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

14-AMRP-0273

SEP 09 2014

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 600-384, SEGMENT 4 STAINED SOIL AREA #3 WASTE SITE, REVISION 0

Attached for your use is the approved Waste Site Reclassification Form No. 2014-008 and supporting "Remaining Sites Verification Package for the 600-384, Segment 4 Stained Soil Area #3 Waste Site," Rev. 0. If you have questions, please contact me or your staff may contact Ellwood Glossbrenner, of my staff, on (509) 376-5828.

Sincerely,

Mark S. French, Director
River Corridor Division

AMRP:ETG

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.:** 2014-008

Waste Site Code(s)/Subsite Code(s):
600-384, Segment 4 Stained Soil Area #3
600-384:1, Segment 4 Stained Soil Area #3a
600-384:2, Segment 4 Stained Soil Area #3b
600-384:3, Segment 4 Stained Soil Area #3c
600-384:4, Segment 4 Stained Soil Area #3d
600-384:5, Segment 4 Stained Soil Area #3e

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 600-384, Segment 4 Stained Soil Area #3 waste site, part of the 100-HR-2 Operable Unit, consisted of five locations that had yellow powder, tar, or crusted soils. The 600-384 waste site includes five subsites: 600-384:1, 600-384:2, 600-384:3, 600-384:4, and 600-384:5. The 600-384 waste site is located in the 600 Area, north of the railroad tracks and Route 2 North, between the 100-H and 100-D Areas. The 600-384 waste site was added to the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999), as a candidate site for confirmatory sampling in the Tri-Party Agreement Administrative Record Fact Sheet *100 Area "Plug-In" and Candidate Waste sites for Calendar Year 2012,* U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2013). The 600-384 waste site was subsequently recommended for remove, treat and dispose (RTD) without confirmatory sampling based on the observed presence of stained soils, stressed vegetation, and barren ground at the five subsites and is being dispositioned as a "plug-in" waste site in accordance with the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington* U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 2009).

Remediation of the 600-384 waste site was performed on November 4, 5, and 25, 2013, and March 3 through 5, 2014. The remediation resulted in approximately 325 bank cubic meters (425 bank cubic yards) of material being removed and disposed at the Environmental Restoration Disposal Facility (ERDF). Cleanup verification sampling was performed on January 29 and March 6, 2014, to determine if the waste site meets remedial action objectives (RAOs) and remedial action goals (RAGs) established by the Remaining Sites ROD (EPA 1999) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP), DOE/RL 96-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2009b). The selected remedy involved (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at ERDF at the 200 Area of the Hanford Site, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the site for reclassification as Interim Closed Out.

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-HR-2 **Control No.:** 2014-008

Waste Site Code(s)/Subsite Code(s):

600-384, Segment 4 Stained Soil Area #3
600-384:1, Segment 4 Stained Soil Area #3a
600-384:2, Segment 4 Stained Soil Area #3b
600-384:3, Segment 4 Stained Soil Area #3c
600-384:4, Segment 4 Stained Soil Area #3d
600-384:5, Segment 4 Stained Soil Area #3e

Basis for reclassification:

In accordance with this evaluation, the verification sampling results support a reclassification of the 600-384 waste site to Interim Closed Out. The current site conditions achieve the RAOs and RAGs established by the Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009b). The results of verification sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. 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 600-384, Segment 4 Stained Soil Area #3 Waste Site* (attached).

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		8/5/14
DOE Federal Project Director (printed)	Signature	Date
N. Menard Kim Welsch for	Kim Welsch for	8/13/14
Ecology Project Manager (printed)	Signature	Date
NA		
EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 600-384, SEGMENT 4 STAINED SOIL AREA #3 WASTE SITE

Attachment to Waste Site Reclassification Form 2014-008

August 2014

REMAINING SITES VERIFICATION PACKAGE FOR THE 600-384, SEGMENT 4 STAINED SOIL AREA #3 WASTE SITE

EXECUTIVE SUMMARY

The 600-384, Segment 4 Stained Soil Area #3 waste site, part of the 100-HR-2 Operable Unit, consisted of five locations that had yellow powder, tar or crusted soils. The 600-384 waste site includes five subsites: 600-384:1, 600-384:2, 600-384:3, 600-384:4, and 600-384:5. The 600-384 waste site is located north of the railroad tracks and Route 2 North, between the 100-D and 100-H Areas. The 600-384 waste site was added to the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD) (EPA 1999) as a candidate site for confirmatory sampling by the Tri-Party Agreement Administrative Record Fact Sheet *100 Area "Plug-In" and Candidate Waste Sites for Calendar Year 2012* (DOE-RL 2013). The 600-384 waste site was subsequently recommended for remove, treat, and dispose (RTD) without confirmatory sampling based on the observed presence of stained soils, stressed vegetation, and barren ground at the five subsites (WCH 2013a). The 600-384 waste site is being dispositioned as a "plug-in" waste site in accordance with the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington* (EPA 2009).

Remediation of the 600-384 waste site occurred on November 4, 5, and 25, 2013, and resulted in approximately 92 bank cubic meters (BCM) (120 bank cubic yards [BCY]) of soil and debris being removed for disposal at the Environmental Restoration Disposal Facility (ERDF). No overburden soil was stockpiled to be used as backfill.

Following remediation, verification sampling at the 600-384 waste site was conducted on January 29, 2014. The sampling data results indicated that three verification samples and one duplicate collected from the 600-384:3, 600-384:4, and 600-384:5 subsites had motor oil concentrations above the soil cleanup level of 200 mg/kg. On March 3 through 5, 2014, additional remediation was performed at the 600-384:3, 600-384:4, and 600-384:5 subsites to remove additional contaminated soil. The excavation at the three subsites resulted in 233 BCM (305 BCY) of additional soil being removed and disposed at ERDF. The final remediation resulted in a total of approximately 325 BCM (425 BCY) of contaminated material being removed and disposed at ERDF. Resampling at the three subsites was performed on March 6, 2014.

The final verification results indicated that the waste site achieved compliance with the remedial action objectives (RAOs) and remedial action goals (RAGs) for the 600-384 waste site. Verification sampling results support a determination that residual contaminant concentrations in the soil meet cleanup criteria specified in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE RL 2009b) and the

Remaining Sites ROD (EPA 1999). The results indicated that the waste removal action achieved compliance with the RAOs and RAGs for the 600-384 waste site.

A summary of the evaluation for the soil results against the applicable criteria is presented in Table ES-1. The results of the verification sampling are used to make reclassification decisions for the 600-384 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 600-384 Waste Site. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain a dose rate of <15 mrem/yr above background for 1,000 years.	Radionuclides were not COPCs for the 600-384 waste site.	NA
Direct Exposure – Nonradionuclides	Attain individual COPC direct exposure 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 (6.3×10^{-3}) is <1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	The individual carcinogens all have excess cancer risks that are $<1 \times 10^{-6}$	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	The total excess cancer risk is 7.2×10^{-7}, and thus is $<1 \times 10^{-5}$.	
Groundwater/River Protection – Radionuclides	Attain single-COPC groundwater and river protection RAGs.	Radionuclides were not COPCs for the 600-384 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].		

