | UR | 1.3 | 40.6 | | 1.8 | 5.8 | | 0.10 | 8.85 | | 0.100 |
| SPA-2 | J1R696 | 4/1/13 | 3.5 | | 0.30 | 1.2 | UR | 1.2 | 374 | | 1.7 | 1.6 | | 0.10 | 8.37 | | 0.100 |
| SPA-3 | J1R697 | 4/1/13 | 1.2 | | 0.30 | 1.2 | UR | 1.2 | 13.1 | | 1.7 | 2.5 | | 0.10 | 8.94 | | 0.100 |
| SPA-4 | J1R698 | 4/1/13 | 2.3 | | 0.31 | 1.3 | UR | 1.3 | 39.8 | | 1.8 | 3.8 | | 0.10 | 8.78 | | 0.100 |
| SPA-5 | J1R699 | 4/1/13 | 0.91 | | 0.31 | 1.3 | UR | 1.3 | 15.2 | | 1.8 | 4.0 | | 0.10 | 8.65 | | 0.100 |
| SPA-6 | J1R6C0 | 4/1/13 | 1.2 | | 0.31 | 1.3 | UR | 1.3 | 12.5 | | 1.8 | 3.5 | | 0.10 | 8.71 | | 0.100 |
| SPA-7 | J1R6C1 | 4/1/13 | 1.3 | | 0.31 | 1.3 | UR | 1.3 | 97.3 | | 1.8 | 3.5 | | 0.10 | 8.6 | | 0.100 |
| SPA-8 | J1R6C2 | 4/1/13 | 0.67 | B | 0.30 | 1.3 | UR | 1.3 | 298 | | 1.8 | 4.4 | | 0.10 | 8.32 | | 0.100 |
| SPA-9 | J1R6C3 | 4/1/13 | 101 | | 0.31 | 1.3 | UR | 1.3 | 172 | | 1.8 | 6.4 | | 0.10 | 8.09 | | 0.100 |
| SPA-10 | J1R6C4 | 4/1/13 | 14.8 | M | 0.30 | 1.3 | URN | 1.3 | 189 | N | 1.8 | 2.4 | | 0.10 | 8.44 | | 0.100 |
| SPA-11 | J1R6C5 | 4/1/13 | 6.6 | | 0.30 | 1.2 | UR | 1.2 | 35.9 | | 1.7 | 4.3 | | 0.10 | 8.74 | | 0.100 |
| SPA-12 | J1R6C6 | 4/1/13 | 0.31 | U | 0.31 | 1.3 | UR | 1.3 | 12.6 | | 1.8 | 4.7 | | 0.10 | 8.76 | | 0.100 |
| Equipment Blank | J1R6C8 | 4/1/13 | | | | | | | | | | 0.19 | | 0.10 | | | |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 6 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

**Attachment 1. 100-D-78 Waste Site Confirmatory Sample Results - Water Sample (Radionuclides) [a].**

| Sample Location | HEIS Number | Sample Date | Americium-241 GEA | | | Antimony-125 | | | Beryllium-7 | | | Cesium-134 | | | Cesium-137 | | | Cobalt-60 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | pCi/L | Q | MDA | pCi/L | Q | MDA | pCi/L | Q | MDA | pCi/L | Q | MDA | pCi/L | Q | MDA | pCi/L | Q | MDA |
| 1B, water | J17J48 | 9/17/08 | 29.4 | U | 29.4 | 20.5 | U | 20.5 | 69.2 | U | 69.2 | 11.5 | U | 11.5 | 9.39 | U | 9.39 | 8.82 | U | 8.82 |

| Sample Location | HEIS Number | Sample Date | Europium-152 | | | Europium-154 | | | Europium-155 | | | Gross alpha | | | Gross beta | | | Potassium-40 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | pCi/L | Q | MDA | pCi/L | Q | MDA | pCi/L | Q | MDA | pCi/L | Q | MDA | pCi/L | Q | MDA | pCi/L | Q | MDA |
| 1B, water | J17J48 | 9/17/08 | 24.8 | U | 24.8 | 26.7 | U | 26.7 | 25.8 | U | 25.8 | 26.9 | U | 250 | 41.8 | U | 46 | 264 | U | 264 |

| Sample Location | HEIS Number | Sample Date | Radium-226 | | | Radium-228 | | | Ruthenium-106 | | | Thorium-228 GEA | | | Thorium-232 GEA | | | Uranium-235 GEA | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | pCi/L | Q | MDA | pCi/L | Q | MDA | pCi/L | Q | MDA | pCi/L | Q | MDA | pCi/L | Q | MDA | pCi/L | Q | MDA |
| 1B, water | J17J48 | 9/17/08 | 21.4 | U | 21.4 | 42.4 | U | 42.4 | 76.2 | U | 76.2 | 14 | U | 14 | 42.4 | U | 42.4 | 35.2 | U | 35.2 |

| Sample Location | HEIS Number | Sample Date | Uranium-238 GEA | | |
|---|---|---|---|---|---|
| | | | pCi/L | Q | MDA |
| 1B, water | J17J48 | 9/17/08 | 1140 | U | 1140 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 7 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

**Attachment 1. 100-D-78 Waste Site Confirmatory Sample Results (Metals) [a].**

| Sample Location | HEIS Number | Sample Date | Aluminum | | | Antimony | | | Arsenic | | | Barium | | | Beryllium | | | Boron | | | Cadmium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 1B, resin | J17FL3 | 9/15/08 | 2050 | | 3.0 | 0.23 | U | 0.23 | 1.4 | | 0.38 | 9.2 | C | 0.08 | 0.10 | | 0.04 | 0.76 | | 0.38 | 0.07 | | 0.04 |
| 2C, surface | J17FK5 | 9/15/08 | 6960 | C | 10.2 | 0.76 | U | 0.76 | 2.7 | | 1.3 | 68.3 | | 0.25 | 0.13 | | 0.13 | 1.3 | | 1.3 | 0.13 | U | 0.13 |
| 2C, 0.6 m | J17FK6 | 9/11/08 | 7830 | C | 10.5 | 1.3 | | 0.78 | 13 | | 1.3 | 93.5 | | 0.26 | 0.16 | | 0.13 | 5.6 | | 1.3 | 0.13 | U | 0.13 |
| 2C, 1.2 m | J17FK7 | 9/11/08 | 7640 | C | 9.3 | 0.69 | U | 0.69 | 3.1 | | 1.2 | 47.5 | | 0.23 | 0.12 | U | 0.12 | 1.7 | | 1.2 | 0.12 | U | 0.12 |
| 2C, 1.2 m | J17FK8 | 9/15/08 | 5060 | | 3.0 | 0.22 | U | 0.22 | 2.3 | | 0.37 | 60.6 | C | 0.07 | 0.35 | | 0.04 | 1.0 | | 0.37 | 0.04 | U | 0.04 |
| 2C, brick | J17FN5 | 9/15/08 | 357 | | 2.9 | 0.22 | U | 0.22 | 0.63 | | 0.37 | 7.9 | C | 0.07 | 0.04 | U | 0.04 | 0.37 | U | 0.37 | 0.04 | U | 0.04 |
| 2D, 1.2 m | J17FK4 | 9/11/08 | 6070 | C | 9.3 | 0.70 | U | 0.70 | 2.4 | | 1.2 | 59.3 | | 0.23 | 0.12 | U | 0.12 | 1.2 | U | 1.2 | 0.12 | U | 0.12 |
| 2E, surface | J17FK0 | 9/11/08 | 8970 | C | 9.8 | 0.73 | U | 0.73 | 3.2 | | 1.2 | 68.7 | | 0.24 | 0.12 | U | 0.12 | 3.0 | | 1.2 | 0.12 | U | 0.12 |
| 2E, 0.6 m | J17FK1 | 9/11/08 | 11900 | C | 11.8 | 5.5 | | 0.89 | 37.7 | | 1.5 | 89.9 | | 0.30 | 0.15 | U | 0.15 | 4.2 | | 1.5 | 0.18 | | 0.15 |
| 2E, 1.2 m | J17FK2 | 9/11/08 | 5380 | C | 9.7 | 0.73 | U | 0.73 | 1.9 | | 1.2 | 55.1 | | 0.24 | 0.12 | U | 0.12 | 1.3 | | 1.2 | 0.12 | U | 0.12 |
| Duplicate of J17FK2 | J17FK3 | 9/11/08 | 5720 | C | 9.4 | 0.70 | U | 0.70 | 1.6 | | 1.2 | 56.8 | | 0.23 | 0.12 | U | 0.12 | 1.2 | | 1.2 | 0.12 | U | 0.12 |
| 2E, brick | J17FN4 | 9/11/08 | 207 | | 3.1 | 0.24 | U | 0.24 | 0.39 | U | 0.39 | 4.7 | | 0.08 | 0.04 | U | 0.04 | 0.39 | U | 0.39 | 0.04 | U | 0.04 |
| Stain 3, surface | J17HM2 | 9/15/08 | 4830 | | 3.0 | 0.22 | U | 0.22 | 2.3 | | 0.37 | 72.0 | C | 0.07 | 0.33 | | 0.04 | 1.7 | | 0.37 | 0.04 | U | 0.04 |
| Stain 3, 0.6 m | J17HM3 | 9/15/08 | 5480 | | 3.0 | 0.23 | U | 0.23 | 2.0 | | 0.38 | 60.0 | C | 0.08 | 0.34 | | 0.04 | 1.5 | | 0.38 | 0.04 | U | 0.04 |
| Stain 3, 1.2 m | J17HM4 | 9/15/08 | 6420 | | 3.2 | 0.24 | U | 0.24 | 3.1 | | 0.40 | 65.4 | C | 0.08 | 0.30 | | 0.04 | 1.1 | | 0.40 | 0.04 | U | 0.04 |
| Stain 4, surface | J17FK9 | 9/15/08 | 9480 | | 3.1 | 0.23 | U | 0.23 | 3.1 | | 0.38 | 77.6 | C | 0.08 | 0.31 | | 0.04 | 2.8 | | 0.38 | 0.04 | U | 0.04 |
| Stain 4, 0.6 m | J17FL0 | 9/15/08 | 7770 | | 2.9 | 0.22 | U | 0.22 | 3.5 | | 0.36 | 84.8 | C | 0.07 | 0.38 | | 0.04 | 1.6 | | 0.36 | 0.04 | U | 0.04 |
| Stain 4, 1.2 m | J17FL1 | 9/15/08 | 6870 | | 3.2 | 0.24 | U | 0.24 | 3.2 | | 0.40 | 73.8 | C | 0.08 | 0.38 | | 0.04 | 1.6 | | 0.40 | 0.04 | U | 0.04 |
| Equipment blank | J17FJ9 | 9/11/08 | 95.3 | C | 3.3 | 0.25 | U | 0.25 | 0.41 | U | 0.41 | 1.1 | | 0.08 | 0.04 | U | 0.04 | 0.41 | U | 0.41 | 0.04 | U | 0.04 |

