Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

14-AMRP-0072

DEC 17 2013

Ms. J. A. Hedges, Program Manager
Nuclear Waste Program
State of Washington
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

Dear Ms. Hedges:

TRANSMITTAL OF APPROVED WASTE SITE RECLASSIFICATION FORM AND SUPPORTING DOCUMENTATION FOR THE 600-381, SEGMENT 4 UNDERGROUND STRUCTURE WITH WOODEN AIR VENTS FEATURE WASTE SITE, REVISION 0

Attached for your use is the approved Waste Site Reclassification Form No. 2013-116, and supporting "Remaining Sites Verification Package for the 600-381, Segment 4 Underground Structure with Wooden Air Vents Feature Waste Site," Rev. 0. If you have questions, please contact me or your staff may contact Ellwood Glossbrenner, of my staff, at (509) 376-5828.

Sincerely,

Mark S. French, Federal Project Director
for the River Corridor Division

AMRP:TCP

Attachment

cc w/attach:
N. M. Menard, Ecology
Administrative Record, H6-08

cc w/o attach:
R. D. Cantwell, WCH
S. L. Feaster, WCH
T. Q. Howell, WCH
D. L. Plung, WCH
J. P. Shearer, CHPRC

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-HR-2 **Control No.:** 2013-116

Waste Site Code(s)/Subsite Code(s): 600-381

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 600-381, Segment 4 Underground Structure with Wooden Air Vents Feature waste site, part of the 100-HR-2 Operable Unit, consisted of two wooden air vents protruding from the ground surface. The 600-381 waste site is located approximately 0.8 km (0.5 mi) south of the Columbia River and 1.3 km (0.8 mi) west of Hadley Loop.

The 600-381 waste site is not included in any record of decision (ROD) or explanation of significant differences. It was added to the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD) (EPA 1999) as a candidate site for confirmatory sampling by a Tri-Party Agreement Administrative Record Fact Sheet for the 100 Area per the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington* (EPA 2009).

Confirmatory sampling of the 600-381 waste site was performed on June 28, 2013. The selected remedy involved (1) evaluating the site using available process information, (2) demonstrating through confirmatory sampling that cleanup goals have been achieved, and (3) proposing the site for reclassification to Interim No Action.

Basis for reclassification:

In accordance with this evaluation, the confirmatory sampling results support a reclassification of the 600-381 waste site to Interim No Action. The current site conditions achieve the remedial action goals established by the Remaining Sites ROD (EPA 1999). The results of confirmatory sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. No contaminants of potential concern were found to exceed direct exposure remedial action goals in shallow zone soils and contamination is likewise concluded not to exist in deep zone soils. Therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone soil are not required. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 600-381, Segment 4 Underground Structure with Wooden Air Vents Feature Waste Site* (attached).

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-HR-2 **Control No.:** 2013-116

Waste Site Code(s)/Subsite Code(s): 600-381

Regulator comments:

Waste Site Controls:

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

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

J. P. Neath	JP Neath	11/21/13
DOE Federal Project Director (printed)	Signature	Date
N. Menard	Alicia J Boyd	12/3/13
Ecology Project Manager (printed)	Signature	Date
NA		
EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 600-381, SEGMENT 4 UNDERGROUND STRUCTURE WITH WOODEN AIR VENTS FEATURE WASTE SITE

Attachment to Waste Site Reclassification Form 2013-116

December 2013

REMAINING SITES VERIFICATION PACKAGE FOR THE 600-381, SEGMENT 4 UNDERGROUND STRUCTURE WITH WOODEN AIR VENTS FEATURE WASTE SITE

EXECUTIVE SUMMARY

The 600-381, Segment 4 Underground Structure with Wooden Air Vents Feature waste site, part of the 100-HR-2 Operable Unit, consisted of two wooden air vents covered with screening protruding from the ground surface. The 600-381 waste site is located approximately 0.8 km (0.5 mi) south of the Columbia River and 1.3 km (0.8 mi) west of Hadley Loop.

Confirmatory sampling at the 600-381 waste site was conducted on June 28, 2013. The results indicated that the waste site achieved compliance with the remedial action objectives (RAOs) and remedial action goals (RAGs); therefore, remediation was not necessary. A summary of the evaluation for the soil results against the applicable criteria is presented in Table ES-1. The results of the confirmatory sampling are used to make reclassification decisions for the 600-381 waste site in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2011).

Table ES-1. Summary of Remedial Action Goals for the 600-381 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 were not COPCs for the 600-381 waste 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	The hazard quotients for individual nonradionuclide COPCs are <1.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogens	The cumulative hazard quotient for all sampling areas (1.3×10^{-3}) is <1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens	The excess cancer risk is $<1 \times 10^{-6}$, and thus is $<1 \times 10^{-6}$	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens	The total excess cancer risk is 1.5×10^{-7}, and thus is $<1 \times 10^{-5}$.	

Table ES-1. Summary of Remedial Action Goals for the 600-381 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 were not COPCs for the 600-381 waste site.	NA
	Attain national primary drinking water standards [a]: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs		
	Meet drinking water standards for alpha emitters: the most stringent of 15 pCi/L MCL or 1/25th of the derived concentration guides from DOE Order 5400.5 [b]		
	Meet total uranium standard of 30 µg/L (21.2 pCi/L) [c].		
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements	Residual concentrations of benzo(a)pyrene within the 600-381 waste site are above the soil RAGs for groundwater and/or river protection. However, RESRAD modeling predicts that benzo(a)pyrene will not reach groundwater (and, therefore, the Columbia River) within 1,000 years [d].	Yes

[a] "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).
[b] *Radiation Protection of the Public and the Environment* (DOE Order 5400.5).
[c] Based on the isotopic distribution of uranium in the 100 Area, the 30 µg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* (BHI 2001).
[d] Based on the RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), residual concentrations of benzo(a)pyrene are not expected to migrate vertically in 1,000 years (based on the distribution coefficient of 5,500 mL/g). The vadose zone underlying the soil below the 600-381 waste site is a minimum of 6.6 m (21.7 ft) thick. Therefore, residual concentrations of benzo(a)pyrene are predicted to be protective of groundwater and the Columbia River.

COPC = contaminant of potential concern
DOE = U.S. Department of Energy
MCL = maximum contaminant level
NA = not applicable
RAG = remedial action goal
RDR/RAWP= Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity (dose model)

In accordance with this evaluation, the confirmatory sampling results support a reclassification of this site to Interim No Action. The current site conditions achieve the remedial action objectives and the corresponding RAGs established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2009) and the *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 contaminant levels remaining in the soil are protective of groundwater and the Columbia River. The 600-381 waste site contaminants of potential concern did not exceed direct exposure RAGs in shallow zone soils, and contamination is likewise concluded not to exist in 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 ecological screening levels in the 2007 *Washington Administrative Code* 173-340, "Model Toxics Control Act – Cleanup," Table 749-3, were boron and vanadium. The U.S. Environmental Protection Agency ecological soil screening levels were exceeded for antimony, cadmium, manganese, vanadium, and zinc. Exceeding screening values does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of antimony, cadmium, manganese, 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 600-381 waste site that exceed ecological screening levels is provided in Appendix A.

REMAINING SITES VERIFICATION PACKAGE FOR THE 600-381, SEGMENT 4 UNDERGROUND STRUCTURE WITH WOODEN AIR VENTS FEATURE WASTE SITE

STATEMENT OF PROTECTIVENESS

The 600-381, Segment 4 Underground Structure with Wooden Air Vents Feature waste site confirmatory sampling data, site evaluations, and supporting documentation demonstrate that this site meets the objectives established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 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. No contaminants of potential concern (COPCs) were found to exceed direct exposure remedial action goals in shallow zone soils and contamination is likewise concluded not to exist in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the ROD, a comparison against ecological risk screening levels has been made for the site contaminants of potential concern and other constituents. Those constituents exceeding ecological screening levels in the 2007 *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup," Table 749-3, were boron and vanadium. The U.S. Environmental Protection Agency (EPA) ecological soil screening levels were exceeded for antimony, cadmium, manganese, vanadium, and zinc. Exceeding screening values does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of antimony, cadmium, manganese, 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 600-381 waste site that exceed ecological screening levels is provided in Appendix A.

GENERAL SITE INFORMATION AND BACKGROUND

The 600-381, Segment 4 Underground Structure with Wooden Vents Feature waste site, part of the 100-HR-2 Operable Unit, consisted of two wooden air vents covered with screening and protruding from the ground.

The site is located 0.8 km (0.5 mi) south of the Columbia River and 1.3 km (0.8 mi) west of Hadley Loop (also known as the 100-H Area perimeter road) (Figure 1). The approximate midpoint of the waste site is located at Washington State Plane (WSP) coordinates N 153561.3, E 575924.6. A photograph of the site is presented in Figure 2.

There is no process history associated with the 600-381 waste site. The site was discovered on November 1, 2010, during the 100-F/IU-2/IU-6 Area – Segment 4 Orphan Sites Evaluation (OSE) (WCH 2010). The site was assigned the OSE-ID: SG4DH-225 (WCH 2011a).

Based on historical aerial photographs, the waste site is in a general location previously used by the military. Aerial photographs of the area from 1943 and 1948 (Figures 3 and 4, respectively) show the area as being undisturbed. An aerial photograph from 1957 (Figure 5) shows surface disturbances consistent with the suspected army activity. No other records of military activity in this area are available. The 600-381 waste site is located within 100 m (328 ft) of a known historical farm boundary.

A geophysical survey was performed at the 600-381 waste site location in October 2011 for general characterization and delineations of the site (WCH 2011b). The geophysical investigation results did not indicate that a void space or structure was present beneath the air vents. A near surface anomaly was detected at approximately 2 m (6.6 ft) south of the air vents at a depth of 0.2 m (0.7 ft) below ground surface at WSP coordinates N 153563.0, E 575918.5. The results of the investigation suggested that the size of the geophysical anomaly was less than the size of a 208-L (55-gal) drum.

Ecological and Cultural

An ecological and cultural resources review was performed for the 600-381 waste site in March 2013 (WCH 2013b). The waste site is located approximately 118 m (387 ft) west of a gravel road. The vegetation primarily observed around this site consists of gray rabbitbrush, cheatgrass, tall tumblemustard, and diffuse knapweed. Existing roads were used as much as possible when accessing the site to reduce the spread of noxious weeds and minimize impacts to existing vegetation. Nesting birds such as killdeer and nighthawks sometimes use these heavily disturbed areas for nesting; and workers were advised to watch for nesting activity. No nests or nesting activity were observed during confirmatory sampling.

No archaeological sites were known or expected to exist in the 100-H Area near the 600-381 waste site. All workers were directed to watch for cultural materials (e.g., bones, stone tools, mussel shells, cans, bottles, Hanford era artifacts) during all work activities. No ecologically- or culturally-significant materials were encountered during confirmatory sampling.

Figure 1. The 600-381 Waste Site Location Map.