Table ES-1. Summary of Remedial Action Goals for the 600-384 Waste Site. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements	Residual concentrations of lead, zinc, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)-fluoranthene, and dibenz(a,h)-anthracene within the 600-384 waste site are above the soil RAGs for groundwater and/or river protection. However, RESRAD modeling predicts that these constituents will not reach groundwater (and, therefore, the Columbia River) within 1,000 years [d].	Yes

[a] "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).
[b] *Radiation Protection of the Public and the Environment* (DOE Order 5400.5).
[c] Based on the isotopic distribution of uranium in the 100 Area, the 30 µg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* (BHI 2001).
[d] Based on the RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), residual concentrations of lead, zinc, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and dibenz(a,h)anthracene are not expected to migrate more than 1.8 m (5.9 ft) vertically in 1,000 years (based on the lowest distribution coefficient of the contaminants exceeding the RAGs, lead and zinc with a distribution coefficient of 30 mL/g). The vadose zone underlying the soil below the 600-384 waste site is a minimum of 5 m (16.4 ft) thick. Therefore, residual concentrations of these constituents 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 verification sampling results support a reclassification of these sites to Interim Closed Out. The current site conditions achieve the RAOs and the corresponding RAGs established in the 100 Area RDR/RAWP (DOE-RL 2009b) and the 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. No contaminants of potential concern (COPCs) were found to exceed direct exposure RAGs 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 of the subsites are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a

comparison against ecological risk screening levels has been made for the sites contaminants of concern, COPCs, and other constituents. Those constituents exceeding the ecological screening level in *Washington Administrative Code* 173-340, "Model Toxics Control Act – Cleanup," were barium, boron, lead, vanadium, and zinc. The U.S. Environmental Protection Agency ecological soil screening levels were exceeded for cobalt, cadmium, lead, manganese, vanadium, and zinc. Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. Because the detected levels of barium, cobalt, cadmium, manganese, and vanadium are below Hanford Site 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 risk to ecological receptors as a part of the final closeout decision for this site.

REMAINING SITES VERIFICATION PACKAGE FOR THE 600-384, SEGMENT 4 STAINED SOIL AREA #3 WASTE SITE

STATEMENT OF PROTECTIVENESS

The 600-384, Segment 4 Stained Soil Area #3 waste site verification sampling data, site evaluations, and supporting documentation demonstrate that this site meets the objectives established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 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 in part on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the sites contaminants of concern, COPCs, and other constituents. Those constituents exceeding the ecological screening level in *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act - Cleanup," were barium, boron, lead, vanadium, and zinc. The U.S. Environmental Protection Agency's (EPA's) ecological soil screening levels were exceeded for cobalt, cadmium, lead, manganese, vanadium and zinc. Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. Because the detected levels of barium, cobalt, cadmium, manganese, and vanadium are below Hanford Site 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 risk to ecological receptors as a part of the final closeout decision for this site. A table showing contaminant concentrations from the 600-384 waste site that exceed ecological screening levels is provided in Appendix A.

GENERAL SITE INFORMATION AND BACKGROUND

The 600-384, Segment 4 Stained Soil Area #3 waste site, part of the 100-HR-2 Operable Unit, consisted of five locations that had yellow powder, tar, or stained or crusted soils. The 600-384 waste site was divided into five subsites (600-384:1, 600-384:2, 600-384:3, 600-384:4, and 600-384:5). The 600-384 subsites are located in the 600 Area, north of the railroad tracks

and Route 2 North, between the 100-D and 100-H Areas (Figure 1). The centers of the five subsites are as follows (rounded to the nearest 0.1 m [4 in.] from the coordinates provided in Waste Information Data System [WIDS]):

- 600-384:1, N 151010.6, E 575505.7
- 600-384:2, N 151135.4, E 575481.9
- 600-384:3, N 152256.6, E 575312.3
- 600-384:4, N 152209.0, E 575508.8
- 600-384:5, N 151249.0, E 575684.1.

There is no process history associated with the 600-384 subsites. These subsites were discovered while the 100-F/IU-2/IU-6 Area – Segment 4 Orphan Sites Evaluation (OSE) was being performed. The 600-384 waste site is reported in WIDS as consisting of five subsites that have stain areas with either yellow powder, tar, or crusted soils. The OSE identification numbers as referenced in the *100-F/IU-2/IU-6 Area – Segment 4 Orphan Sites Evaluation Report* (WCH 2011, Table 7-2) for each subsite are provided in Table 1.

Table 1. Subsite and Orphan Sites Evaluation Identification Numbers.

Subsite WIDS Number	OSE Feature Number
600-384:1	SG4DH-039
600-384:2	SG4DH-040
600-384:3	SG4DH-102
600-384:4	SG4DH-108
600-384:5	SG4DH-121

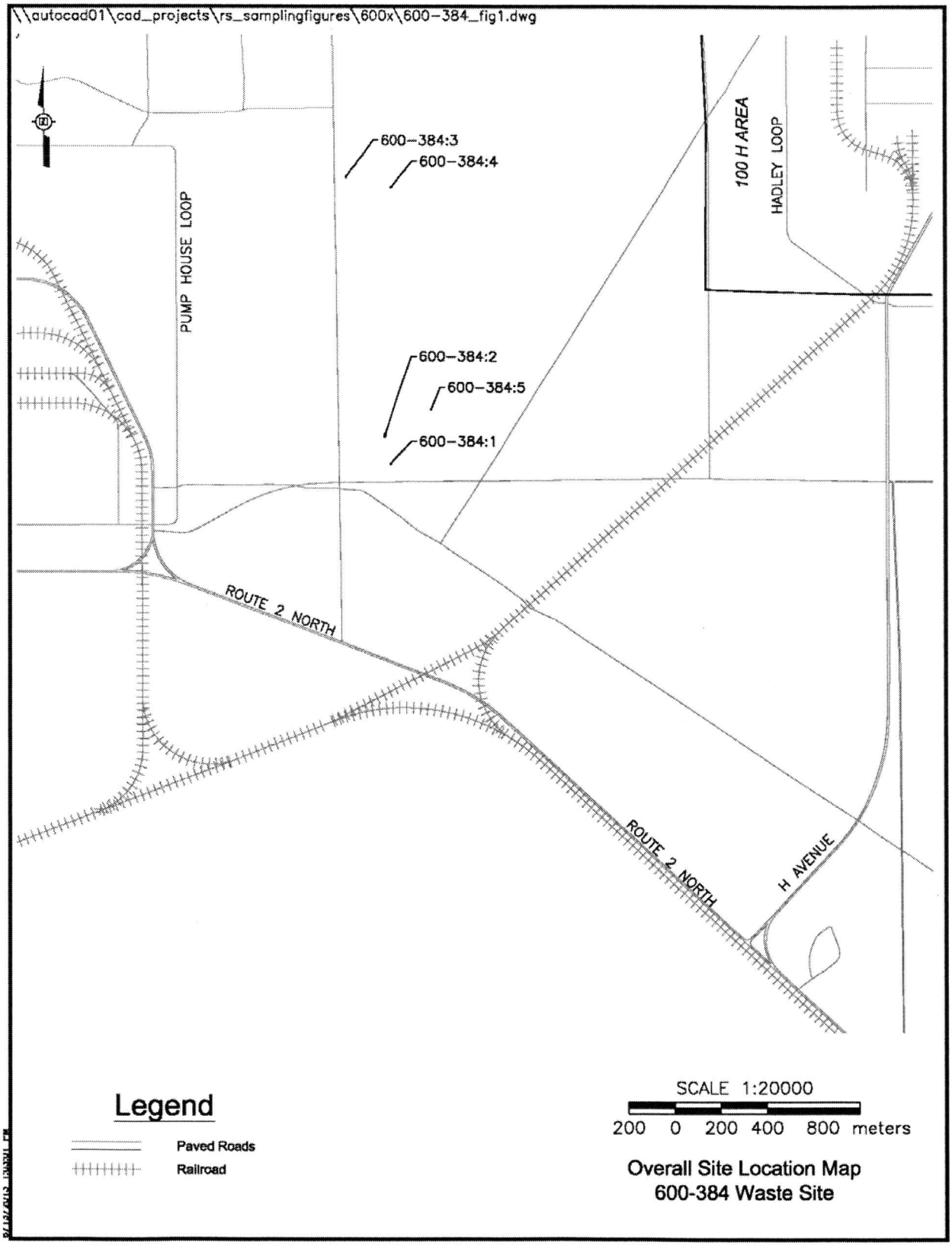
OSE = orphan sites evaluation
WIDS = waste information data system

Ecological and Cultural

An ecological and cultural resources review to support 600 Area waste characterization sampling (WCH 2013b) included evaluation of the 600-384 subsites. Washington Closure Hanford (WCH) Natural Resources staff conducted a survey of these locations to evaluate the project area and record site-specific biological resources. No ecological resources were affected during the remediation of these subsites and the recommendations provided were followed.