| Sample Location | HEIS Number | Sample Date | Calcium | | | Chromium | | | Cobalt | | | Copper | | | Hexavalent chromium | | | Iron | | | Lead | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 1B, resin | J17FL3 | 9/15/08 | 768 | C | 3.0 | 5.1 | | 0.15 | 2.4 | | 0.15 | 7.6 | C | 0.15 | 0.21 | U | 0.21 | 6470 | C | 3.4 | 5.9 | | 0.23 |
| 2C, surface | J17FK5 | 9/15/08 | 4030 | C | 10.2 | 9.8 | C | 0.51 | 7.2 | | 0.51 | 12.4 | | 0.51 | 0.22 | U | 0.22 | 20400 | | 11.4 | 5.3 | | 0.76 |
| 2C, 0.6 m | J17FK6 | 9/11/08 | 57200 | C | 10.5 | 14.7 | C | 0.52 | 7.4 | | 0.52 | 21.2 | | 0.52 | 0.22 | U | 0.22 | 24100 | | 118 | 51.7 | | 0.78 |
| 2C, 1.2 m | J17FK7 | 9/11/08 | 8390 | C | 9.3 | 15.4 | C | 0.46 | 6.8 | | 0.46 | 40.8 | | 0.46 | 0.22 | U | 0.22 | 32400 | | 10.4 | 13.2 | | 0.69 |
| 2C, 1.2 m | J17FK8 | 9/15/08 | 8760 | C | 3.0 | 7.5 | | 0.15 | 8.6 | | 0.15 | 14.4 | C | 0.15 | 0.26 | | 0.20 | 24500 | C | 3.4 | 3.1 | | 0.22 |
| 2C, brick | J17FN5 | 9/15/08 | 729.0 | C | 2.9 | 1.0 | | 0.15 | 0.35 | | 0.15 | 2.3 | C | 0.15 | | | | 1000 | C | 3.3 | 0.91 | | 0.22 |
| 2c, brick, Cr+6 | J17FM5 | 9/15/08 | | | | | | | | | | | | | NR | | | | | | | | |
| 2D, 1.2 m | J17FK4 | 9/11/08 | 6670 | C | 9.3 | 10.2 | C | 0.47 | 8.9 | | 0.47 | 14 | | 0.47 | 0.21 | U | 0.21 | 23900 | | 10.5 | 3.2 | | 0.70 |
| 2E, surface | J17FK0 | 9/11/08 | 4450 | C | 9.8 | 13.1 | C | 0.49 | 7.1 | | 0.49 | 75.7 | | 0.49 | 0.20 | U | 0.20 | 22700 | | 11.0 | 6.0 | | 0.73 |
| 2E, 0.6 m | J17FK1 | 9/11/08 | 27400 | C | 11.8 | 24.5 | C | 0.59 | 9.1 | | 0.59 | 33.1 | | 0.59 | 0.23 | U | 0.23 | 32900 | | 13.3 | 26.6 | | 0.89 |
| 2E, 1.2 m | J17FK2 | 9/11/08 | 6250 | C | 9.78 | 7.0 | C | 0.49 | 8.7 | | 0.49 | 13.3 | | 0.49 | 0.27 | | 0.21 | 24700 | | 10.9 | 4.1 | | 0.73 |
| Duplicate of J17FK2 | J17FK3 | 9/11/08 | 6760 | C | 9.4 | 8.0 | C | 0.47 | 9.4 | | 0.47 | 14.6 | | 0.47 | 0.21 | U | 0.21 | 25200 | | 10.5 | 6.1 | | 0.70 |
| 2E, mastic, Cr+6 | J17FM4 | 9/11/08 | | | | | | | | | | | | | NR | | | | | | | | |
| 2E, brick | J17FN4 | 9/11/08 | 469 | C | 3.1 | 0.4 | C | 0.16 | 0.2 | U | 0.16 | 0.47 | | 0.16 | | | | 656 | C | 3.5 | 0.82 | | 0.24 |
| Stain 3, surface | J17HM2 | 9/15/08 | 6890 | C | 3.0 | 8.5 | | 0.15 | 9.8 | | 0.15 | 14.5 | C | 0.15 | 0.20 | U | 0.20 | 27300 | C | 3.3 | 8.8 | | 0.22 |
| Stain 3, 0.6 m | J17HM3 | 9/15/08 | 7630 | C | 3.0 | 10.2 | | 0.15 | 9.6 | | 0.15 | 15.4 | C | 0.15 | 0.21 | U | 0.21 | 26600 | C | 3.4 | 6.3 | | 0.23 |
| Stain 3, 1.2 m | J17HM4 | 9/15/08 | 8530 | C | 3.2 | 12.9 | | 0.16 | 7.1 | | 0.16 | 13.9 | C | 0.16 | 0.21 | U | 0.21 | 20400 | C | 3.6 | 3.5 | | 0.24 |
| Stain 4, surface | J17FK9 | 9/15/08 | 19400 | C | 3.1 | 15.6 | | 0.15 | 3.7 | | 0.15 | 14.9 | C | 0.15 | 0.20 | U | 0.20 | 35100 | C | 3.5 | 7.3 | | 0.23 |
| Stain 4, 0.6 m | J17FL0 | 9/15/08 | 9790 | C | 2.9 | 12.7 | | 0.14 | 8.1 | | 0.14 | 16.4 | C | 0.14 | 0.20 | U | 0.20 | 23000 | C | 3.3 | 4.8 | | 0.22 |
| Stain 4, 1.2 m | J17FL1 | 9/15/08 | 9360 | C | 3.2 | 11.2 | | 0.16 | 8.0 | | 0.16 | 15.7 | C | 0.16 | 0.22 | U | 0.22 | 23100 | C | 3.6 | 4.0 | | 0.24 |
| Equipment blank | J17FJ9 | 9/11/08 | 24.3 | C | 3.3 | 0.17 | C | 0.16 | 0.16 | U | 0.16 | 0.16 | U | 0.16 | 0.20 | U | 0.20 | 157 | | 3.7 | 0.36 | | 0.25 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 8 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