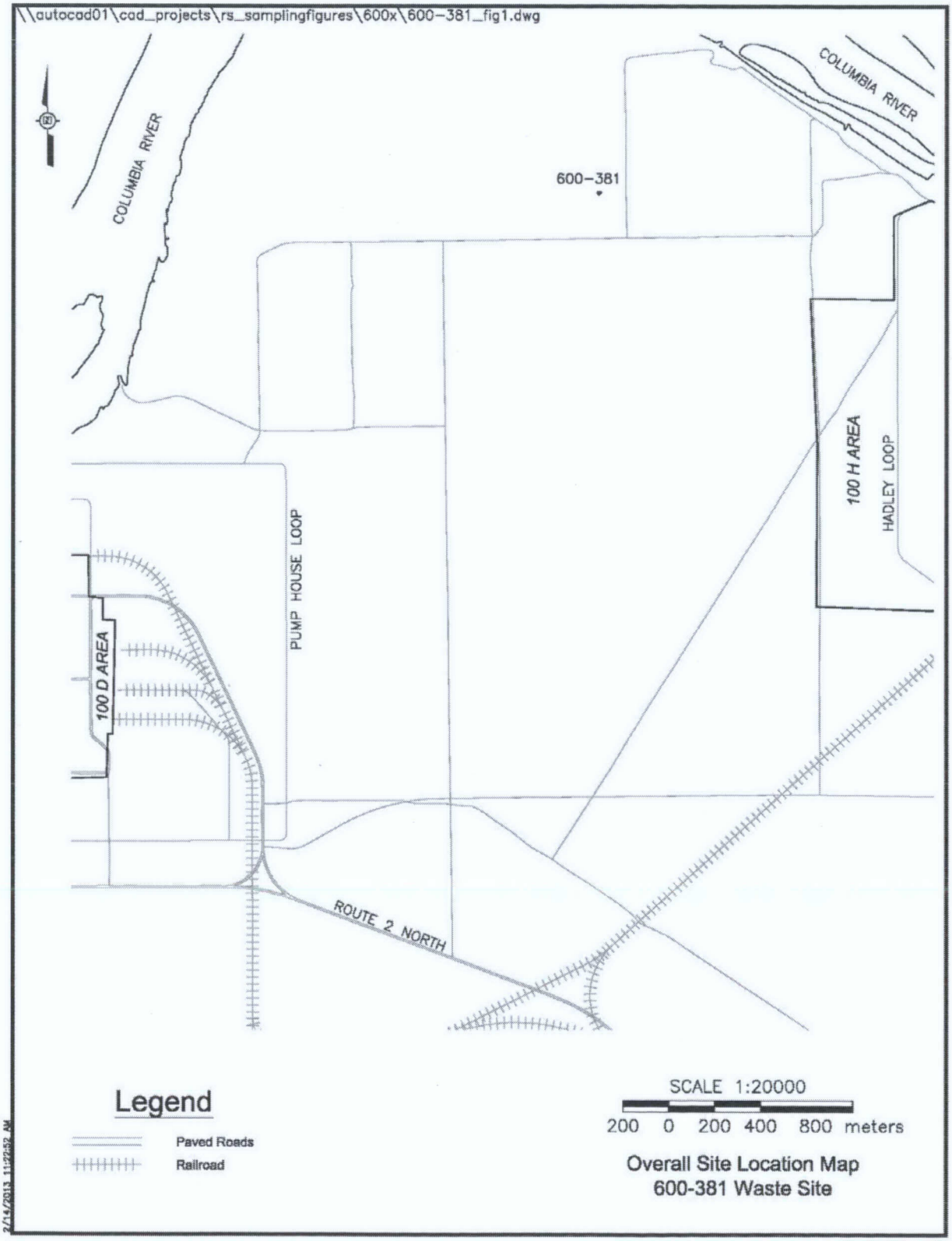


Figure 2. Photograph of the 600-381 Waste Site.

Figure 3. 1943 Historical Photograph Showing Location of the 600-381 Waste Site.

Figure 4. 1948 Historical Photograph Showing Location of the 600-381 Waste Site.

Figure 5. 1957 Historical Photograph Showing Suspected Military Activity and the Location of the 600-381 Waste Site.

CONFIRMATORY SAMPLING SUMMARY

Confirmatory sampling was performed at the 600-381 waste site on June 28, 2013. Excavation of test pit 1 began at the vent structure that was visible at ground surface. The vent structure did not extend more than 15 cm (6 in.) below ground surface (bgs). One discrete sample (J1RNL8) and a duplicate (J1RNM3) was collected from the soils directly below the vent structure.

The excavation of test pit 1 continued until a pipeline was encountered. The pipeline end was visible at 0.6 m (2 ft) below grade trending south towards the test pit 2 location. Due to the close proximity of the test pit 2 location and the excavation layback of test pit 1, the encountered pipeline was deferred for further investigation with test pit 2.

The excavation of test pit 1 continued to the planned depth of 1.2 m (4 ft) bgs (3 ft below sample J1RNL8), and one discrete soil sample (J1RNL9) was collected at this depth. Inert debris, including wood and large cobbles, was observed during the excavation of test pit 1 (Figure 6). The excavation of test pit 1 was expanded to the southwest to follow and observe the nature of debris. An additional 0.6 m (2 ft) of soil and debris was excavated from the bottom of the test pit 1 excavation.

Test pit 2 was focused to investigate an apparent metallic structure that was noted by the geophysical investigation survey. However, no metallic structure other than a pipeline was found at the test pit 2 location. This is the same pipeline that was observed during the excavation of test pit 1. The pipeline was approximately 1.5 m (5 ft) in length and was made of thin, aluminum metal (Figure 7). A ferrous-metallic "elbow" was found attached to the end of the aluminum pipe at the location of the indicated geophysical anomaly (Figure 8), at an approximate depth of 0.3 (1 ft) bgs. The pipeline was pulled from the excavation to the surface for observation. This pipeline was free of contents and did not have any sediment for sampling. One discrete sample (J1RNM1) was collected from the test pit 2 excavation of the soil underlying the pipeline. The test pit 2 was excavated to an approximate depth of 0.6 m (2 ft) bgs. An equipment blank sample (J1RNM4) was also collected.

No hazardous or anomalous debris was discovered during excavation of test pits 1 and 2. Following the investigation of the 600-381 waste site and the collection of appropriate samples, the two test pits were backfilled with the materials that had been excavated. Table 1 identifies the locations and analyses for each confirmatory sample.

Figure 6. Photograph of the 600-381 Waste Site, Test Pit 1 Excavation.

Figure 7. Photograph of the Excavated Pipeline from the 600-381 Waste Site.

Table 1. 600-381 Sample Summary.

Sample Location	HEIS Sample Number	Washington State Plane		Sample Analysis
		Northing (m)	Easting (m)	
TP-1, soil approximately 15 cm (6 in.) below the vent structure	J1RNL8	153564.6	575918.6	ICP metals [a], mercury, hexavalent chromium, IC anions, nitrate/nitrite, PCB, PAH, SVOA, herbicides, pesticides, TPH
TP-1, soil approximately 1 m (3 ft) below the vent structure	J1RNL9	153564.6	575918.6	
TP-2, soil underlying pipeline	J1RNM1	153563.0	575918.5	
Duplicate of J1RNL8	J1RNM3	153564.6	575918.6	
Equipment blank	J1RNM4	NA	NA	ICP metals [a], mercury, SVOA

[a] The expanded list of ICP metals will include antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc in the analytical results package.

HEIS = Hanford Environmental Information System
IC = ion chromatography
ICP = inductively coupled plasma
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyl
SVOA = semivolatile organic analysis
TPH = total petroleum hydrocarbons

Contaminants of Concern for Confirmatory Sampling

The COPCs for the 600-381 waste site were unknown. Therefore, the COPC list included inductively coupled plasma (ICP) metals, mercury, hexavalent chromium, anions, polychlorinated biphenyls (PCBs), pesticides, semivolatile organic compounds, polycyclic aromatic hydrocarbons (PAH), and total petroleum hydrocarbons (TPH). The expanded list of ICP metals included antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc in the analytical results package.

No radiological activity or volatile organic compounds (VOCs) were detected in the field during confirmatory sampling; therefore, samples were not analyzed for radionuclides or VOCs. Suspect asbestos-containing material was not observed during field activities; therefore, asbestos analysis was not performed. Table 2 identifies the EPA-approved methods for the analyses performed for confirmatory sampling.

Table 2. Laboratory Analytical Methods for the 600-381 Waste Site. (2 Pages)

Analytical Method	Contaminants of Potential Concern
ICP metals [a] – EPA Method 6010	Metals
Mercury – EPA Method 7471	Mercury
Hexavalent chromium – EPA Method 7196	Hexavalent chromium
PCB – EPA Method 8082	Polychlorinated biphenyls
PAH [b] – EPA Method 8310	Polycyclic aromatic hydrocarbons
SVOA – EPA Method 8270	Semivolatile organic compounds

Table 2. Laboratory Analytical Methods for the 600-381 Waste Site. (2 Pages)

Analytical Method	Contaminants of Potential Concern
IC anions [c] – EPA Method 300.0	Anions
Nitrate/nitrite – EPA Method 353.2	Nitrate
Pesticides – EPA Method 8081	Pesticides
TPH – NWTPH-Dx	Total petroleum hydrocarbons

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

[b] Because EPA Method 8310 is specifically meant to analyze for PAH, data from this method was used preferentially over EPA Method 8270 data for site evaluation of the PAH analytes.

[c] The extended list of IC anions included bromide, chloride, fluoride, nitrate, nitrite, and phosphate was requested. To preclude holding time issues for nitrate and nitrite with EPA Method 300.0, EPA Method 353.2 was also performed.