Although discovery of cultural resources has not been anticipated, all workers were directed to watch for cultural materials during work activities. If any cultural materials were encountered during verification sampling, work in the discovery area had to stop until a WCH Cultural Resources Specialist has been notified.

Figure 1. The 600-384 Waste Site Location Map.



Geophysical Survey

Geophysical surveys have been performed at each of the 600-384 subsites. The geophysical surveys did not indicate the presence of subsurface metallic objects at any of the 600-384 subsites other than an irrigation line at 600-384:2 (Figure 2). Indications of surface metallic objects were found at the 600-384:1, 600-384:3, and 600-384:4 subsites (Figures 2 through 4). No indication of surface metallic objects was found at the 600 384:5 subsite (Figure 5).

Waste Characterization Sampling

Waste characterization sampling was performed to determine the COPCs and waste disposal requirements for the subsites, and to guide remedial action efforts. All waste characterization sampling data are included in Appendix B.

REMEDIAL ACTION SUMMARY

The 600-384 waste site was recommended for remediation without confirmatory sampling based on the observed presence of stained/crusted soils, stressed vegetation, debris, and barren ground at the waste site subsites (WCH 2013a).

Remedial Action

Remediation of the 600-384:1, 600-384:2, and 600-384:5 subsites was performed on November 4 and 5, 2013. Remediation of the 600-384:3 and 600-384:4 subsites was performed on November 25, 2013. Remediation of the 600-384 waste site resulted in approximately 92 bank cubic meters (BCM) (120 bank cubic yards [BCY]) of soil and debris being removed for disposal at the Environmental Restoration Disposal Facility (ERDF).

The 600-384 waste site verification sampling performed on January 29, 2014, indicated that three of the subsites (600-384:3, 600-384:4, and 600-384:5) exceeded the 200 mg/kg soil cleanup level for motor oil. Additional remediation was performed at the 600-384:3, 600-384:4, and 600-384:5 subsite locations on March 3 through 5, 2014. Additional soil was removed across the entire base of each subsite excavation. Further remediation performed at these three subsites resulted in an additional soil removal of 233 BCM (305 BCY).

The final remediation resulted in a total of approximately 325 BCM (425 BCY) of contaminated material being removed and disposed at ERDF.

Post-excavation photographs of each waste site excavation are provided in Figures 6 through 10. All material removed from the waste sites was direct loaded for disposal at ERDF, and no soil staging pile areas or overburden areas were utilized.

Figure 2. Geophysical Interpretation Map for the 600-384:1 and 600-384:2 Subsites.

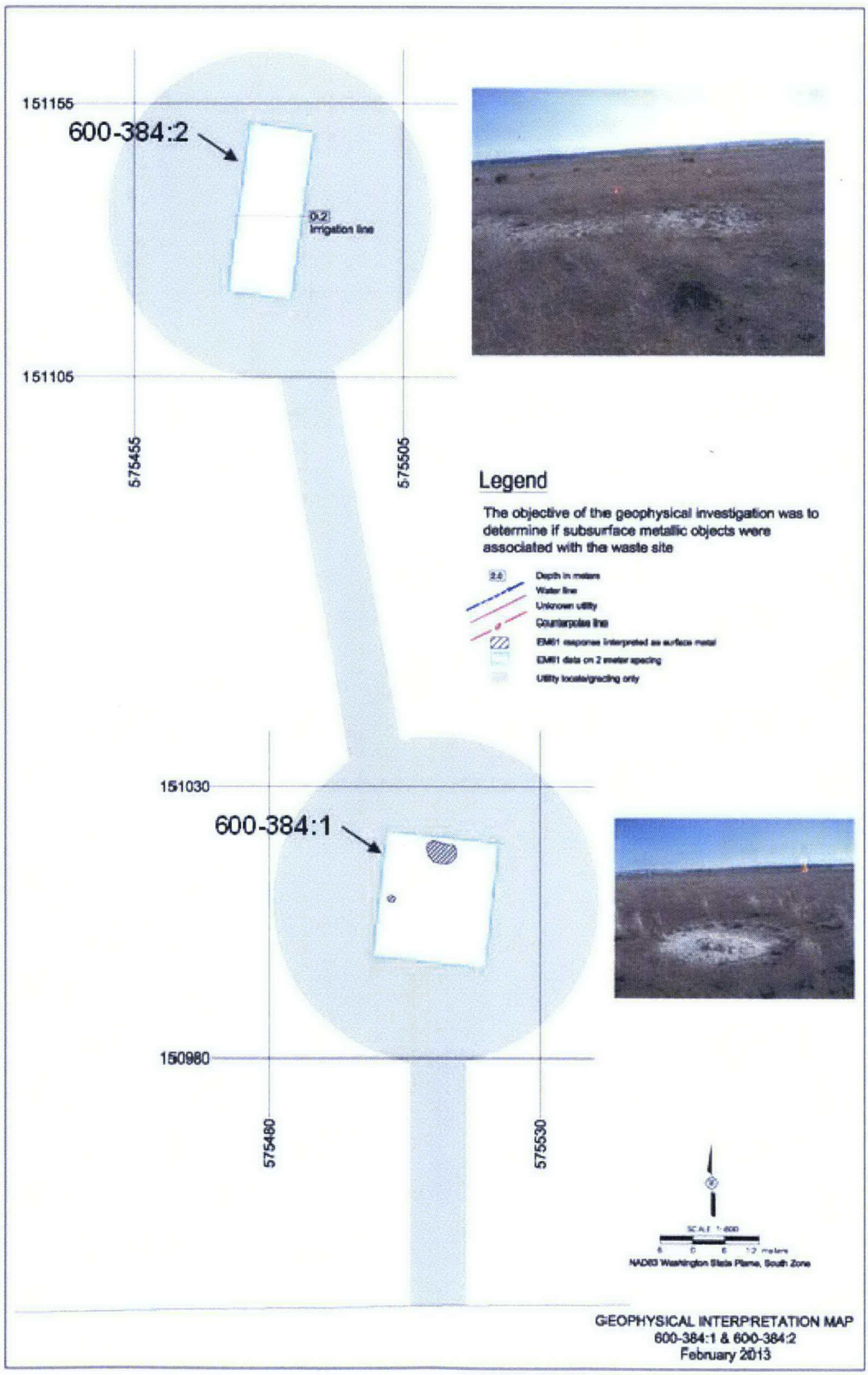


Figure 3. Geophysical Interpretation Map for the 600-384:3 Subsite.