**Attachment 1. 100-D-78 Waste Site Confirmatory Sample Results (Metals) [a].**

| Sample Location | HEIS Number | Sample Date | Magnesium | | | Manganese | | | 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 | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 1B, resin | J17FL3 | 9/15/08 | 833 | C | 1.9 | 53.5 | | 0.03 | 0.03 | | 0.01 | 0.23 | U | 0.23 | 3.9 | C | 0.15 | 115 | | 3.0 | 0.45 | U | 0.45 |
| 2C, surface | J17FK5 | 9/15/08 | 4170 | | 6.4 | 311 | C | 0.10 | 0.01 | U | 0.01 | 0.76 | | 0.76 | 9.7 | | 0.51 | 1200 | | 10.2 | 1.5 | U | 1.5 |
| 2C, 0.6 m | J17FK6 | 9/11/08 | 5030 | | 6.5 | 340 | C | 0.10 | 0.15 | | 0.01 | 0.78 | | 0.78 | 13.1 | | 0.52 | 1260 | | 10.5 | 1.6 | U | 1.6 |
| 2C, 1.2 m | J17FK7 | 9/11/08 | 2970 | | 5.8 | 244 | C | 0.09 | 0.13 | | 0.01 | 0.69 | U | 0.69 | 8.5 | | 0.46 | 1000 | | 9.3 | 1.4 | U | 1.4 |
| 2C, 1.2 m | J17FK8 | 9/15/08 | 4330 | C | 1.9 | 311 | | 0.03 | 0.01 | | 0.009 | 0.43 | | 0.22 | 9.0 | C | 0.15 | 908 | | 3.0 | 0.45 | U | 0.45 |
| 2C, brick | J17FN5 | 9/15/08 | 167 | C | 1.8 | 12.6 | | 0.03 | 0.04 | | 0.01 | 0.22 | U | 0.22 | 1.1 | C | 0.15 | 76.2 | | 2.9 | 0.44 | U | 0.44 |
| 2D, 1.2 m | J17FK4 | 9/11/08 | 4430 | | 5.8 | 335 | C | 0.09 | 0.01 | U | 0.01 | 0.70 | | 0.70 | 11.7 | | 0.47 | 915 | | 9.3 | 1.4 | U | 1.4 |
| 2E, surface | J17FK0 | 9/11/08 | 3720 | | 6.1 | 233 | C | 0.10 | 0.009 | U | 0.009 | 0.73 | U | 0.73 | 9.7 | | 0.49 | 1180 | | 9.8 | 1.5 | U | 1.5 |
| 2E, 0.6 m | J17FK1 | 9/11/08 | 4190 | | 7.4 | 267 | C | 0.12 | 0.1 | | 0.01 | 1.7 | | 0.89 | 10.4 | | 0.59 | 1180 | | 11.8 | 1.8 | U | 1.8 |
| 2E, 1.2 m | J17FK2 | 9/11/08 | 4660 | | 6.1 | 312 | C | 0.10 | 0.008 | U | 0.008 | 0.73 | | 0.73 | 10.0 | | 0.49 | 733 | | 9.7 | 1.5 | U | 1.5 |
| Duplicate of J17FK2 | J17FK3 | 9/11/08 | 4520 | | 5.9 | 321 | C | 0.09 | 0.009 | U | 0.009 | 0.70 | U | 0.70 | 14.4 | | 0.47 | 752 | | 9.4 | 1.4 | U | 1.4 |
| 2E, brick | J17FN4 | 9/11/08 | 108 | | 2.0 | 9.3 | C | 0.03 | 0.01 | U | 0.01 | 0.24 | U | 0.24 | 0.49 | C | 0.16 | 62 | | 38.8 | 0.6 | | 0.47 |
| Stain 3, surface | J17HM2 | 9/15/08 | 4690 | C | 1.8 | 325 | | 0.03 | 0.05 | | 0.008 | 0.69 | | 0.22 | 11.5 | C | 0.15 | 791 | | 3.0 | 0.44 | U | 0.44 |
| Stain 3, 0.6 m | J17HM3 | 9/15/08 | 4750 | C | 1.9 | 333 | | 0.03 | 0.01 | | 0.008 | 0.42 | | 0.23 | 12.2 | C | 0.15 | 930 | | 3.0 | 0.45 | U | 0.45 |
| Stain 3, 1.2 m | J17HM4 | 9/15/08 | 4760 | C | 2.0 | 299 | | 0.03 | 0.01 | U | 0.01 | 0.41 | | 0.24 | 11.7 | C | 0.16 | 1140 | | 3.2 | 0.48 | U | 0.48 |
| Stain 4, surface | J17FK9 | 9/15/08 | 1920 | C | 1.9 | 132 | | 0.03 | 0.009 | | 0.008 | 0.48 | | 0.23 | 4.9 | C | 0.15 | 1520 | | 3.1 | 0.46 | U | 0.46 |
| Stain 4, 0.6 m | J17FL0 | 9/15/08 | 4630 | C | 1.8 | 329 | | 0.03 | 0.009 | | 0.009 | 0.45 | | 0.22 | 12.1 | C | 0.14 | 1410 | | 2.9 | 0.43 | U | 0.43 |
| Stain 4, 1.2 m | J17FL1 | 9/15/08 | 4480 | C | 2.0 | 314 | | 0.03 | 0.009 | U | 0.009 | 0.45 | | 0.24 | 10.7 | C | 0.16 | 1150 | | 3.2 | 0.48 | U | 0.48 |
| Equipment blank | J17FJ9 | 9/11/08 | 10.4 | | 2.0 | 3.1 | C | 0.03 | 0.008 | U | 0.008 | 0.25 | U | 0.25 | 0.16 | U | 0.16 | 21.5 | | 3.3 | 0.49 | U | 0.49 |

| Sample 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 |
| 1B, resin | J17FL3 | 9/15/08 | 306 | | 3.0 | 0.090 | | 0.080 | 39.9 | C | 1.5 | 8.4 | | 0.11 | 24.6 | C | 0.45 |
| 2C, surface | J17FK5 | 9/15/08 | 512 | | 10.2 | 0.25 | U | 0.25 | 149 | C | 5.1 | 48.6 | | 0.36 | 42.2 | C | 1.5 |
| 2C, 0.6 m | J17FK6 | 9/11/08 | 638 | | 10.5 | 0.26 | U | 0.26 | 673 | C | 5.2 | 43.5 | | 0.37 | 166 | C | 1.6 |
| 2C, 1.2 m | J17FK7 | 9/11/08 | 426 | | 9.3 | 0.23 | U | 0.23 | 309 | C | 4.6 | 73.2 | | 0.31 | 52.2 | C | 1.4 |
| 2C, 1.2 m | J17FK8 | 9/15/08 | 436 | | 3.0 | 0.070 | U | 0.070 | 416 | C | 1.5 | 66.3 | | 0.10 | 44.4 | C | 0.45 |
| 2C, brick | J17FN5 | 9/15/08 | 179 | | 2.9 | 0.073 | U | 0.070 | 47 | C | 1.5 | 2.4 | | 0.10 | 3.9 | C | 0.44 |
| 2D, 1.2 m | J17FK4 | 9/11/08 | 401 | | 9.3 | 0.23 | U | 0.23 | 308 | C | 4.7 | 59.6 | | 0.33 | 45.8 | C | 1.4 |
| 2E, surface | J17FK0 | 9/11/08 | 547 | | 9.8 | 0.24 | U | 0.24 | 793 | C | 4.9 | 56.3 | | 0.34 | 50.6 | C | 1.5 |
| 2E, 0.6 m | J17FK1 | 9/11/08 | 594 | | 11.8 | 0.30 | U | 0.30 | 698 | C | 5.9 | 81.3 | | 0.41 | 101 | C | 1.8 |
| 2E, 1.2 m | J17FK2 | 9/11/08 | 553 | | 9.7 | 0.24 | U | 0.24 | 229 | C | 4.9 | 60.1 | | 0.34 | 46.7 | C | 1.5 |
| Duplicate of J17FK2 | J17FK3 | 9/11/08 | 523 | | 9.4 | 0.23 | U | 0.23 | 240 | C | 4.7 | 63.3 | | 0.33 | 47.5 | C | 1.4 |
| 2E, brick | J17FN4 | 9/11/08 | 94.5 | | 3.1 | 0.08 | U | 0.08 | 46.5 | C | 1.6 | 1.2 | | 0.11 | 1.9 | | 0.47 |
| Stain 3, surface | J17HM2 | 9/15/08 | 295 | | 3.0 | 0.070 | U | 0.070 | 275 | C | 1.5 | 71.1 | | 0.10 | 50.4 | C | 0.44 |
| Stain 3, 0.6 m | J17HM3 | 9/15/08 | 302 | | 3.0 | 0.080 | U | 0.080 | 255 | C | 1.5 | 70.3 | | 0.11 | 48.0 | C | 0.45 |
| Stain 3, 1.2 m | J17HM4 | 9/15/08 | 414 | | 3.2 | 0.080 | U | 0.080 | 242 | C | 1.6 | 47.5 | | 0.11 | 38.5 | C | 0.48 |
| Stain 4, surface | J17FK9 | 9/15/08 | 353 | | 3.1 | 0.080 | U | 0.080 | 3040 | C | 1.5 | 76.9 | | 0.11 | 32.0 | C | 0.46 |
| Stain 4, 0.6 m | J17FL0 | 9/15/08 | 342 | | 2.9 | 0.070 | U | 0.070 | 212 | C | 1.4 | 55.6 | | 0.10 | 42.6 | C | 0.43 |
| Stain 4, 1.2 m | J17FL1 | 9/15/08 | 356 | | 3.2 | 0.080 | U | 0.080 | 234 | C | 1.6 | 57.9 | | 0.11 | 42.4 | C | 0.48 |
| Equipment blank | J17FJ9 | 9/11/08 | 52.4 | | 3.3 | 0.080 | U | 0.080 | 34.7 | C | 1.6 | 0.11 | U | 0.11 | 0.66 | C | 0.49 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 9 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