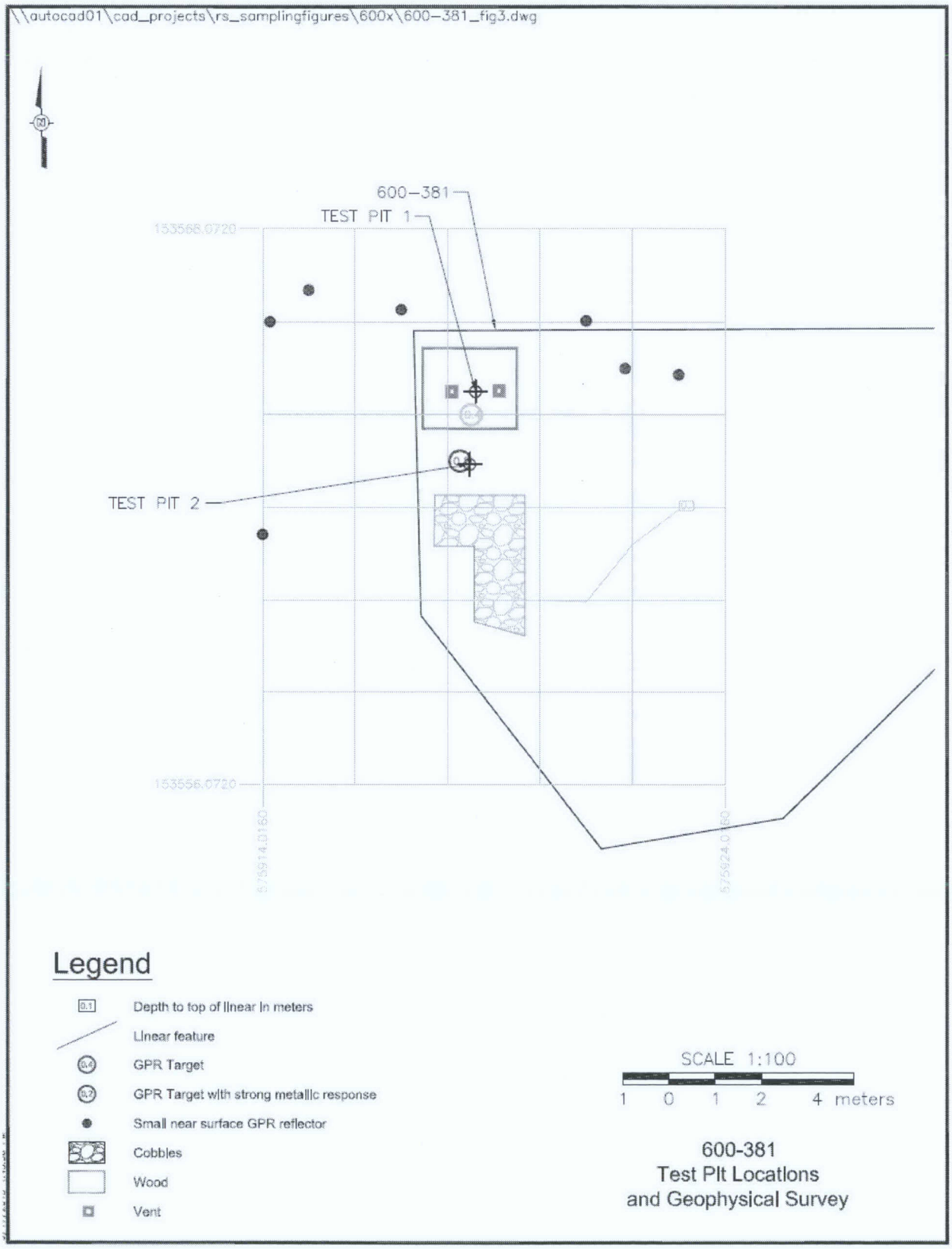
EPA = U.S. Environmental Protection Agency
IC = ion chromatography
ICP = inductively coupled plasma
NWTPH-Dx = Northwest total petroleum hydrocarbons-diesel range organics
PAH = polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyl
SVOA = semivolatile organic analysis
TPH = total petroleum hydrocarbons

Confirmatory Sampling Design

Confirmatory sampling was performed as described in the confirmatory sampling work instruction for 600-381 (WCH 2013c). Analytical sample results for the 600-381 waste site are evaluated against the cleanup criteria specified in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2009b) to support a No Action or Remedial Action decision. All sampling was performed in accordance with the 100 Area SAP (DOE-RL 2009a). Sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management*, consistent with the SAP requirements. Table 2 identifies the EPA-approved methods for the analyses performed for confirmatory sampling. Additional information related to confirmatory sampling can be found in the field sampling logbooks (WCH 2013a).

The locations of the surface vents and the subsurface geophysical anomaly at 600-381 required investigation. Since the depth of the features was unknown, a separate test pit was prescribed for each location. However, it was anticipated that the test pits might eventually overlap, depending on the depth of the features. Test Pit 1 was excavated at WSP coordinates N 153564.6, E 575918.6 at the location of the surface vents (WCH 2010). Test Pit 2 was excavated at WSP coordinates N 153563.0, E 575918.5 at the location of the subsurface geophysical anomaly (WCH 2011b). The test pit, surface features, and geophysical anomaly locations are presented in Figure 8.

Figure 8. 600-381 Confirmatory Sampling Locations and Geophysical Features.



Confirmatory Sampling Results

All confirmatory samples were analyzed using analytical methods approved by EPA (DOE-RL 2009b). Evaluation of the confirmatory data from the 600-381 waste site was performed by direct comparison of the maximum detected value for each COPC against cleanup criteria.

Comparisons of the results for site COPCs against the remedial action goals (RAGs) for the 600-381 waste site are presented in Table 3. Contaminants that were not detected by laboratory analysis are excluded from this table. 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, Volume I: Human Health Evaluation Manual (Part A)* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COPCs and are also not included in this table. The complete laboratory results are stored in a Washington Closure Hanford project-specific database prior to submitting to the Hanford Environmental Information System (HEIS) for archiving and are provided in Appendix B.

Table 3. Comparison of Contaminant Concentrations to Action Levels for the 600-381 Excavation Confirmatory Samples. (2 Pages)

COPC	Maximum Result [b] (mg/kg)	Remedial Action Goals (mg/kg) [a]			Does the Result Exceed RAGs?	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Antimony	1.1 (<BG)	32	5	5	No	--
Arsenic	3.8 (<BG)	20 [c]	20 [c]	20 [c]	No	--
Barium	91.9 (<BG)	5,600	200	400	No	--
Beryllium	0.036 (<BG)	10.4 [d]	1.51 [c]	1.51 [c]	No	--
Boron [e]	2.4	7,200	320	-- [f]	No	--
Cadmium	0.42 (<BG)	13.9 [d]	0.81 [c]	0.81 [c]	No	--
Chromium	13.0 (<BG)	80,000	18.5 [c]	18.5 [c]	No	--
Cobalt	7.6 (<BG)	24	15.7 [c]	-- [f]	No	--
Copper	14.5 (<BG)	2,960	59.2	22.0 [c]	No	--
Lead	7.6 (<BG)	353	10.2 [c]	10.2 [c]	No	--
Manganese	359 (<BG)	3,760	512 [c]	-- [f]	No	--
Molybdenum [e]	0.27	400	8	-- [f]	No	--
Nickel	13.4 (<BG)	1,600	19.1 [c]	27.4	No	--
Vanadium	42.2 (<BG)	560	85.1 [c]	-- [f]	No	--
Zinc	52.7 (<BG)	24,000	480	67.8 [c]	No	--
Chloride	3.5 (<BG)	--	25,000	-- [f]	No	--
Fluoride	1.0 (<BG)	4,800	96	400	No	--
Nitrogen in nitrate	14.1	128,000	1,000	2,000	No	--
Nitrogen in nitrite [e]	0.77	8,000	100	200	No	--
Nitrogen in nitrite and nitrate	17.3	128,000	1,000	2,000	No	--

Table 3. Comparison of Contaminant Concentrations to Action Levels for the 600-381 Excavation Confirmatory Samples. (2 Pages)

COPC	Maximum Result [b] (mg/kg)	Remedial Action Goals (mg/kg) [a]			Does the Result Exceed RAGs?	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Sulfate	20.2 (<BG)	--	25,000	-- [f]	No	--
TPH – diesel range extended	7.0	200	200	200	No	--
4-(2,4-Dichlorophenoxy) butanoic acid	0.013	640	12.8	-- [f]	No	--
Benzo(a)anthracene	0.0038	1.37	0.015 [g]	0.015 [g]	No	--
Benzo(a)pyrene	0.020	0.137	0.015 [g]	0.015 [g]	Yes	Yes [h]
Benzo(b)fluoranthene	0.0064	1.37	0.015 [g]	0.015 [g]	No	--
Benzo(ghi)perylene [i]	0.0099	2,400	48	192	No	--
Chrysene	0.014	13.7	0.12	0.1 [g]	No	--
Di-n-butylphthalate	0.052	8,000	160	540	No	--
Fluoranthene	0.015	3,200	64	18.0	No	--
Indeno(1,2,3-cd)pyrene (SVOA) [j]	0.025	1.37	0.33 [g]	0.33 [g]	No	--
Phenanthrene [i] (SVOA) [j]	0.034	24,000	240	4,200	No	--
Pyrene	0.019	2,400	48	192	No	--

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

[b] Maximum value as described in the *600-381 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations* (Appendix B).

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

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

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

[f] 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], Ecology 1996 [Method B for surface waters]).

[g] Where cleanup levels are less than RDLs, cleanup levels default to RDLs per WAC 173-340-707(2) (Ecology 1996). The cited RDLs are based on EPA-approved analytical methods that may not be available for rapid-turnaround analyses.

[h] Based on the RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), residual concentrations of benzo(a)pyrene are not expected to migrate vertically in 1,000 years (based on the distribution coefficient of 5,500 mL/g). The vadose zone underlying the soil below the 600-381 waste site is a minimum of 6.6 m (21.7 ft) thick. Therefore, residual concentrations of benzo(a)pyrene are predicted to be protective of groundwater and the Columbia River.

[i] Toxicity data for this chemical are not available. Cleanup levels are based on surrogate chemicals:
benzo(ghi)perylene; surrogate: pyrene
phenanthrene; surrogate: anthracene.

[j] Indeno(1,2,3-cd)pyrene and phenanthrene are detected by EPA Method 8270 and undetected by EPA Method 8310. Because EPA Method 8310 was used preferentially over EPA Method 8270, for polycyclic aromatic hydrocarbons, these constituents are excluded from *600-381 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations* (Appendix B).

-- = not applicable
BG = background
COPC = contaminant of potential concern
EPA = U.S. Environmental Protection Agency
RAG = remedial action goal
RDL = required detection limit
RDR/RAWP = Remedial Design Report/Remedial Action Work
RESRAD = RESidual RADioactivity (dose model)
SVOA = semivolatile organic analysis
TPH = total petroleum hydrocarbons
UCL = upper confidence limit
WAC = *Washington Administrative Code*

DATA EVALUATION

This section demonstrates that contaminant concentrations at the 600-381 waste site achieve the applicable RAGs developed to support unrestricted land use at the 100 Area as established in the Remaining Sites ROD (EPA 1999) and documented in the 100 Area RDR/RAWP (DOE-RL 2009b). Table 3 compares the confirmatory sample values to the applicable soil RAGs for direct exposure, protection of groundwater, and protection of the Columbia River.

Nonradionuclide Direct Contact Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 600-381 waste site was determined by calculation of the hazard quotient and excess carcinogenic risk values for direct contact (Appendix B). 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 1×10^{-6}, and a cumulative carcinogenic risk of less than 1×10^{-5}. For the 600-381 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 levels. The calculations indicate that all individual hazard quotients for noncarcinogenic constituents are less than 1.0. The cumulative hazard quotient for the 600-381 waste site is 1.3×10^{-3}. All individual cumulative carcinogenic risk values are less than 1×10^{-6}. The cumulative carcinogenic risk value is 1.5×10^{-7}. Therefore, nonradionuclide risk requirements are met.

Benzo(a)pyrene was quantified at concentrations exceeding soil RAGs for groundwater and river protection. Based on the soil-partitioning coefficient for benzo(a)pyrene (5,500 mL/g); no migration will occur vertically in 1,000 years, as discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b). The vadose zone underlying the 600-381 waste site is approximately 6.6 m (21.7 ft) thick; therefore, residual concentrations of benzo(a)pyrene are predicted to be protective of groundwater. The only pathway for contaminant migration to the Columbia River is via groundwater; therefore, residual concentrations of benzo(a)pyrene are also predicted to be protective of the Columbia River. All other confirmatory data values are less than the applicable RAGs.