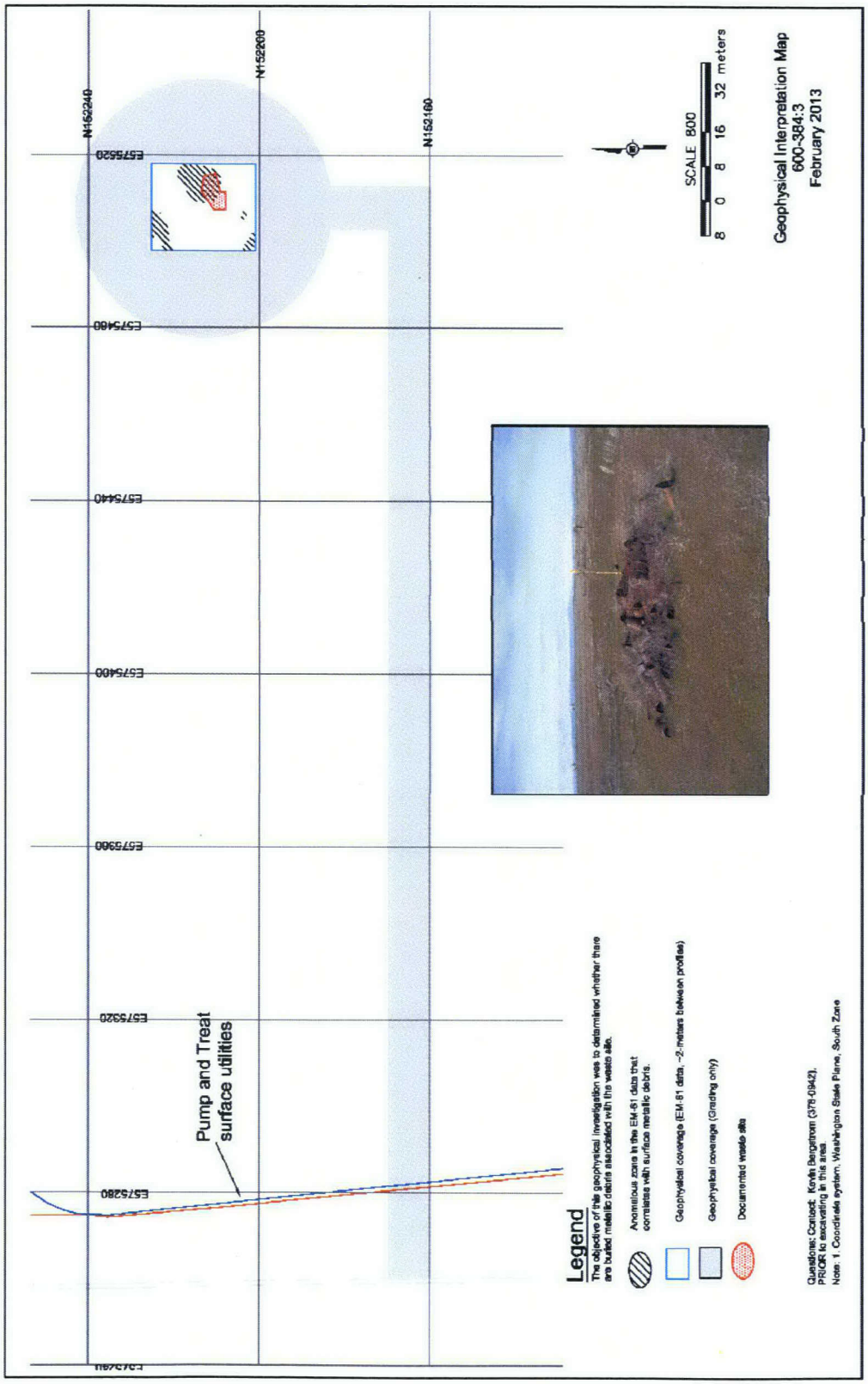


Figure 4. Geophysical Interpretation Map for the 600-384:4 Subsite.

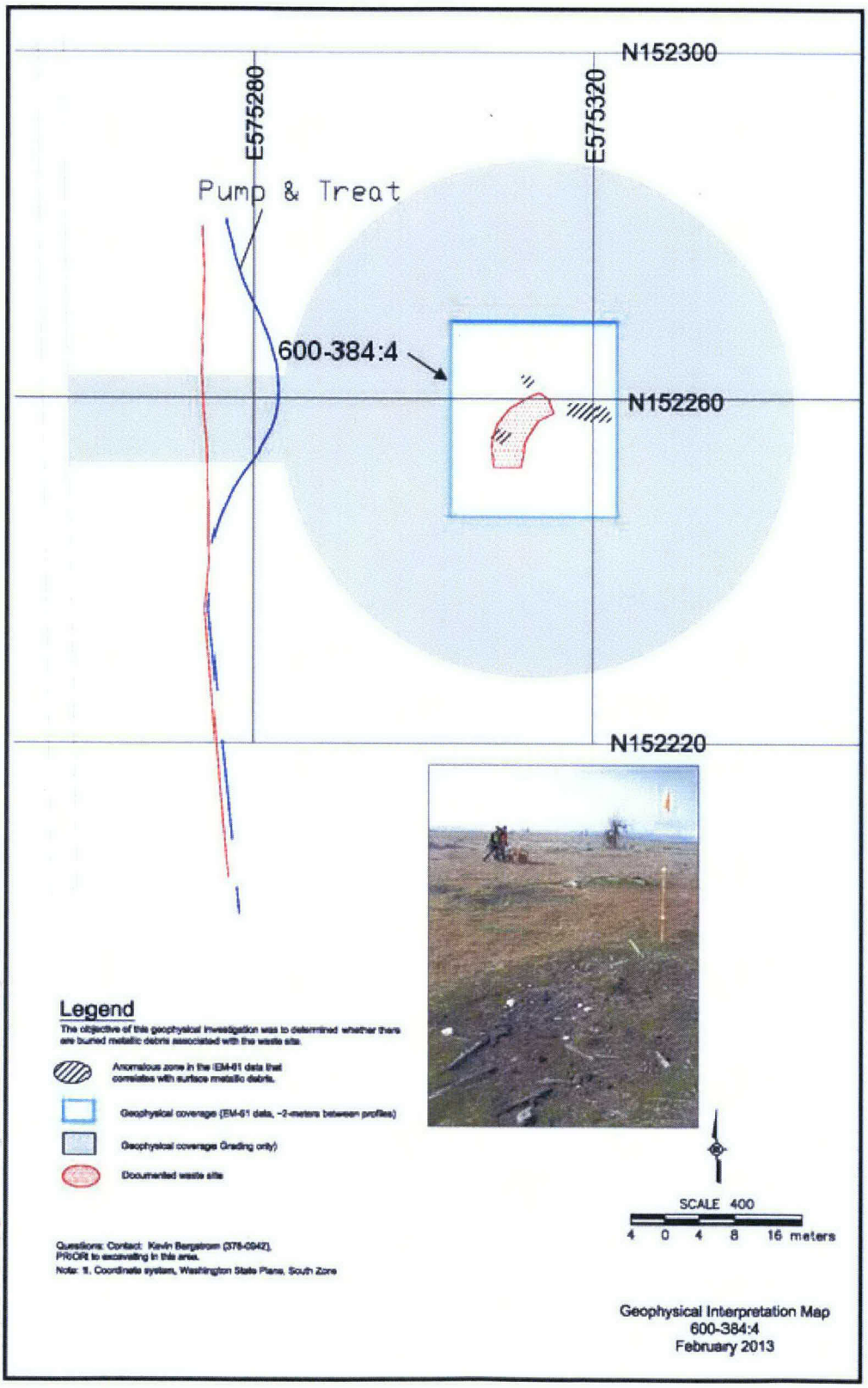


Figure 5. Geophysical Interpretation Map for the 600-384:5 Subsite.