## Attachment 1. 100-D-78 Waste Site Confirmatory Sample Results (Anions)[a].

| Sample Location | HEIS Number | Sample Date | Bromide | | | Chloride | | | Fluoride | | | Nitrate | | | Nitrite | | | Nitrogen as nitrate | | | Nitrogen as nitrite | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 1B, resin | J17FL3 | 9/15/08 | 2.5 | U | 2.5 | 2.5 | U | 2.5 | 2.5 | U | 2.5 | 2.49 | UR | 2.49 | 2.49 | UR | 2.49 | 0.20 | U | 0.20 | 0.20 | U | 0.20 |
| 2C, surface | J17FK5 | 9/11/08 | 2.5 | U | 2.5 | 2.5 | U | 2.5 | 2.5 | U | 2.5 | 5.08 | | 2.52 | 2.52 | UR | 2.52 | 0.21 | U | 0.21 | 0.60 | | 0.21 |
| 2C, 0.6 m | J17FK6 | 9/11/08 | 2.6 | U | 2.6 | 19.7 | | 2.60 | 2.6 | U | 2.6 | 3.65 | | 2.60 | 2.60 | UR | 2.60 | 0.21 | U | 0.21 | 0.57 | | 0.21 |
| 2C, 1.2 m | J17FK7 | 9/11/08 | 2.6 | U | 2.6 | 4.4 | | 2.60 | 4.9 | | 2.6 | 2.61 | UR | 2.61 | 2.61 | UR | 2.61 | 0.21 | U | 0.21 | 0.21 | U | 0.21 |
| 2C, 1.2 m | J17FK8 | 9/15/08 | 2.6 | U | 2.6 | 2.6 | U | 2.60 | 2.6 | U | 2.60 | 2.61 | UR | 2.61 | 2.61 | UR | 2.61 | 0.20 | U | 0.20 | 0.36 | | 0.20 |
| 2D, 1.2 m | J17FK4 | 9/11/08 | 2.6 | U | 2.6 | 2.6 | U | 2.60 | 2.6 | U | 2.6 | 6.4 | | 2.6 | 2.60 | UR | 2.6 | 0.15 | U | 0.15 | 0.8 | | 0.15 |
| 2E, surface | J17FK0 | 9/11/08 | 2.5 | U | 2.5 | 2.5 | U | 2.50 | 2.6 | | 2.5 | 6.8 | | 2.49 | 2.49 | UR | 2.49 | 0.2 | U | 0.19 | 1.4 | | 0.19 |
| 2E, 0.6 m | J17FK1 | 9/11/08 | 2.8 | U | 2.8 | 12.2 | | 2.80 | 2.8 | U | 2.8 | 3.1 | | 2.81 | 2.81 | UR | 2.81 | 0.23 | U | 0.23 | 0.63 | | 0.23 |
| 2E, 1.2 m | J17FK2 | 9/11/08 | 2.5 | U | 2.5 | 2.5 | U | 2.50 | 2.5 | U | 2.5 | 2.5 | | 2.53 | 2.53 | UR | 2.53 | 0.21 | U | 0.21 | 0.46 | | 0.21 |
| Duplicate of J17FK2 | J17FK3 | 9/11/08 | 2.3 | U | 2.3 | 2.30 | U | 2.30 | 2.3 | U | 2.3 | 2.8 | | 2.31 | 2.31 | UR | 2.31 | 0.2 | U | 0.2 | 0.53 | | 0.2 |
| Stain 3, surface | J17HM2 | 9/15/08 | 2.3 | U | 2.3 | 2.3 | U | 2.3 | 2.3 | U | 2.30 | 4.7 | | 2.3 | 2.3 | UR | 2.3 | 0.18 | U | 0.18 | 0.89 | | 0.89 |
| Stain 3, 0.6 m | J17HM3 | 9/15/08 | 2.5 | U | 2.5 | 2.5 | U | 2.5 | 2.5 | U | 2.50 | 2.5 | UR | 2.51 | 2.51 | UR | 2.51 | 0.2 | U | 0.2 | 0.2 | U | 0.2 |
| Stain 3, 1.2 m | J17HM4 | 9/15/08 | 2.7 | U | 2.7 | 2.7 | U | 2.7 | 2.7 | U | 2.70 | 2.7 | UR | 2.69 | 2.69 | UR | 2.69 | 0.21 | U | 0.21 | 0.21 | U | 0.21 |
| Stain 4, surface | J17FK9 | 9/15/08 | 2.5 | U | 2.5 | 2.5 | U | 2.5 | 2.5 | U | 2.50 | 6.1 | | 2.5 | 2.5 | UR | 2.5 | 0.3 | U | 0.3 | 1.8 | | 0.3 |
| Stain 4, 0.6 m | J17FL0 | 9/15/08 | 2.4 | U | 2.4 | 2.4 | U | 2.4 | 2.4 | U | 2.40 | 2.4 | UR | 2.44 | 2.44 | UR | 2.44 | 0.22 | U | 0.22 | 0.35 | | 0.22 |
| Stain 4, 1.2 m | J17FL1 | 9/15/08 | 2.7 | U | 2.7 | 2.7 | U | 2.7 | 2.7 | U | 2.70 | 2.7 | UR | 2.72 | 2.72 | UR | 2.72 | 0.21 | U | 0.21 | 0.21 | U | 0.21 |
| Equipment blank | J17FJ9 | 9/11/08 | 45.9 | | 2.3 | 2.3 | U | 2.3 | 2.4 | | 2.30 | 2.3 | UR | 2.32 | 2.32 | UR | 2.32 | 0.19 | U | 0.19 | 0.19 | U | 0.19 |

| Sample Location | HEIS Number | Sample Date | Phosphate | | | Sulfate | | | pH value |
|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | |
| 1B, resin | J17FL3 | 9/15/08 | 2.5 | UR | 2.5 | 529 | C | 25 | 3.8 |
| 2C, surface | J17FK5 | 9/11/08 | 2.5 | UR | 2.5 | 17.7 | | 2.5 | 3.0 |
| 2C, 0.6 m | J17FK6 | 9/11/08 | 2.6 | UR | 2.6 | 3630 | D | 260 | 8.0 |
| 2C, 1.2 m | J17FK7 | 9/11/08 | 2.6 | UR | 2.6 | 7010 | D | 130 | 3.8 |
| 2C, 1.2 m | J17FK8 | 9/15/08 | 2.6 | UR | 2.6 | 340.0 | C | 26 | 10.3 |
| 2D, 1.2 m | J17FK4 | 9/11/08 | 2.6 | UR | 2.6 | 190 | D | 13 | 9.8 |
| 2E, surface | J17FK0 | 9/11/08 | 2.5 | UR | 2.5 | 3780 | D | 250 | 4.0 |
| 2E, 0.6 m | J17FK1 | 9/11/08 | 2.8 | UR | 2.8 | 14500 | D | 1400 | 6.5 |
| 2E, 1.2 m | J17FK2 | 9/11/08 | 50.5 | UD | 50.5 | 867 | D | 50.5 | 7.8 |
| Duplicate of J17FK2 | J17FK3 | 9/11/08 | 2.3 | UR | 2.3 | 1390 | D | 115 | 7.9 |
| Stain 3, surface | J17HM2 | 9/15/08 | 2.3 | UR | 2.3 | 720 | C | 46 | 7.9 |
| Stain 3, 0.6 m | J17HM3 | 9/15/08 | 2.5 | UR | 2.5 | 58.5 | C | 2.5 | 9.3 |
| Stain 3, 1.2 m | J17HM4 | 9/15/08 | 2.7 | UR | 2.7 | 111 | C | 2.7 | 9.0 |
| Stain 4, surface | J17FK9 | 9/15/08 | 25 | UR | 25 | 15000 | C | 2500 | 3.6 |
| Stain 4, 0.6 m | J17FL0 | 9/15/08 | 125 | | 96 | 1130 | C | 96 | 7.5 |
| Stain 4, 1.2 m | J17FL1 | 9/15/08 | 2.7 | UR | 2.7 | 448 | C | 13.5 | 8.4 |
| Equipment blank | J17FJ9 | 9/11/08 | 2.3 | UR | 2.3 | 2.3 | U | 2.3 | 7.2 |

| Sample Area | HEIS number | Sample Date | Asbestos Result |
|---|---|---|---|
| Pit 2E mortar | J17HR3 | 9/11/2008 | None detected |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 10 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

## Attachment 1. 100-D-78 Waste Site Confirmatory Sample Results - Water Sample (Organics) [a].

| Constituents | Class | Soil stain 1, pit 1B, water sample J17J48 9/17/08 | | |
|---|---|---|---|---|
| | | µg/L | Q | PQL |
| Aroclor-1016 | PCB | 0.40 | U | 0.40 |
| Aroclor-1221 | PCB | 0.40 | U | 0.40 |
| Aroclor-1232 | PCB | 0.40 | U | 0.40 |
| Aroclor-1242 | PCB | 0.40 | U | 0.40 |
| Aroclor-1248 | PCB | 0.40 | U | 0.40 |
| Aroclor-1254 | PCB | 0.40 | U | 0.40 |
| Aroclor-1260 | PCB | 0.40 | U | 0.40 |
| 2,4,5-Trichlorophenoxyacetic acid | HERB | 0.50 | U | 0.50 |
| 2,4-Dichlorophenoxyacetic acid | HERB | 0.50 | U | 0.50 |
| 2-(2,4,5-Trichlorophenoxy)propionic acid | HERB | 0.35 | J | 0.50 |
| 2-secButyl-4,6-dinitrophenol(DNBP) | HERB | 0.50 | U | 0.50 |
| 4-(2,4-Dichlorophenoxy)butanoic acid | HERB | 0.16 | JX | 0.50 |
| Dalapon | HERB | 0.50 | U | 0.50 |
| Dicamba | HERB | 0.50 | U | 0.50 |
| Dichloroprop | HERB | 0.17 | JX | 0.50 |
| Pentachlorophenol | HERB | 0.50 | U | 0.50 |
| Aldrin | PEST | 0.05 | U | 0.05 |
| Alpha-BHC | PEST | 0.05 | U | 0.05 |
| alpha-Chlordane | PEST | 0.05 | U | 0.05 |
| beta-1,2,3,4,5,6-Hexachlorocyclohexane | PEST | 0.05 | U | 0.05 |
| Delta-BHC | PEST | 0.05 | U | 0.05 |
| Dichlorodiphenyldichloroethane | PEST | 0.05 | U | 0.05 |
| Dichlorodiphenyldichloroethylene | PEST | 0.05 | U | 0.05 |
| Dichlorodiphenyltrichloroethane | PEST | 0.05 | U | 0.05 |
| Dieldrin | PEST | 0.05 | U | 0.05 |
| Endosulfan I | PEST | 0.05 | U | 0.05 |
| Endosulfan II | PEST | 0.05 | U | 0.05 |
| Endosulfan sulfate | PEST | 0.05 | U | 0.05 |
| Endrin | PEST | 0.05 | U | 0.05 |
| Endrin aldehyde | PEST | 0.05 | U | 0.05 |
| Endrin ketone | PEST | 0.05 | U | 0.05 |
| Gamma-BHC (Lindane) | PEST | 0.05 | U | 0.05 |
| gamma-Chlordane | PEST | 0.05 | U | 0.05 |
| Heptachlor | PEST | 0.05 | U | 0.05 |
| Heptachlor epoxide | PEST | 0.05 | U | 0.05 |
| Methoxychlor | PEST | 0.05 | U | 0.05 |
| Toxaphene | PEST | 0.50 | U | 0.50 |
| 1,2,4-Trichlorobenzene | SVOA | 10 | U | 10 |
| 1,2-Dichlorobenzene | SVOA | 10 | U | 10 |
| 1,3-Dichlorobenzene | SVOA | 10 | U | 10 |
| 1,4-Dichlorobenzene | SVOA | 10 | U | 10 |
| 2,4,5-Trichlorophenol | SVOA | 25 | U | 25 |
| 2,4,6-Trichlorophenol | SVOA | 10 | U | 10 |
| 2,4-Dichlorophenol | SVOA | 10 | U | 10 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 11 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