Nonradionuclide Groundwater Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 600-381 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 1×10^{-6}, and a cumulative excess carcinogenic risk of less than 1×10^{-5}. These risk values were conservatively calculated for the entire waste site using the highest value for each COPC from each of the decision units. Risk values were calculated for constituents that were detected at concentrations above Hanford Site or Washington State background values or for which there is no background value. In addition, the K_d values for these contaminants are less than that necessary to show no migration to groundwater in 1,000 years based on RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b). Based on this model and a vadose zone of approximately 6.6 m (21.7 ft) in thickness at the excavation, a K_d of 12 or greater is required to

show no predicted migration to groundwater within 1,000 years. All individual hazard quotients for noncarcinogenic constituents are less than 1.0. The cumulative hazard quotient for the 600-381 waste site is 2.0×10^{-2}, which is less than 1.0. The 600-381 waste site does not have any carcinogenic constituents subject to the groundwater cancer risk calculation; therefore, the criterion for excess cancer risk is met. Nonradionuclide risk requirements related to groundwater are met.

DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the confirmatory sampling approach, the field logbook (WCH 2013a), and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications. The DQA for the 600-381 waste site established that the data are of the right type, quality, and quantity to support site closeout decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site confirmation. The confirmatory sample analytical data are stored in the Washington Closure Hanford project-specific database for data evaluation prior to its archival in the HEIS and are summarized in Appendix B. The detailed DQA is presented in Appendix C.

SUMMARY FOR INTERIM CLOSURE

The 600-381 waste site has been evaluated in accordance with the Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009b). Confirmatory sampling was performed, and the analytical results indicate that the residual concentrations of COPCs at this site meet the RAGs and corresponding remedial action objectives for direct exposure, groundwater protection, and river protection. In accordance with this evaluation, the confirmatory sampling results support a reclassification of the 600-381 waste site to Interim No Action.

REFERENCES

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

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

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APPENDIX A

ECOLOGICAL RISK COMPARISON TABLE

Table A-1. Contaminants Exceeding Ecological Screening Levels for the 600-381 Waste Site [a].

Hazardous Substance		2007 WAC 173-340, Table 749-3			EPA Ecological Soil Screening Levels [b]				Waste Site Analyses
		Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian [c]	Mammalian [c]	
Metals (mg/kg)									
	Background								
Antimony	5	5	--	--	--	78	--	0.27	1.1 (<BG)
Boron [d]	--	0.5	--	--	--	--	--	--	2.4
Cadmium	0.81	4	20	14	32	140	0.77	0.36	0.42 (<BG)
Manganese	512	1,100 [e]	--	1,500	220	450	4,300	4,000	359 (<BG)
Vanadium	85.1	2	--	--	--	--	7.8	280	42.2 (<BG)
Zinc	67.8	86 [e]	200	360	160	120	46	79	52.7 (<BG)

NOTE: Shaded cells are exceeded by the maximum or the statistical result.

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

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

[c] Wildlife.

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

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

-- = values not available
BG = background
EPA = U.S. Environmental Protection Agency
WAC = *Washington Administrative Code*

APPENDIX B

CALCULATIONS

APPENDIX B

CALCULATION BRIEFS

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

600-381 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, 0600X-CA-V0146, Rev. 0, Washington Closure Hanford, Richland, Washington.

600-381 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater, 0600X-CA-V0147, 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.

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CALCULATION COVER SHEET

Project Title: 600 Field Remediation **Job No. 14655**

Area: 600

Discipline: Environmental Calculation No: 0600X-CA-V0146

Subject: 600-381 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations

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 Summary = 6 Attachment = 6 Total = 13	N. K. Schiffern N K. Schiffern	J. D. Skoglie J D Skoglie	I. B. Berezovskiy I B Berezovskiy	D. F. Obenauer D. F. Obenauer	11/15/13

SUMMARY OF REVISION

WCH-DE-018 (05/08/2007)

DE01-437.03

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern NS	Date:	8/21/2013	Calc. No.:	0600X-CA-V0146	Rev.:	0
Project:	600 Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	8/21/2013
Subject:	600-381 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 1 of 6	

PURPOSE:

Using sample data from Attachment 1 provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 600-381 waste site. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009b), the following criteria must be met:

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

Also, calculate the relative percent difference (RPD) for primary-duplicate sample pairs from 600-381 waste site confirmatory sampling, as necessary.

GIVEN/REFERENCES:

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

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

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

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

5) WCH, 2013, Remaining Sites Verification Package for the *600-381, Segment 4 Underground Structure With Wooden Air Vents Feature*, Attachment to Waste Site Reclassification Form 2013-116, 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 2009b).

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

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern	Date:	8/21/2013	Calc. No.:	0600X-CA-V0146	Rev.:	0
Project:	600 Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	8/21/2013
Subject:	600-381 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 2 of 6	

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

5) Use data from Attachment 1 to perform the RPD calculations for primary-duplicate sample pairs, as required.

METHODOLOGY:

The 600-381 waste site underwent confirmatory focused sampling at three locations including a duplicate sample. The direct contact hazard quotient and carcinogenic risk calculations for the 600-381 waste site were conservatively calculated using the maximum results from Attachment 1. Of the contaminants of potential concern (COPCs) and other analytes for this site, boron, molybdenum, nitrogen in nitrite, di-n-butylphthalate, detected polycyclic aromatic hydrocarbons (PAH), and 4-(2,4-dichlorophenoxy)butanoic acid (2,4-DB) require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. Nitrogen in nitrite and nitrate requires HQ and risk calculations because this analyte was detected above Washington State or Hanford Site background value. Although total petroleum hydrocarbons (diesel range and diesel range extended) were detected and no background value is available, the risk associated with total petroleum hydrocarbons do not contribute to the cumulative toxicity calculation. All other site nonradionuclide COPCs were not detected or were quantified below background levels. An example of the HQ and risk calculations is presented below:

1) For example, the maximum value for boron is 2.4 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 3.3×10^{-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 for COPCs is 1.3×10^{-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, then multiplied by 1.0×10^{-6}. For example, the maximum value for benzo(a)anthracene is 0.0038 mg/kg, divided by 1.37 mg/kg, and multiplied as indicated, is 2.8×10^{-9}. 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 for COPCs is 1.5×10^{-7}. Comparing these values to the requirement of $<1 \times 10^{-5}$, this criterion is met.

5) The RPD is calculated when both the primary value and the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method and is listed for certain analytes in Table II-1 of the SAP (DOE-RL 2009a). Other analytes will have their own pre-determined

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern	Date:	8/21/2013	Calc. No.:	0600X-CA-V0146	Rev.:	0
Project:	600 Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	8/21/2013
Subject:	600-381 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 3 of 6	

constituents and will have their own TDLs based on the laboratory and method used. Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

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

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

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

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

RESULTS:

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

Table 1 shows the results of the hazard quotient and excess cancer risk calculations for the 600-381 waste site.

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

Table 2 shows the results of the RPD calculations for the 600-381 waste site.

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern	Date:	8/21/2013	Calc. No.:	0600X-CA-V0146	Rev.:	0
Project:	600 Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	8/21/2013
Subject:	600-381 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 4 of 6	

Table 1. Direct Contact Hazard Quotient and Excess Cancer Risk Results for the 600-381 Waste Site.

Contaminants of Potential Concern	Maximum Value [a] (mg/kg)	Noncarcinogen RAG [b] (mg/kg)	Hazard Quotient	Carcinogen RAG [b] (mg/kg)	Carcinogen Risk
Metals					
Boron	2.4	7,200	3.3E-04	--	--
Molybdenum	0.27	400	6.8E-04	--	--
Semivolatiles					
Di-n-butylphthalate	0.052	8,000	6.5E-06	--	--
Anions					
Nitrogen in Nitrite and Nitrate	17.3	128,000	1.4E-04	--	--
Nitrogen in Nitrite	0.77	8,000	9.6E-05	--	--
Polycyclic Aromatic Hydrocarbons					
Benzo(a)anthracene	0.0038	--	--	1.37	2.8E-09
Benzo(a)pyrene	0.020	--	--	0.137	1.5E-07
Benzo(b)fluoranthene	0.0064	--	--	1.37	4.7E-09
Benzo(ghi)perylene [c]	0.0099	2,400	4.1E-06	--	--
Chrysene	0.014	--	--	13.7	1.0E-09
Fluoranthene	0.015	3,200	4.7E-06	--	--
Pyrene	0.019	2,400	7.9E-06	--	--
Total Petroleum Hydrocarbons					
TPH - Diesel Range extended [d]	7.0	200	--	--	--
Herbicides					
2,4-DB	0.013	640	2.0E-05	--	--
Totals					
Cumulative Hazard Quotient:			**1.3E-03**		
Cumulative Excess Cancer Risk:					**1.5E-07**

Notes:

[a] = From Attachment 1.

[b] = Value obtained from the 100 Area RDR/RAWP (DOE-RL 2009b) or *Washington Administrative Code* (WAC) 173-340-740(3), Method B, 1996, unless otherwise noted.

[c] = Toxicity data for benzo(ghi)perylene is not available. The cleanup levels are based on use of surrogate chemicals. benzo(g,h,i)perylene surrogate: pyrene

[d] = The risk associated with total petroleum hydrocarbons do not contribute to the cumulative toxicity calculation.

-- = not applicable

RAG = remedial action goal

Table 2. Relative Percent Difference Calculations for the 600-381 Waste Site (2 pages).

Duplicate Analysis - 600-381 Waste Site

Sampling Area	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	10500	X	1.4	0.43	BJ	0.34	3.6		0.59	90.0	X	0.067
Duplicate of J1RNL8	J1RNM3	6/28/2013	10400	X	1.4	0.67	J	0.35	3.5		0.61	91.9	X	0.070

Analysis:

TDL		5	0.6	10	2
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**
	RPD	1.0%			2.1%
	Difference > 2 TDL?	Not applicable	No - acceptable	No - acceptable	Not applicable

Washington Closure Hanford, Inc. CALCULATION SHEET

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Project:	600 Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	8/21/2013
Subject:	600-381 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 5 of 6	

Table 2. Relative Percent Difference Calculations for the 600-381 Waste Site (2 pages).