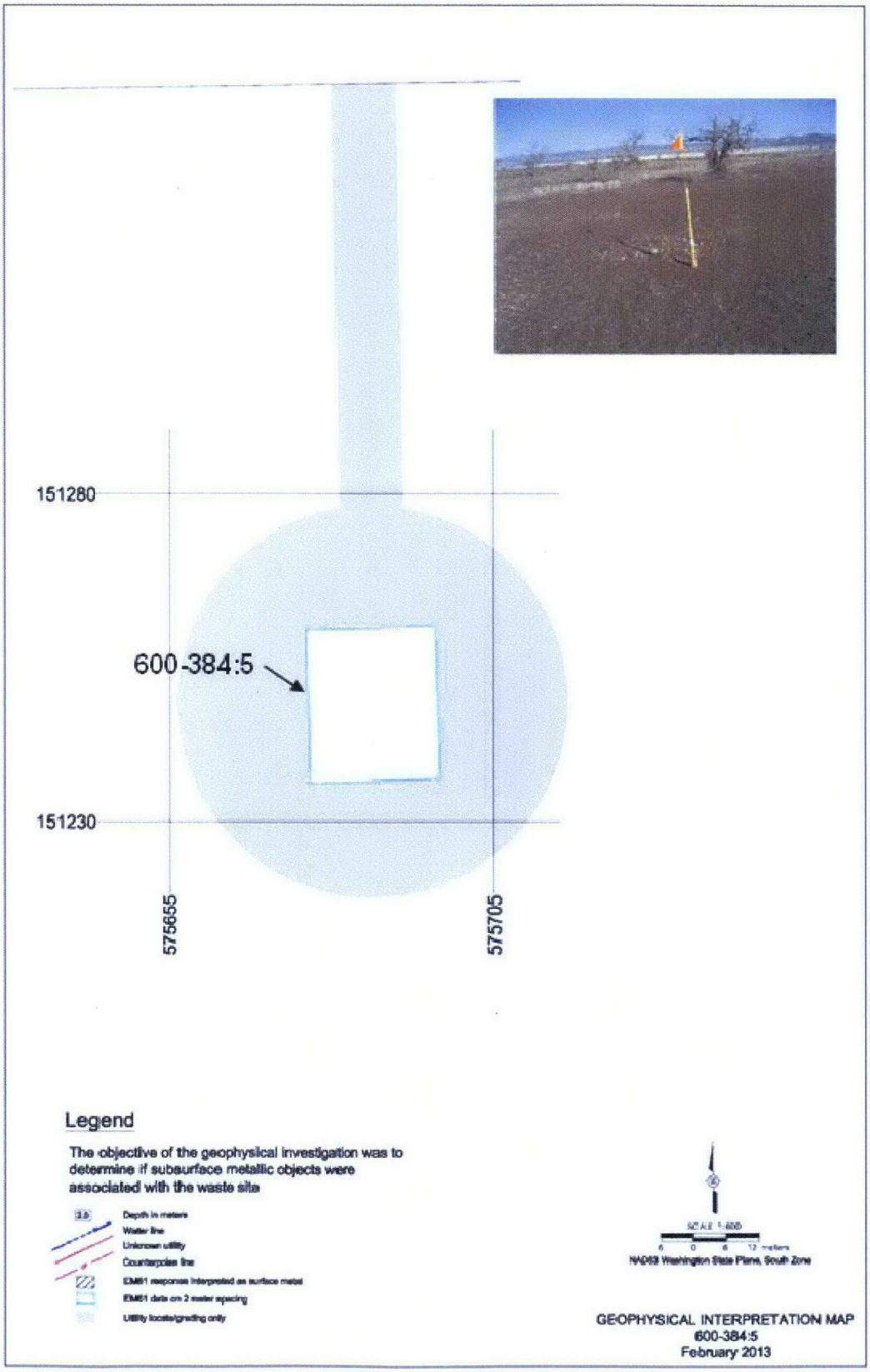


Figure 6. Photograph of the 600-384:1 Subsite Remediation, Looking North (November 4, 2013).

Figure 7. Photograph of the 600-384:2 Subsite Excavation (Dated November 5, 2013).

Figure 8. Photograph of the 600-384:3 Subsite Excavation Following Additional Remediation (Dated March 20, 2014).

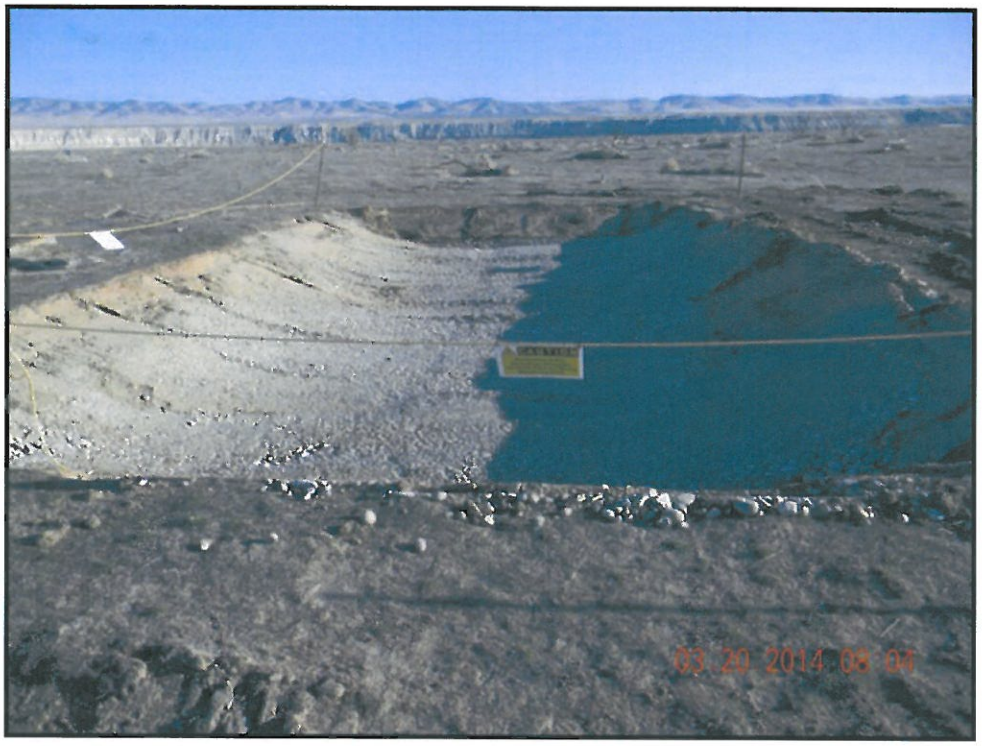


Figure 9. Photograph of the 600-384:4 Subsite Excavation Following Additional Remediation (Dated March 20, 2014).

Figure 10. Photograph of the 600-384:5 Subsite Excavation Following Additional Remediation (Dated March 20, 2014).

VERIFICATION SAMPLING ACTIVITIES

Initial verification sampling was performed at the 600-384 waste site on January 29, 2014. The analytical data results indicated that additional remediation was required at three sample locations (600-384:3b, 600-384:4, and 600-384:5). Motor oil concentrations at these three locations exceeded the soil cleanup level of 200 mg/kg. Following additional remediation, excavation sample locations 600-384:3b, 600-384:4, and 600-384:5 were resampled on March 6, 2014. The resampling locations were analyzed for total petroleum hydrocarbons (TPH).

Additional remediation performed at the 600-384:4 subsite resulted in an excavation area of greater than 100 m^2. Due to the increase of the excavation area, one additional verification sample was collected from the 600-384:4 excavation on March 6, 2014, and analyzed for inductively coupled plasma (ICP) metals, mercury, TPH, polycyclic aromatic hydrocarbons (PAH), pesticides, herbicides, and polychlorinated biphenyls (PCBs). Ion chromatography (IC) anions and cyanide analyses were inadvertently not requested on the additional sample. However, the available analytical data results from the 600-384:4 excavation before additional remediation indicate that sulfate and cyanide (COPCs) concentrations are below their most restrictive soil cleanup values.