**Attachment 1. 100-D-78 Waste Site Confirmatory Sample Results - Water Sample (Organics) [a].**

| Constituents | Class | Soil stain 1, pit 1B, water sample J17J48 9/17/08 | | |
|---|---|---|---|---|
| | | µg/L | Q | PQL |
| 2,4-Dimethylphenol | SVOA | 10 | U | 10 |
| 2,4-Dinitrophenol | SVOA | 25 | U | 25 |
| 2,4-Dinitrotoluene | SVOA | 10 | U | 10 |
| 2,6-Dinitrotoluene | SVOA | 10 | U | 10 |
| 2-Chloronaphthalene | SVOA | 10 | U | 10 |
| 2-Chlorophenol | SVOA | 10 | U | 10 |
| 2-Methylnaphthalene | SVOA | 10 | U | 10 |
| 2-Methylphenol (cresol, o-) | SVOA | 10 | U | 10 |
| 2-Nitroaniline | SVOA | 25 | U | 25 |
| 2-Nitrophenol | SVOA | 10 | U | 10 |
| 3/4 Methylphenol (cresol, m+p) | SVOA | 10 | U | 10 |
| 3,3'-Dichlorobenzidine | SVOA | 10 | U | 10 |
| 3-Nitroaniline | SVOA | 25 | U | 25 |
| 4,6-Dinitro-2-methylphenol | SVOA | 25 | U | 25 |
| 4-Bromophenylphenyl ether | SVOA | 10 | U | 10 |
| 4-Chloro-3-methylphenol | SVOA | 10 | U | 10 |
| 4-Chloroaniline | SVOA | 10 | U | 10 |
| 4-Chlorophenylphenyl ether | SVOA | 10 | U | 10 |
| 4-Nitroaniline | SVOA | 25 | U | 25 |
| 4-Nitrophenol | SVOA | 25 | U | 25 |
| Acenaphthene | SVOA | 10 | U | 10 |
| Acenaphthylene | SVOA | 10 | U | 10 |
| Anthracene | SVOA | 10 | U | 10 |
| Benzo(a)anthracene | SVOA | 10 | U | 10 |
| Benzo(a)pyrene | SVOA | 10 | U | 10 |
| Benzo(b)fluoranthene | SVOA | 10 | U | 10 |
| Benzo(ghi)perylene | SVOA | 10 | U | 10 |
| Benzo(k)fluoranthene | SVOA | 10 | U | 10 |
| Bis(2-chloro-1-methylethyl)ether | SVOA | 10 | U | 10 |
| Bis(2-Chloroethoxy)methane | SVOA | 10 | U | 10 |
| Bis(2-chloroethyl) ether | SVOA | 10 | U | 10 |
| Bis(2-ethylhexyl) phthalate | SVOA | 10 | U | 10 |
| Butylbenzylphthalate | SVOA | 10 | U | 10 |
| Carbazole | SVOA | 10 | U | 10 |
| Chrysene | SVOA | 10 | U | 10 |
| Di-n-butylphthalate | SVOA | 0.60 | J | 10 |
| Di-n-octylphthalate | SVOA | 10 | U | 10 |
| Dibenz[a,h]anthracene | SVOA | 10 | U | 10 |
| Dibenzofuran | SVOA | 10 | U | 10 |
| Diethylphthalate | SVOA | 10 | U | 10 |
| Dimethyl phthalate | SVOA | 10 | U | 10 |
| Fluoranthene | SVOA | 10 | U | 10 |
| Fluorene | SVOA | 10 | U | 10 |
| Hexachlorobenzene | SVOA | 10 | U | 10 |
| Hexachlorobutadiene | SVOA | 10 | U | 10 |
| Hexachlorocyclopentadiene | SVOA | 10 | U | 10 |
| Hexachloroethane | SVOA | 10 | U | 10 |

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|---|---|---|---|
| Attachment | 1 | Sheet No. | 12 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

**Attachment 1. 100-D-78 Waste Site Confirmatory Sample Results - Water Sample (Organics) [a].**

| Constituents | Class | Soil stain 1, pit 1B, water sample J17J48 9/17/08 | | |
|---|---|---|---|---|
| | | µg/L | Q | PQL |
| Indeno(1,2,3-cd)pyrene | SVOA | 10 | U | 10 |
| Isophorone | SVOA | 10 | U | 10 |
| N-Nitroso-di-n-dipropylamine | SVOA | 10 | U | 10 |
| N-Nitrosodiphenylamine | SVOA | 10 | U | 10 |
| Naphthalene | SVOA | 10 | U | 10 |
| Nitrobenzene | SVOA | 10 | U | 10 |
| Pentachlorophenol | SVOA | 25 | U | 25 |
| Phenanthrene | SVOA | 10 | U | 10 |
| Phenol | SVOA | 10 | U | 10 |
| Pyrene | SVOA | 10 | U | 10 |
| 1,1,1-Trichloroethane | VOA | 5.0 | U | 5.0 |
| 1,1,2,2-Tetrachloroethane | VOA | 5.0 | U | 5.0 |
| 1,1,2-Trichloroethane | VOA | 5.0 | U | 5.0 |
| 1,1-Dichloroethane | VOA | 5.0 | U | 5.0 |
| 1,1-Dichloroethene | VOA | 5.0 | U | 5.0 |
| 1,2-Dichloroethane | VOA | 5.0 | U | 5.0 |
| 1,2-Dichloroethene(Total) | VOA | 5.0 | U | 5.0 |
| 1,2-Dichloropropane | VOA | 5.0 | U | 5.0 |
| 2-Butanone | VOA | 10 | U | 10 |
| 2-Hexanone | VOA | 10 | U | 10 |
| 4-Methyl-2-Pentanone | VOA | 6.0 | J | 10 |
| Acetone | VOA | 17 | | 10 |
| Benzene | VOA | 5.0 | U | 5.0 |
| Bromodichloromethane | VOA | 5.0 | U | 5.0 |
| Bromoform | VOA | 5.0 | U | 5.0 |
| Bromomethane | VOA | 10 | U | 10 |
| Carbon disulfide | VOA | 5.0 | U | 5.0 |
| Carbon tetrachloride | VOA | 5.0 | U | 5.0 |
| Chlorobenzene | VOA | 5.0 | U | 5.0 |
| Chloroethane | VOA | 10 | U | 10 |
| Chloroform | VOA | 5.0 | U | 5.0 |
| Chloromethane | VOA | 10 | U | 10 |
| cis-1,2-Dichloroethylene | VOA | 5.0 | U | 5.0 |
| cis-1,3-Dichloropropene | VOA | 5.0 | U | 5.0 |
| Dibromochloromethane | VOA | 5.0 | U | 5.0 |
| Ethylbenzene | VOA | 5.0 | U | 5.0 |
| Methylenechloride | VOA | 5.0 | U | 5.0 |
| Styrene | VOA | 5.0 | U | 5.0 |
| Tetrachloroethene | VOA | 5.0 | U | 5.0 |
| Toluene | VOA | 5.0 | U | 5.0 |
| trans-1,2-Dichloroethylene | VOA | 5.0 | U | 5.0 |
| trans-1,3-Dichloropropene | VOA | 5.0 | U | 5.0 |
| Trichloroethene | VOA | 5.0 | U | 5.0 |
| Vinyl chloride | VOA | 10 | U | 10 |
| Xylenes (total) | VOA | 5.0 | U | 5.0 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 13 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

**Attachment 1. 100-D-78 Waste Site Confirmatory Sample Results - Water Sample (Metals and Anions) [a].**

| Sample Location | HEIS Number | Sample Date | Aluminum | | | Antimony | | | Arsenic | | | Barium | | | Beryllium | | | Boron | | | Cadmium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL |
| 1B, 1.2 m | J17J48 | 9/17/08 | 935000 | | 120 | 9.0 | U | 9.0 | 47.3 | | 15.0 | 626 | C | 3.0 | 41.6 | | 1.5 | 340 | | 15 | 333 | | 1.5 |

| Sample Location | HEIS Number | Sample Date | Calcium | | | Chromium | | | Cobalt | | | Copper | | | Hexavalent chromium | | | Iron | | | Lead | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL |
| 1B, 1.2 m | J17J48 | 9/17/08 | 553000 | | 120 | 451 | | 6 | 1960 | | 6 | 1950 | C | 6 | | | | 706000 | | 135 | 632 | | 9.0 |
| 1B, 1.2 m | J17J49 | 9/17/08 | | | | | | | | | | | | | 27 | | 2.0 | | | | | | |

| Sample Location | HEIS Number | Sample Date | Magnesium | | | Manganese | | | Mercury | | | Molybdenum | | | Nickel | | | Potassium | | | Selenium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL |
| 1B, 1.2 m | J17J48 | 9/17/08 | 574000 | | 75.0 | 77100 | C | 1.20 | 4 | | 0.06 | 14 | | 9 | 1190 | | 6 | 15300 | | 1480 | 18 | U | 18 |

| Sample Location | HEIS Number | Sample Date | Silicon | | | Silver | | | Sodium | | | Vanadium | | | Zinc | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL | µg/L | Q | PQL |
| 1B, 1.2 m | J17J48 | 9/17/08 | 69800 | | 120 | 3.0 | U | 3.0 | 101000 | C | 60.0 | 297 | | 4.2 | 21400 | | 18 |

| Sample Location | HEIS Number | Sample Date | Bromide | | | Chloride | | | Fluoride | | | Nitrate | | | Nitrite | | | Nitrogen as nitrate | | | Nitrogen as nitrite | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/L | Q | PQL | mg/L | Q | PQL | mg/L | Q | PQL | mg/L | Q | PQL | mg/L | Q | PQL | mg/L | Q | PQL | mg/L | Q | PQL |
| 1B, 1.2 m | J17J48 | 9/17/08 | 100 | U | 100 | 100 | U | 100 | 100 | U | 100 | 100 | UR | 100 | 100 | UR | 100 | 0.29 | | 0.020 | 0.20 | | 0.020 |

| Sample Location | HEIS Number | Sample Date | Phosphate | | | Sulfate | | | Sulfide | | | pH value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/L | Q | PQL | mg/L | Q | PQL | mg/L | Q | PQL | |
| 1B, 1.2 m | J17J48 | 9/17/08 | 100 | UR | 100 | 10500 | | 500 | 2.6 | | 1.0 | 3.5 |