Duplicate Analysis - 600-381 Waste Site

Sampling Area	HEIS Number	Sample Date	Boron			Cadmium			Calcium			Chromium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	2.4	N	0.87	0.42		0.036	4400		12.5	13.0		0.052
Duplicate of J1RNL8	J1RNM3	6/28/2013	2.3		0.90	0.40		0.038	4280		13.0	12.0		0.054

Analysis:

TDL		2	0.2	100	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD			2.8%	8.0%
	Difference > 2 TDL?	No - acceptable	No - acceptable	Not applicable	Not applicable

Duplicate Analysis - 600-381 Waste Site

Sampling Area	Sample Number	Sample Date	Cobalt			Copper			Iron			Lead		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	7.3	X	0.089	13.4		0.19	18100		3.4	7.5		0.24
Duplicate of J1RNL8	J1RNM3	6/28/2013	7.4	X	0.092	13.7		0.20	17900		3.5	7.6		0.25

Analysis:

TDL		2	1	5	5
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)
	RPD		2.2%	1.1%	
	Difference > 2 TDL?	No - acceptable	Not applicable	Not applicable	No - acceptable

Duplicate Analysis - 600-381 Waste Site

Sampling Area	Sample Number	Sample Date	Magnesium			Manganese			Nickel			Potassium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	5010		3.3	357		0.089	11.8	X	0.11	1960		36.4
Duplicate of J1RNL8	J1RNM3	6/28/2013	5050		3.4	352		0.092	13.4	X	0.11	1980		37.9

Analysis:

TDL		75	5	4	400
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD	0.8%	1.4%		
	Difference > 2 TDL?	Not applicable	Not applicable	No - acceptable	No - acceptable

Duplicate Analysis - 600-381 Waste Site

Sampling Area	Sample Number	Sample Date	Silicon			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	353	NJ	5.0	192		52.4	40.7		0.083	46.8	X	0.35
Duplicate of J1RNL8	J1RNM3	6/28/2013	373	J	5.2	189		54.5	40.0		0.087	46.1	X	0.37

Analysis:

TDL		2	50	2.5	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD	5.5%		1.7%	1.5%
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	Not applicable

Duplicate Analysis - 600-381 Waste Site

Sampling Area	Sample Number	Sample Date	Nitrogen in Nitrate			Nitrogen in Nitrite and Nitrate			Sulfate			Benzo(a)pyrene - PAH		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	ug/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	1.8	BJ	0.32	1.5	M	0.32	5.1		1.7	20	J	6.1
Duplicate of J1RNL8	J1RNM3	6/28/2013	1.6	BJ	0.31	1.9		0.30	5.0	N	1.7	16	NJ	6.2

Analysis:

TDL		0.75	0.75	5	15
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD				
	Difference > 2 TDL?	No - acceptable	No - acceptable	No - acceptable	No - acceptable

Duplicate Analysis - 600-381 Waste Site

Sampling Area	Sample Number	Sample Date	Benzo(b)fluoranthene - PAH			Chrysene - PAH			Fluoranthene - PAH			Pyrene - PAH		
			ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	6.4	JX	4.0	14	J	4.6	14	JX	12	19	J	11
Duplicate of J1RNL8	J1RNM3	6/28/2013	5.0	JN	4.0	12	JXN	4.6	15	JN	12	17	JN	12

Analysis:

TDL		15	15	15	15
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD				
	Difference > 2 TDL?	No - acceptable	No - acceptable	No - acceptable	No - acceptable

Duplicate Analysis - 600-381 Waste Site

Sampling Area	Sample Number	Sample Date	Pyrene - SVOA		
			ug/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	67	J	12
Duplicate of J1RNL8	J1RNM3	6/28/2013	14	J	12

Analysis:

TDL		660
Duplicate Analysis	Both > PQL?	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)
	RPD	
	Difference > 2 TDL?	No - acceptable

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern NS	Date:	8/21/2013	Calc. No.:	0600X-CA-V0146	Rev.:	0
Project:	600 Field Remediation	Job No:	14655	Checked:	J. D. Skoglie JDS	Date:	8/21/2013
Subject:	600-381 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 6 of 6	

CONCLUSION:

The calculations in Tables 1 and 2 demonstrate that the 600-381 waste site meets the requirements for the direct contact hazard quotients and carcinogenic (excess cancer) risk and RPDs, respectively, as identified in the RDR/RAWP (DOE-RL 2009b) and SAP (DOE-RL 2009a). The direct contact hazard quotients and carcinogenic (excess cancer) risk calculations are for use in the RSVP for this site.

Attachment 1. 600-381 Waste Site Confirmatory Sample Results (Metals)

LOCATION	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	10500	X	1.4	0.43	BJ	0.34	3.6		0.59	90.0	X	0.067	0.029	U	0.029
Duplicate of J1RNL8	J1RNM3	6/28/2013	10400	X	1.4	0.67	J	0.35	3.5		0.61	91.9	X	0.070	0.036	B	0.030
TP1 Soil at 1 m below vent feature	J1RNL9	6/28/2013	10000	X	1.6	0.47	BJ	0.40	3.5		0.69	77.1	X	0.079	0.035	U	0.035
TP2 Soil below subsurface feature/container	J1RNM1	6/28/2013	10900	X	1.6	1.1	J	0.39	3.8		0.67	85.5	X	0.077	0.034	U	0.034
Equipment Blank	J1RNM4	6/28/2013	222	X	1.5	0.37	UJ	0.37	0.63	U	0.63	3.4	X	0.073	0.047	B	0.032

LOCATION	HEIS Number	Sample Date	Boron			Cadmium			Calcium			Chromium			Cobalt		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	2.4	N	0.87	0.42		0.036	4400		12.5	13.0		0.052	7.3	X	0.089
Duplicate of J1RNL8	J1RNM3	6/28/2013	2.3		0.90	0.40		0.038	4280		13.0	12.0		0.054	7.4	X	0.092
TP1 Soil at 1 m below vent feature	J1RNL9	6/28/2013	1.9	B	1.0	0.39		0.043	6080		14.7	12.6		0.061	7.4	X	0.10
TP2 Soil below subsurface feature/container	J1RNM1	6/28/2013	1.7	B	1.0	0.41		0.042	3760		14.4	12.9		0.059	7.6	X	0.10
Equipment Blank	J1RNM4	6/28/2013	0.94	U	0.94	0.039	U	0.039	49.7		13.6	0.13	B	0.056	0.14	BX	0.096

LOCATION	HEIS Number	Sample Date	Copper			Hexavalent Chromium			Iron			Lead			Magnesium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	13.4		0.19	0.155	U	0.155	18100		3.4	7.5		0.24	5010		3.3
Duplicate of J1RNL8	J1RNM3	6/28/2013	13.7		0.20	0.155	U	0.155	17900		3.5	7.6		0.25	5050		3.4
TP1 Soil at 1 m below vent feature	J1RNL9	6/28/2013	14.5		0.23	0.155	U	0.155	17700		4.0	6.0		0.28	5300		3.9
TP2 Soil below subsurface feature/container	J1RNM1	6/28/2013	14.1		0.22	0.155	U	0.155	18600		3.9	6.1		0.28	5260		3.8
Equipment Blank	J1RNM4	6/28/2013	0.21	U	0.21				411		3.7	0.44	B	0.26	29.8		3.6

LOCATION	HEIS Number	Sample Date	Manganese			Mercury			Molybdenum			Nickel			Potassium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	357		0.089	0.0055	U	0.0055	0.23	U	0.23	11.8	X	0.11	1960		36.4
Duplicate of J1RNL8	J1RNM3	6/28/2013	352		0.092	0.0057	U	0.0057	0.24	U	0.24	13.4	X	0.11	1980		37.9
TP1 Soil at 1 m below vent feature	J1RNL9	6/28/2013	334		0.10	0.0061	U	0.0061	0.27	B	0.27	12.9	X	0.13	2040		42.9
TP2 Soil below subsurface feature/container	J1RNM1	6/28/2013	359		0.10	0.0057	U	0.0057	0.27	U	0.27	12.7	X	0.13	2140		41.8
Equipment Blank	J1RNM4	6/28/2013	24		0.096	0.0059	U	0.0059	0.25	U	0.25	0.20	BX	0.12	61.3	B	39.4

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, C, J, M, N, and/or X are considered acceptable values.

B = blank contamination (inorganic constituents)

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

HEIS = Hanford Environmental Information System

HERB = herbicide

J = estimate

M = sample duplicate precision not met.

N = recovery exceeds upper or lower control limit.

PAH = polycyclic aromatic hydrocarbons

PCB = polychlorinated biphenyls

PEST = pesticide

PQL = practical quantitation limit

Q = qualifier

R = rejected.

RAG = remedial action goal

SVOA = semivolatile organic analysis

TP = test pit

TPH = total petroleum hydrocarbons

U = not detected.

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

X (organics) = recovery exceeds upper or lower control limits.

Attachment	1	Sheet No.	1 of 6
Originator	N. K. Schiffern	Date	8/21/2013
Checked	J. D. Skoglie	Date	8/21/2013
Calc. No.	0600X-CA-V0146	Rev. No.	0

Attachment 1. 600-381 Waste Site Confirmatory Sample Results (Metals, Anions, TPHs, and Physical)

LOCATION	HEIS Number	Sample Date	Selenium			Silicon			Silver			Sodium			Vanadium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	0.76	U	0.76	353	NJ	5.0	0.14	U	0.14	192		52.4	40.7		0.083
Duplicate of J1RNL8	J1RNM3	6/28/2013	0.79	U	0.79	373	J	5.2	0.15	U	0.15	189		54.5	40.0		0.087
TP1 Soil at 1 m below vent feature	J1RNL9	6/28/2013	0.90	U	0.90	405	J	5.9	0.17	U	0.17	181		61.7	40.7		0.098
TP2 Soil below subsurface feature/container	J1RNM1	6/28/2013	0.88	U	0.88	401	J	5.8	0.16	U	0.16	182		60.1	42.2		0.096
Equipment Blank	J1RNM4	6/28/2013	0.83	U	0.83	139	J	5.4	0.15	U	0.15	56.7	U	56.7	0.53	B	0.090

LOCATION	HEIS Number	Sample Date	Zinc			Bromide			Chloride			Fluoride			Nitrogen in Nitrate		
			mg/kg	Q	PQL	mg/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	mg/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	46.8	X	0.35	0.39	U	0.39	2.0	U	2.0	0.83	UJ	0.83	1.8	BJ	0.32
Duplicate of J1RNL8	J1RNM3	6/28/2013	46.1	X	0.37	0.39	U	0.39	2.0	U	2.0	0.82	UNJ	0.82	1.6	BJ	0.31
TP1 Soil at 1 m below vent feature	J1RNL9	6/28/2013	42.6	X	0.42	0.42	U	0.42	3.5	B	2.1	1.0	BJ	0.89	14.1	J	0.34
TP2 Soil below subsurface feature/container	J1RNM1	6/28/2013	52.7	X	0.41	0.45	U	0.45	2.3	U	2.3	0.94	UJ	0.94	4.5	J	0.36
Equipment Blank	J1RNM4	6/28/2013	1.8	XCUJ	0.38												

LOCATION	HEIS Number	Sample Date	Nitrogen in Nitrite and Nitrate			Nitrogen in Nitrite			Phosphorous in phosphate			Sulfate			TPH - Diesel		
			mg/kg	Q	PQL	mg/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	1.5	M	0.32	0.34	UR	0.34	1.3	UR	1.3	5.1		1.7	5000	U	690
Duplicate of J1RNL8	J1RNM3	6/28/2013	1.9		0.30	0.34	UR	0.34	1.2	UR	1.2	5.0	N	1.7	5000	JBU	690
TP1 Soil at 1 m below vent feature	J1RNL9	6/28/2013	17.3		0.34	0.77	BJ	0.37	5.9	J	1.3	20.2		1.9	5000	U	730
TP2 Soil below subsurface feature/container	J1RNM1	6/28/2013	5.0		0.33	0.39	UR	0.39	1.4	UR	1.4	5.7		2.0	5000	JBU	790