The final verification results indicated that the waste site achieved compliance with the remedial action objectives (RAOs) and RAGs for the 600-384 waste site.

Sampling was conducted to support a determination that residual contaminant concentrations in the soil meet cleanup criteria specified in the 100 Area RDR/RAWP (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999).

The verification sample results are provided in Appendix C and indicate that the waste removal action achieved compliance with the RAOs and RAGs for the 600-384 waste site. The following subsections provide additional discussion of the information used to develop the verification sampling design. The maximum results of verification sampling are summarized to support interim closure of the waste site. A more detailed discussion of the verification sampling can be found in the *Work Instruction for Verification Sampling of the 600-384, Segment 4 Stained Soil Area #3* (WCH 2013c) and associated sampling agreements (WCH 2014a, 2014b).

Contaminants of Potential Concern

The COPCs for the individual subsites were based on site descriptions, observations during walkdowns, the results of waste characterization sampling (Appendix B), and professional judgment. Analytes that were detected near or above RAGs during waste characterization sampling (Appendix B) were included as COPCs for verification sampling. During waste characterization sampling, it was noted that the powder material located at the surface of the 600-384:1 and 600-384:2 subsites had a slight sulfur smell; therefore, IC anions analysis was performed for verification sampling. The 600-384 waste site COPCs included ICP metals, mercury, IC anions, cyanide, TPH, PAH, pesticides, herbicides, and PCBs. 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. The COPCs for verification sampling and the laboratory analytical methods are identified in Table 2.

Verification Sampling Design

This section describes the basis for selection of an appropriate sample design and determination of the number of verification sample that were collected. All sampling was performed in accordance with the *100 Area Remedial Action Sampling and Analysis Plan* (100 Area SAP) (DOE-RL 2009a). Verification soil sampling occurred based on the size of each subsite area in accordance with Table 3.

Table 4 includes information from the verification sampling instruction (WCH 2013c) that estimated the dimensions of each waste site and correlated the number of samples to be collected to the estimated waste site size based on Table 2. The actual dimensions and surface area of the subsites after remediation along with the updated number of samples for the sample design is also presented.

Table 2. Laboratory Analytical Methods for the 600-384 Waste Site.

Analytical Method	Contaminant of Potential Concern
ICP metals [a] – EPA Method 6010	ICP metals
Mercury – EPA Method 7471	Mercury
IC anions – EPA Method 300.0	Sulfate
Total cyanide – EPA Method 9010	Cyanide
TPH – NWTPH-Dx	TPH
PAH – EPA Method 8310	PAH
PCB – EPA Method 8082	PCBs
Pesticides – EPA Method 8081	Pesticides
Herbicides – EPA Method 8151	Herbicides

[a] Analysis was performed for the expanded list of ICP metals to include antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, magnesium, molybdenum, nickel, selenium, silver, vanadium, and zinc.

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
TPH = total petroleum hydrocarbons

Table 3. Verification Sampling Design Based on Waste Site Surface Area.

Surface Area	Sample Design
<100 m^2	One focused sample
100 - 500 m^2	Two focused samples (halves)
500 - 1000 m^2	Four focused samples (quadrants)
>1000 m^2	Statistical design using Visual Sample Plan

Table 4. Waste Site Dimension Information. (2 Pages)

Subsite	WIDS Subsite Area Description	WSP Coordinates (m)		Estimated Remediation Dimensions [b] L x W x D (m)	Estimated Surface Area (m^2)	Actual Remediation Dimensions L x W x D (m)	Actual Surface Area (m^2)	Sample Design
		Northing [a]	Easting [a]					
600-384:1	"4 m (13 ft) diameter area"	151010.6	575505.7	4 x 4 x 1	16	7 x 7 x 1.5	49	One focused
600-384:2	"a 15 m (49 ft) diameter area"	151135.4	575481.9	15 x 15 x 1	225	16 x 9 x 1.2	144	Two focused
600-384:3	"Approximate 10-m area" [c]	152256.6	575312.3	10 x 10 x 1	100	14 x 8 x 1	112	Two focused
600-384:4	"a 4 m (13 ft) diameter area"	152209.0	575508.8	4 x 4 x 1	16	14 x 13.3 x 1.3	186	Two focused [d]

Table 4. Waste Site Dimension Information. (2 Pages)

Subsite	WIDS Subsite Area Description	WSP Coordinates (m)		Estimated Remediation Dimensions [b] L x W x D (m)	Estimated Surface Area (m^2)	Actual Remediation Dimensions L x W x D (m)	Actual Surface Area (m^2)	Sample Design
		Northing [a]	Easting [a]					
600-384:5	"a 1.5 m (5 ft) diameter area"	151249.0	575684.1	2 x 2 x 1	4	10 x 7 x 0.9	70	One focused

[a] These coordinates are rounded to the nearest 0.1 m (4 in.) from those given in WIDS.
[b] The vertical and lateral extent of contamination at these sites is unknown; however, reasonable certainty exists to conclude that the contamination is restricted to the surface debris and the surface stained soil. The L x W dimensions are based on a square that fits around a circle of contamination having a diameter equal to L and W. The remediation depth (D) is estimated based on remediation at analogous sites.
[c] WIDS does not provide the area for the 600-384:3 subsite. The listed area is from the *100-F/IU-2/IU-6 Area – Segment 4 Orphan Sites Evaluation Report* (WCH 2011, p. 7-69).
[d] The remediated area exceeded the 100-m^2 threshold following additional remediation. In accordance with the regulatory concurrence, two focused samples were collected instead of one focused sample (WCH 2014a, 2014b).

WIDS = waste information data system
WSP = Washington State Plane

The Washington State Plane coordinates shown in Table 4 are the approximate center of the sample area for each focused sample. Figures 11 through 15 show the waste site excavation footprints and the focused sample locations. A summary of the verification samples collected and laboratory analyses performed is provided in Table 5. All sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management*, to fulfill the requirements of the 100 Area SAP (DOE RL 2009a). Additional information related to verification sampling can be found in the field sampling logbook (WCH 2014c).

Verification Sample Results

All verification samples were analyzed using analytical methods approved by EPA (DOE-RL 2009b). Evaluation of the verification data from the 600-384 waste site was performed by direct comparison of the maximum sample results for each COPC against cleanup criteria. If no detections for a given COPC were reported in the data set, then no maximum evaluation calculations were performed for that COPC.

Comparisons of the results for site COPCs with the RAGs for the 600-384 waste site are listed in Table 6. Contaminants that were not detected by laboratory analysis are excluded from these tables. Calculated cleanup levels are not presented in the Cleanup Levels and Risk Calculations Database (Ecology 2014) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COPCs and are also not included in this table. The laboratory-reported data results for all constituents are stored in the WCH project-specific database prior to archival in the Hanford Environmental Information System (HEIS), and are presented in Attachment 1 of the 600-384 Waste Site Relative Percent Difference and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations (Appendix C).

Figure 11. 600-384:1 Excavation Boundary Overlaying the WIDS Boundary.