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|---|---|---|---|
| Attachment | 1 | Sheet No. | 14 of 14 |
| Originator | J. D. Skoglie | Date | 6/12/13 |
| Checked | N. K. Schiffern | Date | 6/12/13 |
| Calc. No. | 0100D-CA-V0499 | Rev. No. | 0 |

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# CALCULATION COVER SHEET

Project Title: 100-D Field Remediation **Job No. 14655**

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0500

Subject: 100-D-78 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculation

Computer Program: Excel Program No: Excel 2003

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 | J. D. Skoglie | N. K. Schiffern | I. B. Berezovskiy | D. F. Obenauer | 6/12/13 |
| | | | | | | |
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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, Inc. CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | J. D. Skoglie | Date: | 06/12/13 | Calc. No.: | 0100D-CA-V0500 | Rev.: | 0 |
| Project: | 100-D Area Field Remediation | Job No: | 14655 | Checked: | N. K. Schiffern | Date: | 06/12/13 |
| Subject: | 100-D-78 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculation | | | | | Sheet No. | 1 of 3 |

**PURPOSE:**

Provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 100-D-78 waste site. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009a), 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) DOE-RL, 2009a, *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.

2) DOE-RL, 2009b, 100 Area Remedial Action Sampling and Analysis Plan, DOE/RL-96-22, Rev. 5, 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, 2013, *100-D-78 Waste Site Cleanup Verification 95% UCL Calculation*, 0100D-CA-V0499, Rev. 0, Washington Closure Hanford, Inc., 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 2009a).

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 2009a).

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

Washington Closure Hanford, Inc. CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | J. D. Skoglie | Date: | 06/12/13 | Calc. No.: | 0100D-CA-V0500 | Rev.: | 0 |
| Project: | 100-D Area Field Remediation | Job No: | 14655 | Checked: | N. K. Schiffern | Date: | 06/12/13 |
| Subject: | 100-D-78 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculation | | | | | Sheet No. | 2 of 3 |

## METHODOLOGY:

The 100-D-78 waste site is comprised of two decision units for verification sampling; the excavation and the staging pile area. In addition, focused sampling was performed at two decision units; stained soil areas 3 and 4. Besides stained soil areas 3 and 4, all other confirmatory focused samples are for information only as discussed in the RSVP. The direct contact hazard quotient and carcinogenic risk calculations for the 100-D-78 waste site were conservatively calculated for the entire waste site using the greater of the statistical or maximum value for each analyte in all decision units from WCH (2013). Of the contaminants of potential concern (COPCs) for this site, boron, hexavalent chromium, molybdenum, and nitrogen in nitrite require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. Nitrogen in nitrate and nitrite requires an HQ and risk calculation because this analyte was detected above a Washington State or Hanford Site background value. 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 statistical value for boron is 3.3 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]), is $4.6 \times 10^{-4}$. 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 $4.6 \times 10^{-3}$. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum or statistical value is divided by the carcinogenic RAG value, and then multiplied by $1.0 \times 10^{-6}$. For example, the maximum value for hexavalent chromium is 0.383 mg/kg, divided by 2.1 mg/kg, and multiplied as indicated, is $1.8 \times 10^{-7}$. 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 $1.8 \times 10^{-7}$. Comparing these values to the requirement of $<1 \times 10^{-5}$, this criterion is met.

## 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 $>1 \times 10^{-6}$: None
4) List the cumulative excess cancer risk for carcinogens $>1 \times 10^{-5}$: None

Table 1 shows the results of the calculations.

Washington Closure Hanford, Inc. CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | J. D. Skoglie | Date: | 06/12/13 | Calc. No.: | 0100D-CA-V0500 | Rev.: | 0 |
| Project: | 100-D Area Field Remediation | Job No: | 14655 | Checked: | N. K. Schiffern | Date: | 06/12/13 |
| Subject: | 100-D-78 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculation | | | | | Sheet No. | 3 of 3 |

**Table 1. Direct Contact Hazard Quotient and Excess Cancer Risk Results for the 100-D-78 Waste Site**

| Contaminant of Potential Concern[a] | Maximum or Statistical Value[a] (mg/kg) | Noncarcinogen RAG[b] (mg/kg) | Hazard Quotient | Carcinogen RAG[b] (mg/kg) | Carcinogen Risk |
|---|---|---|---|---|---|
| ***Metals*** | | | | | |
| Boron | 3.3 | 7,200 | 4.6E-04 | -- | -- |
| Chromium, hexavalent[c] | 0.383 | 240 | 1.6E-03 | 2.1 | 1.8E-07 |
| Molybdenum | 0.69 | 400 | 1.7E-03 | -- | -- |
| ***Anions*** | | | | | |
| Nitrogen in Nitrate and Nitrite | 79.3 | 128,000 | 6.2E-04 | -- | -- |
| Nitrogen in Nitrite | 1.8 | 8,000 | 2.3E-04 | -- | -- |
| ***Totals*** | | | | | |
| **Cumulative Hazard Quotient:** | | | **4.6E-03** | | |
| **Cumulative Excess Cancer Risk:** | | | | | **1.8E-07** |

Note:

[a] = From WCH (2013).

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

[c] = Carcinogenic cleanup level calculated based on the inhalation exposure pathway; WAC 173-340-750(3), 1996.

-- = not applicable

RAG = remedial action goal

## CONCLUSION:

The calculations in Table 1 demonstrate that the 100-D-78 waste site meets the requirements for the direct contact hazard quotients and carcinogenic (excess cancer) risk, respectively, as identified in the RDR/RAWP (DOE-RL 2009a) and SAP (DOE-RL 2009b). The direct contact hazard quotients and carcinogenic (excess cancer) risk calculations are for use in the RSVP for this site.

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# CALCULATION COVER SHEET

Project Title: 100-D Area Field Remediation **Job No. 14655**

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0501

Subject: 100-D-78 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater

Computer Program: Excel Program No: Excel 2003

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 | J. D. Skoglie | N. K. Schiffern | I. B. Berezovskiy | D. F. Obenauer | 6/12/13 |
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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, Inc. CALCULATION SHEET

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| Originator: | J. D. Skoglie JS | Date: | 6/12/2013 | Calc. No.: | 0100D-CA-V0501 | Rev.: | 0 |
| Project: | 100-D Area Field Remediation | Job No: | 14655 | Checked: | N. K. Schiffern NO | Date: | 6/12/2013 |
| Subject: | 100-D-78 Waste Site 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-78 waste site. 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, 2013, *100-D-78 Waste Site Cleanup Verification 95% UCL Calculations*, 0100D-CA-V0499, 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, Inc. CALCULATION SHEET

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| Originator: | J. D. Skoglie | Date: | 6/12/2013 | Calc. No.: | 0100D-CA-V0501 | Rev.: | 0 |
| Project: | 100-D Area Field Remediation | Job No: | 14655 | Checked: | N. K. Schiffern | Date: | 6/12/2013 |
| Subject: | 100-D-78 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater | | | | | Sheet No. 2 of 3 | |

**METHODOLOGY:**

The 100-D-78 waste site was divided into two decision units for the purpose of verification sampling; excavation and staging pile area. In addition, focused sampling was performed at two decision units; stained soil areas 3 and 4. Besides stained soil areas 3 and 4, all other confirmatory focused samples are for information only as discussed in the RSVP. Hazard quotient and carcinogenic risk calculations for potential impact to groundwater at the 100-D-78 waste site were conservatively calculated for the entire waste site using the greater of the statistical or maximum value for each analyte in all decision units from the 95% UCL calculation (WCH 2013). Of the contaminants of potential concern (COPCs) for this site, boron, hexavalent chromium, and nitrogen in 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 nitrate and nitrite is included because this constituent is above Washington State or Hanford Site background value and the distribution coefficient is less than that necessary to show no migration to groundwater within 1,000 years using the generic site RESRAD model (BHI 2005). Based on this model and a vadose zone of approximately 24.0 m (79.0 ft) thickness, a $K_d$ of 3.1 or greater is required to show no predicted migration to groundwater in 1,000 years. All other site nonradionuclide COPCs were not detected, quantified below background levels, or have a $K_d$ greater than or equal to 3.1. 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 statistical value for boron of 3.3 mg/kg, divided by the noncarcinogenic RAG value of 320 mg/kg is $1.0 \times 10^{-2}$. 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-78 waste site is $1.7 \times 10^{-1}$. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum or statistical value is divided by the carcinogenic RAG value, and then multiplied by $1 \times 10^{-6}$. There were not any constituents with a carcinogenic RAG, therefore, comparing zero to the requirement of $<1 \times 10^{-6}$, this criterion is met. 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 groundwater 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.

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| Subject: | 100-D-78 Waste Site 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-78 waste site.**

| Contaminants of Potential Concern[a] | Maximum or Statistical Value[a] (mg/kg) | Noncarcinogen RAG[b] (mg/kg) | Hazard Quotient | Carcinogen RAG[b] (mg/kg) | Carcinogen Risk |
|---|---|---|---|---|---|
| ***Metals*** | | | | | |
| Boron | 3.3 | 320 | 1.0E-02 | -- | -- |
| Chromium, hexavalent | 0.383 | 4.8 | 8.0E-02 | -- | -- |
| ***Anions*** | | | | | |
| Nitrogen in nitrate and nitrite | 79.3 | 1,000 | 7.9E-02 | -- | -- |
| Nitrogen in nitrite | 1.8 | 100 | 1.8E-02 | -- | -- |
| ***Totals*** | | | | | |
| **Cumulative Hazard Quotient:** | | | **1.7E-01** | | |
| **Cumulative Excess Cancer Risk:** | | | | | **0.0E+00** |

Notes:
[a] = From WCH (2013).
[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:

This calculation demonstrates that the 100-D-78 waste site meets the requirements for the hazard quotients and excess carcinogenic risk for protection of groundwater as identified in the RDR/RAWP (DOE-RL 2009).