LOCATION	HEIS Number	Sample Date	TPH - Diesel Ext			Percent moisture (wet sample)			pH Measurement		
			ug/kg	Q	PQL	%	Q	PQL	pH	Q	PQL
TP1 Soil below surface vent feature	J1RNL8	6/28/2013	6000	BU	1000	3.8		0.10	9.14	J	0.100
Duplicate of J1RNL8	J1RNM3	6/28/2013	6600	B	1000	4.1		0.10	8.85	J	0.100
TP1 Soil at 1 m below vent feature	J1RNL9	6/28/2013	7000	B	1100	8.9		0.10	8.74	J	0.100
TP2 Soil below subsurface feature/container	J1RNM1	6/28/2013	5000	JBU	1200	14.7		0.10	8.43	J	0.100
Equipment Blank	J1RNM4	6/28/2013				0.10	U	0.10			

Attachment	1	Sheet No.	2 of 6
Originator	N. K. Schiffern	Date	8/21/2013
Checked	J. D. Skoglie	Date	8/21/2013
Calc. No.	0600X-CA-V0146	Rev. No.	0

Attachment 1. 600-381 Waste Site Confirmatory Sample Results (Organics)

CONSTITUENT	CLASS	J1RNL8, TP1 Soil below surface vent feature			J1RNM3, Duplicate of J1RNL8			J1RNL9, TP1 Soil at 1 m below vent feature		
		6/28/2013			6/28/2013			6/28/2013		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
2-(2,4,5-Trichlorophenoxy)propionic acid	HERB	1.4	U	1.4	1.4	U	1.4	1.5	U	1.5
2-(2-methyl-4-chlorophenoxy) propionic acid	HERB	2100	U	2100	2100	U	2100	2200	U	2200
2,4,5-Trichlorophenoxyacetic acid	HERB	2.4	U	2.4	2.4	U	2.4	2.5	U	2.5
2,4-Dichlorophenoxyacetic acid	HERB	14	U	14	14	U	14	15	U	15
2-Methyl-4 chlorophenoxyacetic acid	HERB	2100	U	2100	2100	U	2100	2200	U	2200
2-secButyl-4,6-dinitrophenol(DNBP)	HERB	1.4	UNJ	1.4	1.4	UJ	1.4	1.5	UJ	1.5
4-(2,4-Dichlorophenoxy)butanoic acid	HERB	7.7	U	7.7	13	J	7.7	8.1	U	8.1
Dalapon	HERB	1.4	U	1.4	1.4	U	1.4	1.5	U	1.5
Dicamba	HERB	1.4	U	1.4	1.4	U	1.4	1.5	U	1.5
Dichloroprop	HERB	3.3	U	3.3	3.3	U	3.3	3.5	U	3.5
Acenaphthene	PAH	9.5	UJ	9.5	9.6	UNJ	9.6	11	UJ	11
Acenaphthylene	PAH	8.5	UJ	8.5	8.6	UNJ	8.6	9.5	UJ	9.5
Anthracene	PAH	2.9	UJ	2.9	2.9	UNJ	2.9	3.2	UJ	3.2
Benzo(a)anthracene	PAH	3.8	JX	3.0	3.1	UNJ	3.1	3.4	UJ	3.4
Benzo(a)pyrene	PAH	20	J	6.1	16	NJ	6.2	6.8	UJ	6.8
Benzo(b)fluoranthene	PAH	6.4	JX	4.0	5.0	JN	4.0	4.4	UJ	4.4
Benzo(ghi)perylene	PAH	9.9	J	6.8	6.9	UNJ	6.9	7.6	UJ	7.6
Benzo(k)fluoranthene	PAH	3.7	UJ	3.7	3.8	UNJ	3.8	4.2	UJ	4.2
Chrysene	PAH	14	J	4.6	12	JXN	4.6	5.1	UJ	5.1
Dibenz[a,h]anthracene	PAH	10	UJ	10	11	UNJ	11	12	UJ	12
Fluoranthene	PAH	14	JX	12	15	JN	12	14	UJ	14
Fluorene	PAH	5.0	UJ	5.0	5.1	UNJ	5.1	5.6	UJ	5.6
Indeno(1,2,3-cd)pyrene	PAH	11	UJ	11	12	UNJ	12	13	UJ	13
Naphthalene	PAH	11	UJ	11	12	UNJ	12	13	UJ	13
Phenanthrene	PAH	11	UJ	11	12	UNJ	12	13	UJ	13
Pyrene	PAH	19	J	11	17	JN	12	13	UJ	13
Aroclor-1016	PCB	2.8	U	2.8	2.7	U	2.7	3.0	U	3.0
Aroclor-1221	PCB	8.1	U	8.1	7.9	U	7.9	8.7	U	8.7
Aroclor-1232	PCB	2.0	U	2.0	2.0	U	2.0	2.2	U	2.2
Aroclor-1242	PCB	4.7	U	4.7	4.6	U	4.6	5.0	U	5.0
Aroclor-1248	PCB	4.7	U	4.7	4.6	U	4.6	5.0	U	5.0
Aroclor-1254	PCB	2.6	U	2.6	2.6	U	2.6	2.8	U	2.8
Aroclor-1260	PCB	2.6	U	2.6	2.6	U	2.6	2.8	U	2.8
Aldrin	PEST	0.24	U	0.24	0.26	U	0.26	0.26	U	0.26
Alpha-BHC	PEST	0.21	U	0.21	0.22	U	0.22	0.22	U	0.22
alpha-Chlordane	PEST	0.31	U	0.31	0.33	U	0.33	0.33	U	0.33
beta-1,2,3,4,5,6-Hexachlorocyclohexane	PEST	0.64	U	0.64	0.68	U	0.68	0.67	U	0.67
Delta-BHC	PEST	0.39	U	0.39	0.41	U	0.41	0.41	U	0.41
Dichlorodiphenyldichloroethane	PEST	0.53	U	0.53	0.56	U	0.56	0.56	U	0.56
Dichlorodiphenyldichloroethylene	PEST	0.23	U	0.23	0.25	U	0.25	0.24	U	0.24
Dichlorodiphenyltrichloroethane	PEST	0.57	U	0.57	0.61	U	0.61	0.60	U	0.60
Dieldrin	PEST	0.20	U	0.20	0.22	U	0.22	0.21	U	0.21
Endosulfan I	PEST	0.17	U	0.17	0.18	U	0.18	0.18	U	0.18
Endosulfan II	PEST	0.28	U	0.28	0.30	U	0.30	0.29	U	0.29
Endosulfan sulfate	PEST	0.27	U	0.27	0.28	U	0.28	0.28	U	0.28
Endrin	PEST	0.29	U	0.29	0.32	U	0.32	0.31	U	0.31
Endrin aldehyde	PEST	0.16	U	0.16	0.18	U	0.18	0.17	U	0.17
Endrin ketone	PEST	0.47	U	0.47	0.50	U	0.50	0.50	U	0.50
Gamma-BHC (Lindane)	PEST	0.45	U	0.45	0.48	U	0.48	0.47	U	0.47
gamma-Chlordane	PEST	0.26	U	0.26	0.27	U	0.27	0.27	U	0.27
Heptachlor	PEST	0.21	U	0.21	0.22	U	0.22	0.22	U	0.22
Heptachlor epoxide	PEST	0.41	U	0.41	0.44	U	0.44	0.43	U	0.43
Methoxychlor	PEST	0.43	U	0.43	0.46	U	0.46	0.46	U	0.46
Toxaphene	PEST	15	UJ	15	16	UJ	16	16	UJ	16

Attachment	1	Sheet No.	3 of 6
Originator	N. K. Schiffern	Date	08/21/13
Checked	J. D. Skoglie	Date	08/21/13
Calc. No.	0600X-CA-V0146	Rev. No.	0

Attachment 1. 600-381 Waste Site Confirmatory Sample Results (Organics)

CONSTITUENT	CLASS	J1RNM1, TP2 Soil below subsurface feature/container		
		6/28/2013		
		ug/kg	Q	PQL
2-(2,4,5-Trichlorophenoxy)propionic acid	HERB	1.6	U	1.6
2-(2-methyl-4-chlorophenoxy) propionic acid	HERB	2300	U	2300
2,4,5-Trichlorophenoxyacetic acid	HERB	2.6	U	2.6
2,4-Dichlorophenoxyacetic acid	HERB	16	U	16
2-Methyl-4 chlorophenoxyacetic acid	HERB	2300	U	2300
2-secButyl-4,6-dinitrophenol(DNBP)	HERB	1.6	UJ	1.6
4-(2,4-Dichlorophenoxy)butanoic acid	HERB	8.6	U	8.6
Dalapon	HERB	1.6	U	1.6
Dicamba	HERB	1.6	U	1.6
Dichloroprop	HERB	3.7	U	3.7
Acenaphthene	PAH	11	UJ	11
Acenaphthylene	PAH	10	UJ	10
Anthracene	PAH	3.5	UJ	3.5
Benzo(a)anthracene	PAH	3.7	UJ	3.7
Benzo(a)pyrene	PAH	7.4	UJ	7.4
Benzo(b)fluoranthene	PAH	4.8	UJ	4.8
Benzo(ghi)perylene	PAH	8.3	UJ	8.3
Benzo(k)fluoranthene	PAH	4.5	UJ	4.5
Chrysene	PAH	5.6	UJ	5.6
Dibenz[a,h]anthracene	PAH	13	UJ	13
Fluoranthene	PAH	15	UJ	15
Fluorene	PAH	6.1	UJ	6.1
Indeno(1,2,3-cd)pyrene	PAH	14	UJ	14
Naphthalene	PAH	14	UJ	14
Phenanthrene	PAH	14	UJ	14
Pyrene	PAH	14	UJ	14
Aroclor-1016	PCB	3.2	U	3.2
Aroclor-1221	PCB	9.2	U	9.2
Aroclor-1232	PCB	2.3	U	2.3
Aroclor-1242	PCB	5.3	U	5.3
Aroclor-1248	PCB	5.3	U	5.3
Aroclor-1254	PCB	3.0	U	3.0
Aroclor-1260	PCB	3.0	U	3.0
Aldrin	PEST	0.29	U	0.29
Alpha-BHC	PEST	0.24	U	0.24
alpha-Chlordane	PEST	0.37	U	0.37
beta-1,2,3,4,5,6-Hexachlorocyclohexane	PEST	0.76	U	0.76
Delta-BHC	PEST	0.46	U	0.46
Dichlorodiphenyldichloroethane	PEST	0.62	U	0.62
Dichlorodiphenyldichloroethylene	PEST	0.27	U	0.27
Dichlorodiphenyltrichloroethane	PEST	0.67	U	0.67
Dieldrin	PEST	0.24	U	0.24
Endosulfan I	PEST	0.20	U	0.20
Endosulfan II	PEST	0.33	U	0.33
Endosulfan sulfate	PEST	0.31	U	0.31
Endrin	PEST	0.35	U	0.35
Endrin aldehyde	PEST	0.19	U	0.19
Endrin ketone	PEST	0.56	U	0.56
Gamma-BHC (Lindane)	PEST	0.53	U	0.53
gamma-Chlordane	PEST	0.30	U	0.30
Heptachlor	PEST	0.24	U	0.24
Heptachlor epoxide	PEST	0.48	U	0.48
Methoxychlor	PEST	0.51	U	0.51
Toxaphene	PEST	18	UJ	18