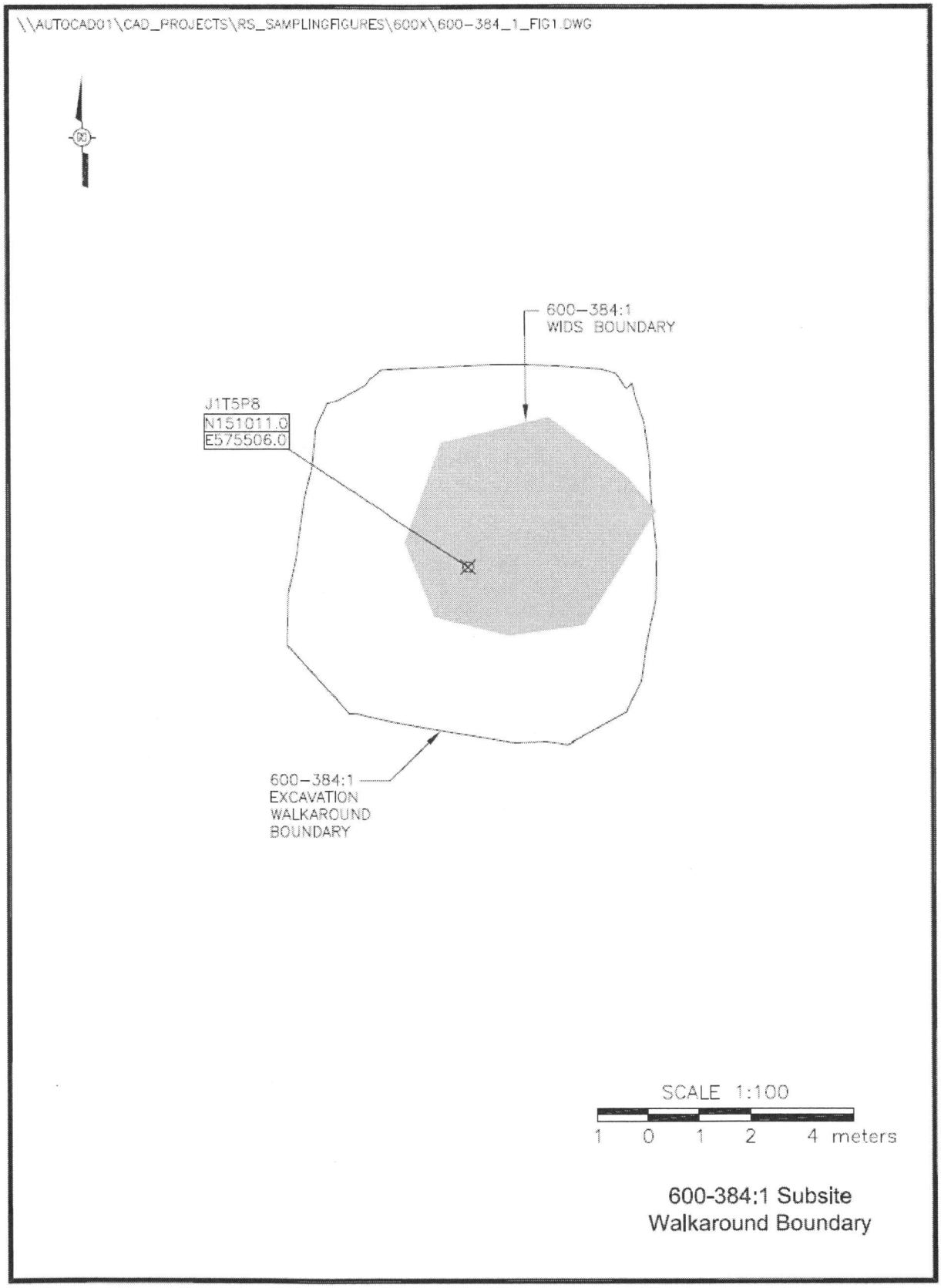


Figure 12. 600-384:2 Excavation Boundary Overlaying the WIDS Boundary.

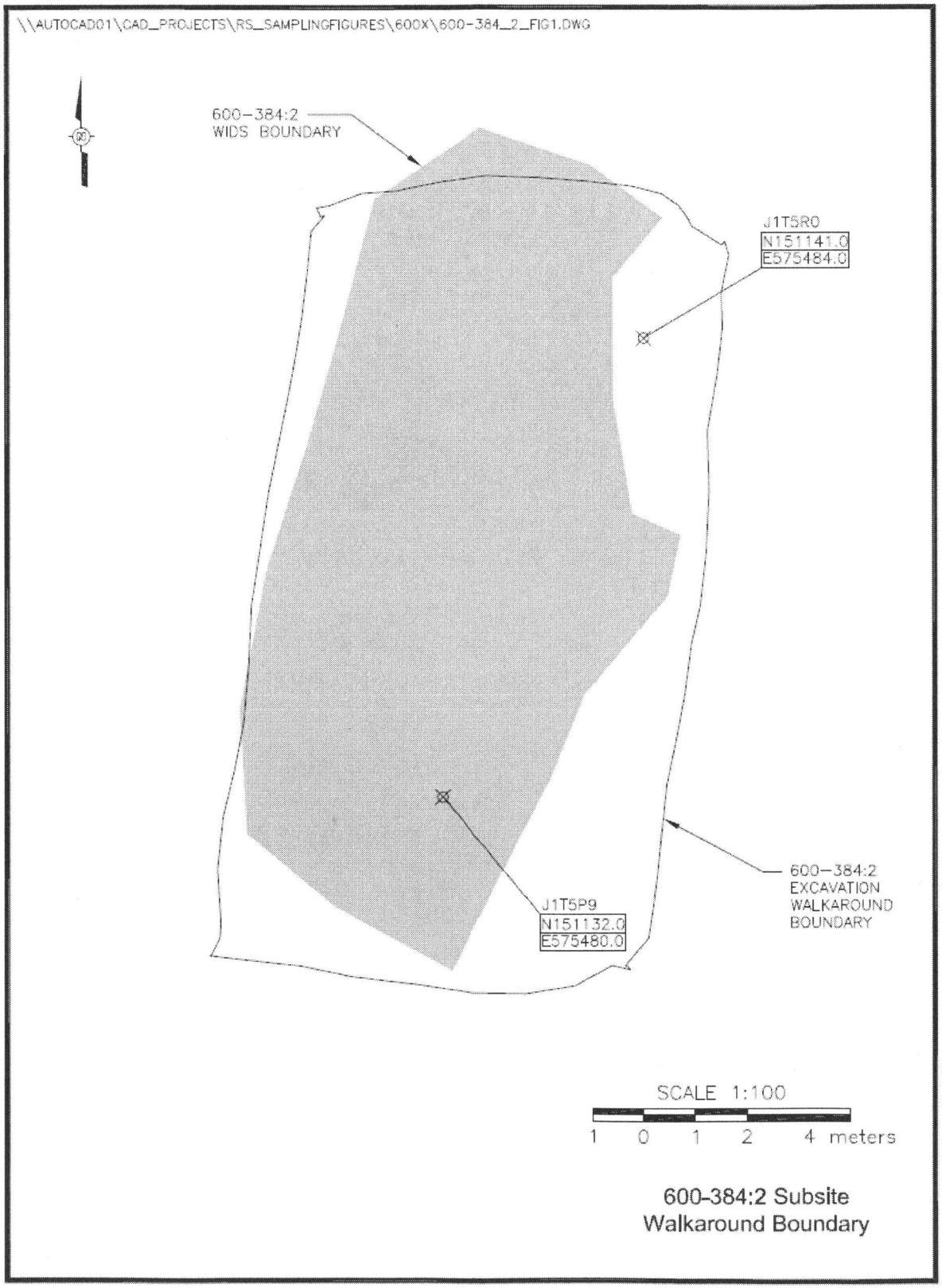


Figure 13. 600-384:3 Excavation Boundary Overlaying the WIDS Boundary.