# APPENDIX C

# DATA QUALITY ASSESSMENT

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# DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the confirmatory and verification sampling approaches and resulting analytical data with the sampling and data requirements specified in the site-specific sample designs (WCH 2008b, 2012). This DQA was performed in accordance with site-specific data quality objectives found in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2009).

A review of the sample designs (WCH 2008b, 2012), field logbooks (WCH 2008a, 2013), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design, with the exception of several confirmatory test pits in stained soil areas 1 and 2. Due to field observations at stained soil areas 1 and 2, it was determined that these areas would require remediation prior to collecting all the confirmatory samples. Since the confirmatory sample locations that were not sampled were later remediated, there is no deficiency in the confirmatory sample collection.

To ensure quality data, the SAP data assurance requirements and the data validation procedures for chemical analysis and radiochemical analysis (BHI 2000a, 2000b) 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).

## CONFIRMATORY SAMPLING

Confirmatory sample data collected at the 100-D-78 waste site were provided by the laboratories in sample delivery groups (SDGs) J00194, J00195, J00196, K1334, K1336, K1337, K1338, K1341, and 08-A-4854. Major and minor deficiencies are discussed for the 100-D-78 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

EPA Method 300 holding times for nitrate, nitrite, and phosphate were exceeded by more than twice the acceptable range on all samples. All undetected nitrate, nitrite, and phosphate results from EPA Method 300 were qualified as rejected with "R" flags. EPA Method 300 is primarily used to obtain verification data for the COPC sulfate. The holding time issue was anticipated and in order to obtain acceptable nitrate and nitrite data EPA Method 353.2 was also run. Phosphate is not a regulated compound. The rejected data is effectively replaced by the EPA Method 353.2 data. The data are useable for decision-making purposes.

**J00194**

This SDG is comprised of one focused sample (J17FM4) of mortar (other solid) collected during confirmatory sampling of the 100-D-78 test pit 2E on September 11, 2008. The sample was analyzed for hexavalent chromium only. During analysis, a white precipitate formed in the sample. Due to matrix interference, the sample was not able to be analyzed and no data was obtained or reported by the laboratory.

**J00195**

This SDG is comprised of one focused sample (J17FM5) of mortar (other solid) collected during confirmatory sampling of the 100-D-78 test pit 2C on September 15, 2008. The sample was analyzed for hexavalent chromium only. During analysis, a white precipitate formed in the sample. Due to matrix interference, the sample was not able to be analyzed and no data was obtained or reported by the laboratory.

## MINOR DEFICIENCIES

**SDG J00196**

This SDG is comprised of one water sample (J17J49) collected during confirmatory sampling of the 100-D-78 test pit 1B on September 17, 2008. The sample was analyzed for hexavalent chromium only.

In the hexavalent chromium analysis, the matrix spike (MS) (5%) and matrix spike duplicate (MSD) (18%) recoveries were outside of quality control (QC) limits. The laboratory report noted that there was no change in color of the MS/MSD when the colorizing agent for the analysis was added, indicating that the media was a reducing environment. Although not qualified for the MS/MSD recoveries outside of QC limits, the associated analyte results may be considered estimated. Estimated data are usable for decision-making purposes.

**SDG K1334**

This SDG is comprised of one focused sample (J17J49) of mortar (other solid) collected during confirmatory sampling of the 100-D-78 test pit 2E on September 11, 2008. The sample was analyzed for inductively coupled plasma (ICP) metals and mercury.

In the ICP metals analysis, calcium, iron, nickel, and lead were detected in the method blank (MB) at less than twice the method detection limit (MDL). Manganese and sodium were detected in the MB at less than 15 times the MDL. Method blank contamination at this concentration does not significantly impact the sample data. The data are usable for decision-making purposes.

In the ICP metals analysis, MS recoveries were outside of project acceptance criteria for silicon (18.1%). Although not qualified for MS recovery outside of QC limits, all silicon results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory control sample (LCS) recovery was outside of QC limits for silicon (9.5%). Although not qualified for LCS recovery outside of QC limits, all silicon results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the relative percent difference (RPD) calculation from the laboratory duplicate analysis was above QC limits for calcium (100.3%), chromium (165.2%), copper (94.6%), iron (85.0%), potassium (36.2%), magnesium (52.9%), manganese (88.3%), nickel (124.5%), lead (37.5%), vanadium (50.0%), and zinc (31.1%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for an RPD outside of QC limits, all subject results may be considered estimated. Estimated data are usable for decision-making purposes.

**SDG K1335**

This SDG is composed of eight focused soil samples (J17FK0 through J17FK7) collected during confirmatory sampling of the 100-D-78 test pits 2C, 2D, and 2E on September 11, 2008. This SDG includes a field duplicate pair (J1RFK2/J1RFK3). All samples were analyzed for ICP metals, mercury, hexavalent chromium, IC anions, and pH. In addition, one equipment blank (J17FJ9) was analyzed for ICP metals, mercury, hexavalent chromium, IC anions, nitrate/nitrite as nitrogen, and pH.

In the IC anions analysis, holding times were exceeded by more than twice the specified holding time for nitrate, nitrite, phosphate, and pH. The nondetected results for these analytes are discussed above in the Major Deficiencies section and were qualified as rejected with an "R" flag. Although not qualified for a holding time exceedance, all detected nitrate, nitrite, and phosphate results may be considered estimated. Estimated data are usable for decision-making purposes.

In the IC anions analysis, sulfate detected in the MB at less than twice the MDL. Method blank contamination at this concentration does not significantly impact the sample data. The data are usable for decision-making purposes.

In the ICP metals analysis, calcium, chromium, manganese, and zinc were detected in the MB at less than three times the MDL. Aluminum and sodium were detected in the MB at less than 10 times the MDL. Method blank contamination at this concentration does not significantly impact the sample data. The data are usable for decision-making purposes.

In the ICP metals analysis, MS recoveries were outside of project acceptance criteria for aluminum (899.9%), antimony (43.1%), iron (678.3%), manganese (130.2%), and silicon (-8.7%). 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 analytical variability of the native concentration rather than a measure of the recovery from the sample. Antimony and silicon did not have mismatched spike and native concentrations in the original MS. To confirm quantitation, a post-digestion spike (PDS) and serial dilution were performed for aluminum, antimony, iron, manganese, and silicon. All PDS recoveries were within QC limits. Although not qualified for MS recovery outside of QC limits, all aluminum, antimony, iron, manganese, and silicon results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery was outside of QC limits for silicon (13.9%). Although not qualified for LCS recovery outside of QC limits, all silicon results may be considered estimated. Estimated data are usable for decision-making purposes.

**SDG K1337**

This SDG is comprised of one focused sample (J17FN5) of mortar (other solid) collected during confirmatory sampling of the 100-D-78 test pit 2C on September 15, 2008. The sample was analyzed for ICP metals and mercury.

In the ICP metals analysis, barium, calcium, copper, iron, magnesium, nickel, and zinc were detected in the MB at less than four times the MDL. Sodium was detected in the MB at less than 10 times the MDL. Method blank contamination at this concentration does not significantly impact the sample data. The data are usable for decision-making purposes.

In the ICP metals analysis, MS recoveries were outside of project acceptance criteria for aluminum (203.0%), barium (59.2%), iron (650.1%), and silicon (42.7%). For aluminum and iron, 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 analytical variability of the native concentration rather than a measure of the recovery from the sample. Barium and silicon did not have mismatched spike and native concentrations in the original MS. To confirm quantitation, a PDS and serial dilution were performed for aluminum, barium, iron, and silicon. All PDS recoveries were within QC limits. Although not qualified for MS recovery outside of QC limits, all aluminum, barium, iron, and silicon results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery was outside of QC limits for silicon (37.2%). Although not qualified for LCS recovery outside of QC limits, all silicon results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the RPD calculation for from the laboratory duplicate analysis was above QC limits for cobalt (36.1%), copper (35.9%), and potassium (30.2%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for an RPD outside of QC limits, all cobalt, copper, and potassium results may be considered estimated. Estimated data are usable for decision-making purposes.

**SDG K1338**

This SDG is composed of eight focused soil samples (J17FL3, J17FK8, J17HM2 through J17HM4, J17FK9, J17FL0, and J17FL1M) collected during confirmatory sampling of the 100-D-78 test pits 1B, 2C, soil stain 3 and soil stain 4 on September 15, 2008. All samples were analyzed for ICP metals, mercury, hexavalent chromium, IC anions, nitrate/nitrite as nitrogen, and pH.

In the IC anions analysis, holding times were exceeded by more than twice the specified holding time for nitrate, nitrite, phosphate, and pH. The nondetected results for these analytes are discussed above in the Major Deficiencies section and were qualified as rejected with an "R" flag. Although not qualified for a holding time exceedance, all pH and detected nitrate, nitrite, and phosphate results may be considered estimated. Estimated data are usable for decision-making purposes.

In the IC anions analysis, sulfate was detected in the MB at less than twice the MDL. Method blank contamination at this concentration does not significantly impact the sample data. The data are usable for decision-making purposes.

In the ICP metals analysis, barium, calcium, copper, iron, magnesium, nickel, and zinc were detected in the MB at less than four times the MDL. Sodium was detected in the MB at less than 10 times the MDL. Method blank contamination at this concentration does not significantly impact the sample data. The data are usable for decision-making purposes.