Attachment	1	Sheet No.	4 of 6
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Calc. No.	0600X-CA-V0146	Rev. No.	0

Attachment 1. 600-381 Waste Site Confirmatory Sample Results (Organics)

CONSTITUENT	CLASS	J1RNL8, TP1 Soil below surface vent feature			J1RNM3, Duplicate of J1RNL8			J1RNL9, TP1 Soil at 1 m below vent feature		
		6/28/2013			6/28/2013			6/28/2013		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
1,2,4-Trichlorobenzene	SVOA	29	U	29	28	U	28	30	U	30
1,2-Dichlorobenzene	SVOA	22	U	22	22	U	22	23	U	23
1,3-Dichlorobenzene	SVOA	12	U	12	12	U	12	13	U	13
1,4-Dichlorobenzene	SVOA	14	U	14	14	U	14	14	U	14
2,4,5-Trichlorophenol	SVOA	10	U	10	10	U	10	11	U	11
2,4,6-Trichlorophenol	SVOA	10	U	10	10	U	10	11	U	11
2,4-Dichlorophenol	SVOA	10	U	10	10	U	10	11	U	11
2,4-Dimethylphenol	SVOA	67	U	67	66	U	66	70	U	70
2,4-Dinitrophenol	SVOA	340	UJ	340	330	UXJ	330	350	UJ	350
2,4-Dinitrotoluene	SVOA	67	U	67	66	U	66	70	U	70
2,6-Dinitrotoluene	SVOA	29	U	29	28	U	28	30	U	30
2-Chloronaphthalene	SVOA	10	U	10	10	U	10	11	U	11
2-Chlorophenol	SVOA	21	U	21	21	U	21	22	U	22
2-Methylnaphthalene	SVOA	19	U	19	19	U	19	20	U	20
2-Methylphenol (cresol, o-)	SVOA	13	U	13	13	U	13	14	U	14
2-Nitroaniline	SVOA	51	U	51	50	U	50	53	U	53
2-Nitrophenol	SVOA	10	U	10	10	U	10	11	U	11
3,3'-Dichlorobenzidine	SVOA	92	UJ	92	90	UJ	90	96	UJ	96
3+4 Methylphenol (cresol, m+p)	SVOA	34	U	34	33	U	33	35	U	35
3-Nitroaniline	SVOA	75	UJ	75	73	UJ	73	78	UJ	78
4,6-Dinitro-2-methylphenol	SVOA	340	UJ	340	330	UXJ	330	350	UJ	350
4-Bromophenylphenyl ether	SVOA	19	U	19	19	U	19	20	U	20
4-Chloro-3-methylphenol	SVOA	67	U	67	66	U	66	70	U	70
4-Chloroaniline	SVOA	84	UJ	84	82	UJ	82	87	UJ	87
4-Chlorophenylphenyl ether	SVOA	21	U	21	21	U	21	22	U	22
4-Nitroaniline	SVOA	74	U	74	72	U	72	77	U	77
4-Nitrophenol	SVOA	99	U	99	97	U	97	100	U	100
Acenaphthene	SVOA	11	U	11	10	U	10	11	U	11
Acenaphthylene	SVOA	17	U	17	17	U	17	18	U	18
Anthracene	SVOA	17	U	17	17	U	17	18	U	18
Benzo(a)anthracene	SVOA	32	J	20	20	U	20	21	U	21
Benzo(a)pyrene	SVOA	36	J	20	20	U	20	21	U	21
Benzo(b)fluoranthene	SVOA	42	J	27	26	U	26	28	U	28
Benzo(ghi)perylene	SVOA	19	J	16	16	U	16	17	U	17
Benzo(k)fluoranthene	SVOA	41	U	41	40	U	40	43	U	43
Bis(2-chloro-1-methylethyl)ether	SVOA	24	U	24	23	U	23	25	U	25
Bis(2-Chloroethoxy)methane	SVOA	24	U	24	23	U	23	25	U	25
Bis(2-chloroethyl) ether	SVOA	17	U	17	17	U	17	18	U	18
Bis(2-ethylhexyl) phthalate	SVOA	47	U	47	46	U	46	49	U	49
Butylbenzylphthalate	SVOA	44	U	44	43	U	43	46	U	46
Carbazole	SVOA	37	U	37	36	U	36	38	U	38
Chrysene	SVOA	37	J	28	27	U	27	29	U	29
Dibenz[a,h]anthracene	SVOA	19	U	19	19	U	19	20	U	20
Dibenzofuran	SVOA	20	U	20	20	U	20	21	U	21
Diethylphthalate	SVOA	27	U	27	26	U	26	28	U	28
Dimethyl phthalate	SVOA	24	U	24	23	U	23	25	U	25
Di-n-butylphthalate	SVOA	30	U	30	29	U	29	31	U	31
Di-n-octylphthalate	SVOA	15	U	15	14	U	14	15	U	15
Fluoranthene	SVOA	58	J	37	36	U	36	38	U	38
Fluorene	SVOA	18	U	18	18	U	18	19	U	19
Hexachlorobenzene	SVOA	30	U	30	29	U	29	31	U	31
Hexachlorobutadiene	SVOA	10	U	10	10	U	10	11	U	11
Hexachlorocyclopentadiene	SVOA	51	UJ	51	50	UXJ	50	53	UJ	53
Hexachloroethane	SVOA	22	U	22	21	U	21	23	U	23
Indeno(1,2,3-cd)pyrene	SVOA	25	J	22	22	U	22	23	U	23
Isophorone	SVOA	17	U	17	17	U	17	18	U	18
Naphthalene	SVOA	32	U	32	31	U	31	33	U	33
Nitrobenzene	SVOA	22	U	22	22	U	22	23	U	23
N-Nitroso-di-n-dipropylamine	SVOA	32	U	32	31	U	31	33	U	33
N-Nitrosodiphenylamine	SVOA	21	U	21	21	U	21	22	U	22
Pentachlorophenol	SVOA	340	U	340	330	UX	330	350	U	350
Phenanthrene	SVOA	34	J	17	17	U	17	18	U	18
Phenol	SVOA	18	U	18	18	U	18	19	U	19
Pyrene	SVOA	67	J	12	14	J	12	13	U	13

Attachment	1	Sheet No.	5 of 6
Originator	N. K. Schiffern	Date	08/21/13
Checked	J. D. Skoglie	Date	08/21/13
Calc. No.	0600X-CA-V0146	Rev. No.	0

Attachment 1. 600-381 Waste Site Confirmatory Sample Results (Organics)

CONSTITUENT	CLASS	J1RNM1, TP2 Soil below subsurface feature/container 6/28/2013			J1RNM4, Equipment Blank 6/28/2013		
		ug/kg	Q	PQL	ug/kg	Q	PQL
1,2,4-Trichlorobenzene	SVOA	31	U	31	26	U	26
1,2-Dichlorobenzene	SVOA	25	U	25	21	U	21
1,3-Dichlorobenzene	SVOA	13	U	13	11	U	11
1,4-Dichlorobenzene	SVOA	15	U	15	13	U	13
2,4,5-Trichlorophenol	SVOA	11	U	11	9.4	U	9.4
2,4,6-Trichlorophenol	SVOA	11	U	11	9.4	U	9.4
2,4-Dichlorophenol	SVOA	11	U	11	9.4	U	9.4
2,4-Dimethylphenol	SVOA	74	U	74	62	U	62
2,4-Dinitrophenol	SVOA	370	UJ	370	310	UJ	310
2,4-Dinitrotoluene	SVOA	74	U	74	62	U	62
2,6-Dinitrotoluene	SVOA	31	U	31	26	U	26
2-Chloronaphthalene	SVOA	11	U	11	9.4	U	9.4
2-Chlorophenol	SVOA	24	U	24	20	U	20
2-Methylnaphthalene	SVOA	21	U	21	18	U	18
2-Methylphenol (cresol, o-)	SVOA	15	U	15	12	U	12
2-Nitroaniline	SVOA	56	U	56	47	U	47
2-Nitrophenol	SVOA	11	U	11	9.4	U	9.4
3,3'-Dichlorobenzidine	SVOA	100	UJ	100	85	UJ	85
3+4 Methylphenol (cresol, m+p)	SVOA	37	U	37	31	U	31
3-Nitroaniline	SVOA	82	UJ	82	69	UJ	69
4,6-Dinitro-2-methylphenol	SVOA	370	UJ	370	310	UJ	310
4-Bromophenylphenyl ether	SVOA	21	U	21	18	U	18
4-Chloro-3-methylphenol	SVOA	74	U	74	62	U	62
4-Chloroaniline	SVOA	92	UJ	92	77	UJ	77
4-Chlorophenylphenyl ether	SVOA	24	U	24	20	U	20
4-Nitroaniline	SVOA	81	U	81	68	U	68
4-Nitrophenol	SVOA	110	U	110	92	U	92
Acenaphthene	SVOA	12	U	12	9.7	U	9.7
Acenaphthylene	SVOA	19	U	19	16	U	16
Anthracene	SVOA	19	U	19	16	U	16
Benzo(a)anthracene	SVOA	22	U	22	19	U	19
Benzo(a)pyrene	SVOA	22	U	22	19	U	19
Benzo(b)fluoranthene	SVOA	29	U	29	25	U	25
Benzo(ghi)perylene	SVOA	18	U	18	15	U	15
Benzo(k)fluoranthene	SVOA	45	U	45	38	U	38
Bis(2-chloro-1-methylethyl)ether	SVOA	26	U	26	22	U	22
Bis(2-Chloroethoxy)methane	SVOA	26	U	26	22	U	22
Bis(2-chloroethyl) ether	SVOA	19	U	19	16	U	16
Bis(2-ethylhexyl) phthalate	SVOA	52	U	52	43	U	43
Butylbenzylphthalate	SVOA	48	U	48	41	U	41
Carbazole	SVOA	40	U	40	34	U	34
Chrysene	SVOA	30	U	30	25	U	25
Dibenz[a,h]anthracene	SVOA	21	U	21	18	U	18
Dibenzofuran	SVOA	22	U	22	19	U	19
Diethylphthalate	SVOA	29	U	29	25	U	25
Dimethyl phthalate	SVOA	26	U	26	22	U	22
Di-n-butylphthalate	SVOA	52	J	33	27	U	27
Di-n-octylphthalate	SVOA	16	U	16	14	U	14
Fluoranthene	SVOA	40	U	40	34	U	34
Fluorene	SVOA	20	U	20	17	U	17
Hexachlorobenzene	SVOA	33	U	33	27	U	27
Hexachlorobutadiene	SVOA	11	U	11	9.4	U	9.4
Hexachlorocyclopentadiene	SVOA	56	UJ	56	47	UJ	47
Hexachloroethane	SVOA	24	U	24	20	U	20
Indeno(1,2,3-cd)pyrene	SVOA	25	U	25	21	U	21
Isophorone	SVOA	19	U	19	16	U	16
Naphthalene	SVOA	35	U	35	29	U	29
Nitrobenzene	SVOA	25	U	25	21	U	21
N-Nitroso-di-n-dipropylamine	SVOA	35	U	35	29	U	29
N-Nitrosodiphenylamine	SVOA	24	U	24	20	U	20
Pentachlorophenol	SVOA	370	U	370	310	U	310
Phenanthrene	SVOA	19	U	19	16	U	16
Phenol	SVOA	20	U	20	17	U	17
Pyrene	SVOA	14	U	14	11	U	11

Attachment	1	Sheet No.	6 of 6
Originator	N. K. Schiffern	Date	08/21/13
Checked	J. D. Skoglie	Date	08/21/13
Calc. No.	0600X-CA-V0146	Rev. No.	0

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 600 Field Remediation **Job No. 14655**

Area: 600

Discipline: Environmental *Calculation No: 0600X-CA-V0147

Subject: 600-381 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 Sheets = 3 Total = 4	N. K. Schiffern N. K. Schiffern	J. D. Skoglie J. D. Skoglie	L. B. Berezovskiy L. B. Berezovskiy	D. F. Obenauer D. F. Obenauer	11/18/13

SUMMARY OF REVISION

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern	Date:	8/26/2013	Calc. No.:	0600X-CA-V0147	Rev.:	0
Project:	600 Area Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	8/26/2013
Subject:	600-381 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 600-381 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, *600-381 Waste Site Relative Percent Difference (RPD) and Direct Hazard Quotient and Carcinogenic Risk Calculation*, 0600X-CA-V0146, 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

Originator:	N. K. Schiffern	Date:	8/26/2013	Calc. No.:	0600X-CA-V0147	Rev.:	0
Project:	600 Area Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	8/26/2013
Subject:	600-381 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No. 2 of 3	

METHODOLOGY:

The 600-381 waste site underwent confirmatory focused sampling at three locations including a duplicate sample. Hazard quotient and carcinogenic risk calculations for potential impact to groundwater at the 600-381 waste site were conservatively calculated for the entire waste site using the maximum value for each analyte from the RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculation (WCH 2013). Based on this model and a vadose zone of approximately 6.6 m (21.7 ft) thickness, a K_d value of 10 mL/g is adequate to show no migration to groundwater in 1,000 years using the generic RESRAD model (BHI 2005). Contaminants with a K_d of 12 mL/g are highly adsorbed to soil particles, and even when immersed in water, any migration will be negligible. Therefore, HQ and risk calculations were performed with the exclusion of these analytes with a K_d over 12 mL/g. Of the contaminants of potential concern (COPCs) for this site, boron, nitrogen in nitrite, di-n-butylphthalate, and 4-(2,4-dichlorophenoxy)butanoic acid (2,4-DB) are included because no Hanford background value has been established and the distribution coefficient is less than that necessary to show no migration to groundwater in 1,000 years using the generic site RESRAD model (BHI 2005). Nitrogen in nitrite and nitrate requires HQ and risk calculations because this analyte was detected above a Washington State or Hanford Site background value, and a K_d of less than 12. All other site nonradionuclide COPCs were not detected, quantified below background levels, or have a K_d greater than or equal to 12. An example of the HQ and risk calculations for soil constituents with a potential impact to groundwater is presented below:

1) The hazard quotient is defined as the ratio of the dose of a substance obtained over a specified time (mg/kg/day) to a reference dose for the same substance derived over the same specified time (mg/kg/day). The hazard quotient can also be calculated as the ratio of the concentration in soil (maximum or statistical value) (mg/kg) to the soil RAG (mg/kg) for protection of groundwater, where the RAG is the groundwater cleanup level (mg/L) (calculated with, and related to the hazard quotient through, WAC 173-340-720(3)(a)(ii)(A), 1996) x 100 x 1 mg/1000 mg (conversion factor). This is based on the "100 times rule" of WAC 173-340-740(3)(a)(ii)(A) (1996). For example, the maximum value for boron is 2.4 mg/kg, divided by the noncarcinogenic RAG value of 320 mg/kg produces an HQ value of 7.5×10^{-3}. 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 600-381 waste site is 2.0×10^{-2}. 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 1×10^{-6}. The 600-381 waste site does not have any constituents with carcinogen RAGs; therefore, the criterion for excess cancer risk is met. Consequently, the criterion for cumulative excess cancer risk for carcinogens is also met.

4) The soil cleanup RAGs for protection of groundwater are based on the "100 times" provision in WAC 173-340-740(3)(a)(ii)(A). WAC 173-340-740(3)(a)(ii)(A) (1996) provides the "100 times rule" but also states "unless it can be demonstrated that a higher soil concentration is protective of

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern	Date:	8/26/2013	Calc. No.:	0600X-CA-V0147	Rev.:	0
Project:	600 Area Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	8/26/2013
Subject:	600-381 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No. 3 of 3	

ground water at the site." When the "100 times rule" values are exceeded, RESRAD was used to demonstrate that higher soil concentrations may be protective of groundwater.

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 600-381 Waste Site.

Contaminants of Potential Concern	Maximum Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Metals					
Boron	2.4	320	7.5E-03	--	--
Semivolatiles					
Di-n-butylphthalate	0.052	160	3.3E-04	--	--
Herbicides					
2,4-DB	0.013	12.8	1.0E-03	--	--
Anions					
Nitrogen in nitrite and nitrate	17.3	2,560	6.8E-03	--	--
Nitrite as nitrogen	0.77	160	4.8E-03	--	--
Totals					
Cumulative Hazard Quotient:			**2.0E-02**		
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:

The calculation in Table 1 demonstrates that the 600-381 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

APPENDIX C

DATA QUALITY ASSESSMENT

CONFIRMATORY SAMPLING

A data quality assessment (DQA) was performed to compare the confirmatory sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WCH 2013b). This DQA was performed in accordance with site-specific data quality objectives found in the *100 Area Remedial Action Sampling and Analysis Plan* (100 Area SAP) (DOE-RL 2009).

A review of the sample design (WCH 2013b), the field logbook (WCH 2013a), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design. To ensure quality data, the 100 Area SAP data assurance requirements and the data validation procedures for chemical analysis and radiochemical analysis (BHI 2000) are used as appropriate. This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use (i.e., closeout decisions). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process (EPA 2006).

Confirmatory sample data collected at the 600-381 waste site was provided by the laboratories in sample delivery group (SDG) J01846. SDG J01846 was submitted for third-party validation. Major and minor deficiencies are discussed for the 600-381 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 ion chromatograph (IC) anions analysis, the holding times for nitrate, nitrite, and orthophosphate in method 300.0 were exceeded by more than twice the limit in SDG J01846. All undetected nitrate, nitrite, and orthophosphate results in the SDG were qualified as rejected with "UR" flags. These results were anticipated by the project. To obtain usable nitrate data method 353.2 was also run, which has longer allowable holding time. These data effectively replace the rejected method 300.0 nitrate data. Nitrite is not considered a COPC for this waste site, but data for it is provided due to its inclusion within the EPA Method. Orthophosphate is not a regulated compound. Therefore, the resulting data set is sufficient for decision-making purposes.

MINOR DEFICIENCIES

SDG J01846

This SDG is comprised of four soil samples (J1RNL8, J1RNL9, J1RNM1, and J1RNM3) collected during confirmatory sampling of the 600-381 waste site on June 28, 2013. This SDG includes a field duplicate pair (J1RNL8/J1RNM3). All samples were analyzed for inductively coupled plasma (ICP) metals, mercury, hexavalent chromium, IC anions, nitrate/nitrite, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAH), semivolatile organic compounds (SVOC), herbicides, pesticides, and total petroleum hydrocarbons (TPH). In addition, one equipment blank (J1RNM4) was analyzed for ICP metals, mercury, and SVOCs. SDG J01846 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, and orthophosphate. The nondetected results for these analytes are discussed above in the Major Deficiencies section. Third-party validation qualified all undetected nitrate, nitrite and orthophosphate as rejected with "UR" flags. All detected nitrate, nitrite, and orthophosphate results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the IC anions analysis, the matrix spike (MS) recovery was outside of quality control (QC) limits for fluoride (54%). All 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 (1,678%), antimony (43%), iron (989%), and silicon (12%). 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 and these data may be considered estimated. Antimony and silicon did not have mismatched spike and native concentrations in the original MS. All antimony and silicon data were considered estimated 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 and iron 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 (17%). 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, iron and zinc were detected in the method blank (MB) at less than twice the minimum detection limit. Due to the MB contamination, the zinc result in sample J1RNM4 was qualified as undetected and flagged "UJ" by third-party validation. The data are usable for decision-making purposes.

In the pesticide analysis, there was no MS, matrix spike duplicate (MSD), or LCS for toxaphene. The laboratory typically quantitates toxaphene but does not include toxaphene in quality

assurance (QA)/QC samples. All toxaphene results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the SVOC analysis, the LCS recovery was outside of QC limits for 4-chloroaniline (28%), 3,3-dichlorobenzene (46%), and 3-nitroaniline (44%). All 4-chloroaniline, 3,3-dichlorobenzene, and 3-nitroaniline results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the SVOC analysis, the MS and MSD recoveries were outside of QC limits for 4,6-dinitro-2-methylphenol (28% and 27%), 2,4-dinitrophenol (14% and 13%), and hexachlorocyclopentadiene (6% and 7%). All 4,6-dinitro-2-methylphenol, 2,4-dinitrophenol, and hexachlorocyclopentadiene results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the PAH analysis, the MS/MSD relative percent difference (RPD) calculations for all analytes were above QC limits. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. All PAH results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the herbicides analysis, the dinoseb recoveries were outside of QC limits in the LCS (9%), MS (10%), and MSD (2%). The resulting MS/MSD RPD calculation for dinoseb was above QC limits at 145%. All dinoseb results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the herbicides analysis, the 4-(2,4-dichlorophenoxy)butanoic acid (2,4-DB) recovery in the MSD (47%) was outside of QC limits. The resulting MS/MSD RPD calculation for 2,4-DB was above QC limits at 32%. Although not qualified for the MSD and MS/MSD RPD calculation outside of QC limits, all 2,4-DB results may be considered estimated. Estimated data are usable for decision-making purposes.

In the TPH analysis, contamination in the MB at less than twice the minimum detection limit was measured for diesel range and diesel range extended hydrocarbons. Due to MB contamination, the diesel range extended result in sample J1RNL8 was qualified as undetected and flagged "U" while the result in sample J1RNM1 was qualified as undetected, raised to the required detection limit, and flagged "U" by third-party validation. Due to MB contamination, all diesel range hydrocarbon results were qualified as undetected, raised to the required detection limit, and flagged "U" by third-party validation. 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 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 2013a), 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
TP1 soil below surface vent feature	J1RNL8	J1RNM3

Field duplicate samples are collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the sample/duplicate pair(s) for each contaminant of potential concern. Relative percent differences are not calculated for analytes that are not detected in both the main and duplicate sample at more than five times the target detection limit. The RPDs 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.

All calculated RPDs for the field QA/QC duplicate samples were within the acceptance criteria of 30%. The data are usable for decision-making purposes.

A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the target detection limit, including undetected analytes. In these cases, a control limit of ±2 times the target detection limit 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 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 600-381 waste site confirmatory 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 600-381 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 confirmatory sample analytical data are stored in a Washington Closure Hanford project-specific database prior to being submitted for inclusion in the Hanford Environmental

Information System database. The confirmatory sample analytical data are also summarized in Appendix B.

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