In the ICP metals analysis, MS recoveries were outside of project acceptance criteria for aluminum (624.1%), antimony (58.6%), calcium (209.2%), iron (3,029%), manganese (131.6%), and silicon (360.8%). For aluminum, calcium, 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 analytical variability of the native concentration rather than a measure of the recovery from the sample. Antimony and silicon did not have mismatched spike and native concentrations in the original MS. To confirm quantitation, a PDS and serial dilution were performed for aluminum, antimony, calcium, iron, manganese, and silicon. All PDS recoveries were within QC limits. Although not qualified for MS recovery outside of QC limits, all aluminum, antimony, calcium, iron, manganese, and silicon results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery was outside of QC limits for silicon (37.2%). Although not qualified for LCS recovery outside of QC limits, all silicon results may be considered estimated. Estimated data are usable for decision-making purposes.

In the mercury analysis, the RPD calculation for from the laboratory duplicate analysis was above QC limits at 141.6%. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for an RPD outside of QC limits, all mercury results may be considered estimated. Estimated data are usable for decision-making purposes.

**SDG K1341**

This SDG is comprised of one water sample (J17J48) collected during confirmatory sampling of the 100-D-78 test pit 1B on September 17, 2008. The sample was analyzed for ICP metals, mercury, IC anions, nitrate/nitrite as nitrogen,, sulfide, polychlorinated biphenyls, volatile organic compounds, semi-volatile organic compounds (SVOC), pesticides, herbicides, gamma energy analysis, and pH.

In the IC anions analysis, holding times were exceeded by more than twice the specified holding time for nitrate, nitrite, phosphate, and pH. The nondetected results for these analytes are discussed above in the Major Deficiencies section and were qualified as rejected with an "R" flag. Although not qualified for a holding time exceedance, all pH and detected nitrate, nitrite, and phosphate results may be considered estimated. Estimated data are usable for decision-making purposes.

In the IC anions analysis, the MS recovery was outside of QC limits for phosphate at 66.6%. Although not qualified for MS recovery outside of QC limits, all phosphate results may be considered estimated. Estimated data are usable for decision-making purposes.

In the IC anion analysis, the RPD calculation for from the laboratory duplicate analysis was above QC limits for sulfate (37.3%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for an RPD outside of QC limits, all sulfate results may be considered estimated. Estimated data are usable for decision-making purposes.

In the nitrate/nitrite as nitrogen analysis, the MS recovery was outside of QC limits at 61.8%. Although not qualified for MS recovery outside of QC limits, all nitrite/nitrate as nitrogen results may be considered estimated. Estimated data are usable for decision-making purposes.

In the SVOC analysis, the MS/MSD recoveries were outside of QC limits for 1,3-dichlorobenzene (39% [MS only]), 1,4-dichlorobenzene (39% [MS only]), 1,2-dichlorobenzene (42% [MS only]), hexachloroethane (38% [MS only]), 1,2,4-trichlorobenzene (43% [MS only]), naphthalene (49% [MSD only]), 4-chloroaniline (1% and 8%), hexachlorobutadiene (42% [MS only]), hexachlorocyclopentadiene (31% and 41%), 3-nitroaniline (3% and 6%), 4-nitroaniline (29% and 30%), and 3,3'-dichlorobenzidine (0% and 3%). Although not qualified for MS/MSD recoveries outside of QC limits, all subject results may be considered estimated. Estimated data are usable for decision-making purposes.

In the pesticides analysis, the MS/MSD recoveries were not quantified for beta-BHC due to matrix interference. The MSD recovery was outside of QC limits for heptachlor (163%). Although not qualified for MS/MSD recoveries outside of QC limits, the heptachlor and beta-BHC results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, barium, copper, manganese, and sodium were detected in the MB at less than three times the MDL. Method blank contamination at this concentration does not significantly impact the sample data. The data are usable for decision-making purposes.

In the ICP metals analysis, MS recoveries were outside of QC criteria for aluminum (492.9%), barium (10.2%), iron (-310%), manganese (32.8%), and silicon (1,100%). For aluminum, iron, manganese, and silicon, 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 analytical variability of the native concentration rather than a measure of the recovery from the sample. Barium did not have mismatched spike and native concentrations in the original MS. To confirm quantitation, a PDS and serial dilution were performed for aluminum, barium, iron, manganese, and silicon. All PDS recoveries were within QC limits. Although not qualified for MS recovery outside of QC limits, all aluminum, barium, iron, manganese, and silicon results may be considered estimated. Estimated data are usable for decision-making purposes.

**SDG 08-A-4854**

This SDG is comprised of one focused soil sample (J17HR3) from the 100-D-78 test pit 2E collected on September 11, 2008. No minor deficiencies were found in SDG 08-A-4854. The data are useable for decision making purposes.

## VERIFICATION SAMPLING

Verification sample data collected at the 100-D-78 waste site were provided by the laboratories in SDGs J01669 and JP0514. SDG J01669 was submitted for third-party validation. Major and minor deficiencies are discussed for the 100-D-78 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

In the IC anions analysis, the holding times for nitrate, nitrite, and orthophosphate were exceeded by more than twice the acceptable range on all samples. All undetected nitrate, nitrite, and orthophosphate results were qualified as rejected with "R" flags.

## MINOR DEFICIENCIES

**SDG J01725**

This SDG is composed of 13 statistical soil samples (J1R681 through J1R693) collected during verification sampling of the 100-D-78 excavation area on January 16, 2013. This SDG includes a field duplicate pair (J1R684/J1R693). All samples were analyzed for ICP metals, mercury,

hexavalent chromium, IC anions, nitrate/nitrite, and pH. In addition, one equipment blank (J1R694) was analyzed for ICP metals and mercury. SDG J01725 was submitted for third-party validation.

In the IC anions analysis, holding times were exceeded by more than twice the specified holding time for nitrate, nitrite, orthophosphate, and pH. The nondetected results for these analytes are discussed above in the Major Deficiencies section and were qualified as rejected with an "R" flag. All detected nitrate, nitrite, orthophosphate, and pH results were qualified as estimates with a "J" flag. Estimated data are usable for decision-making purposes.

In the IC anions analysis, the MS recoveries were outside of QC criteria for orthophosphate (56%) and fluoride (61%). All orthophosphate and fluoride results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, MS recoveries were outside of project acceptance criteria for aluminum (1,284%), antimony (60%), calcium (140%), iron (2,969%), manganese (245%), silicon (16%), and silver (68%). For aluminum, calcium, 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 analytical variability of the native concentration rather than a measure of the recovery from the sample. Antimony, silicon, and silver did not have mismatched spike and native concentrations in the original MS. All antimony, calcium, silicon, and silver data were qualified as estimates and flagged "J" by third-party validation due to the MS recoveries outside the QC limits. Although not qualified for MS recovery outside of QC limits, all aluminum, iron, and manganese results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery was outside of QC limits for silicon (15%). All silicon results were considered estimates and flagged "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, zinc was detected in the MB at less than twice the MDL. The zinc result in sample J1R694 (equipment blank) was qualified as undetected and flagged "UJ" by third-party validation. Barium was also detected in the MB at less than twice the MDL. Method blank contamination at this concentration does not significantly impact the sample data. The data are usable for decision-making purposes.

In the hexavalent chromium analysis, the RPD calculation for hexavalent chromium (39.3%) from the laboratory duplicate analysis was above QC limits. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for an RPD outside of QC limits, all hexavalent chromium results may be considered estimated. Estimated data are usable for decision-making purposes.

**SDG JP0514**

This SDG is composed of 13 statistical soil samples (J1R695 through J1R699 and J156C0 through J1R6C7) collected during verification sampling of the 100-D-78 staging pile area on April 1, 2013. This SDG includes a field duplicate pair (J1R695/J1R6C7). All samples were analyzed for ICP metals, mercury, hexavalent chromium, IC anions, nitrate/nitrite, and pH. In addition, one equipment blank (J1R6C8) was analyzed for ICP metals and mercury.

In the IC anions analysis, holding times were exceeded by more than twice the specified holding time for nitrate, nitrite, and orthophosphate. The nondetected results for these analytes are discussed above in the Major Deficiencies section and were qualified as rejected with an "R" flag. Although not qualified for a holding time exceedance, all pH and detected nitrate, nitrite, and orthophosphate results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, MS recoveries were outside of project acceptance criteria for aluminum (1,024%), antimony (49%), iron (1,247%), manganese (135%), and silicon (-11%). 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 analytical variability of the native concentration rather than a measure of the recovery from the sample. Antimony and silicon did not have mismatched spike and native concentrations in the original MS. Although not qualified for MS recovery outside of QC limits, all associated analyte results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery was outside of QC limits for silicon (16%). All silicon results were considered estimates and flagged "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, chromium was detected in the MB at less than twice the MDL. Method blank contamination at this concentration does not significantly impact the sample data. The 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 2008a, 2013), are shown in Table C-1. The main and QA/QC sample results are presented in Appendix B.

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

| Sample Area | Main Sample | Duplicate Sample |
|---|---|---|
| Confirmatory Sampling | | |
| 2E | J17FK2 | J17FK3 |
| Verification Sampling | | |
| 78D-4 | J1R684 | J1R693 |
| SPA-1 | J1R695 | J1R6C7 |

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 (COPC). 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 (TDL). 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 B provides details on duplicate pair evaluation and RPD calculation.

The calculated RPDs for the field QA/QC duplicate samples were within the acceptance criteria of 30%, with the exception of sulfate (46.5%) from the confirmatory sampling at 2E and silicon (34.9%) from the verification sampling at the staging pile area. Elevated RPDs in the analysis of environmental soil samples are largely attributed to heterogeneities in the soil matrix and only in small part attributed to precision and accuracy issues at the laboratory. 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 TDL, including undetected analytes. In these cases, a control limit of ±2 times the TDL is used (Appendix B) to indicate that a visual check of the data is required by the reviewer. No sample results 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-78 waste site 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-78 waste site 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 Environmental Restoration 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 B.

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