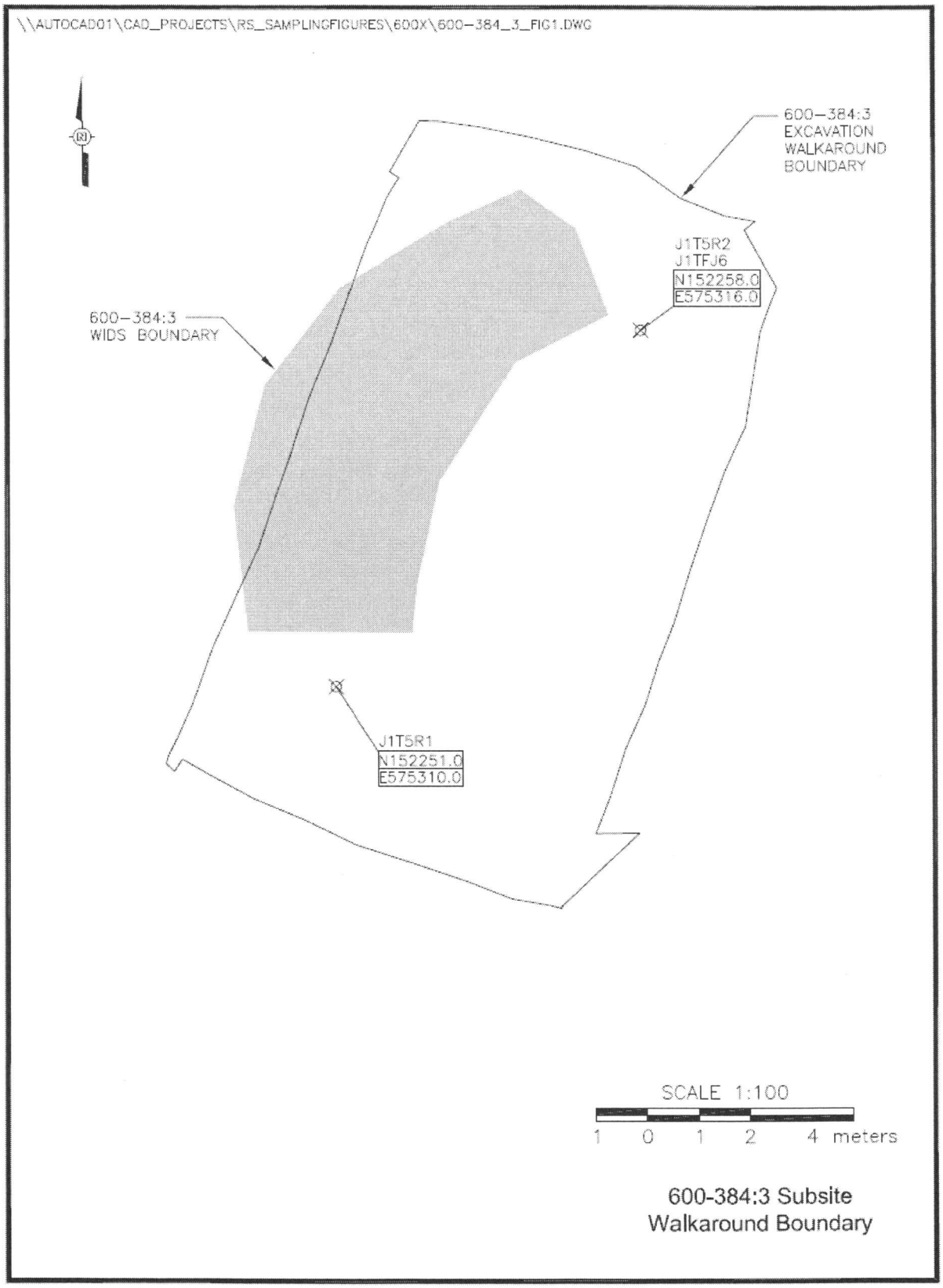


Figure 14. 600-384:4 Excavation Boundary Overlaying the WIDS Boundary.

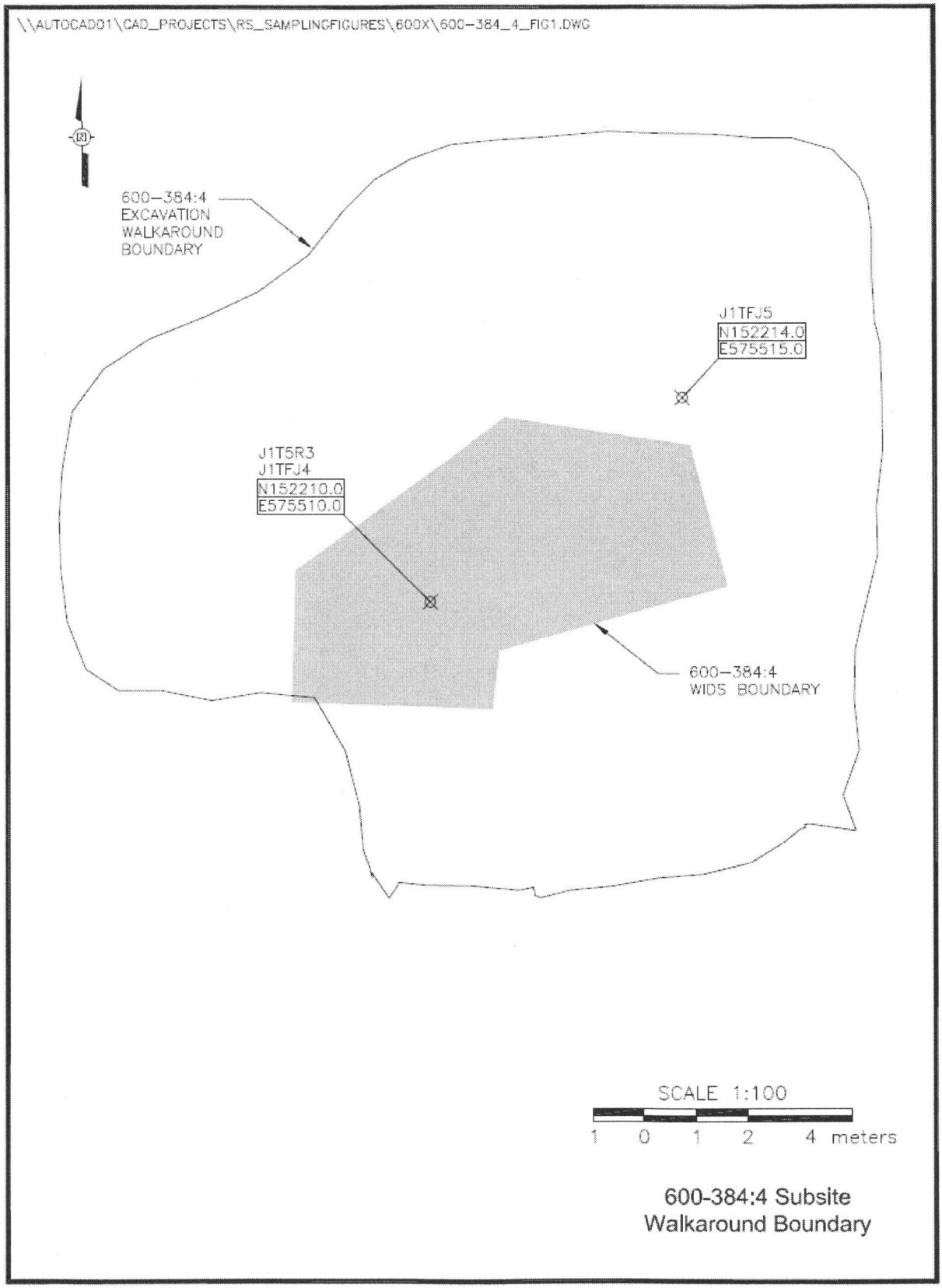


Figure 15. 600-384:5 Excavation Boundary Overlaying the WIDS Boundary.

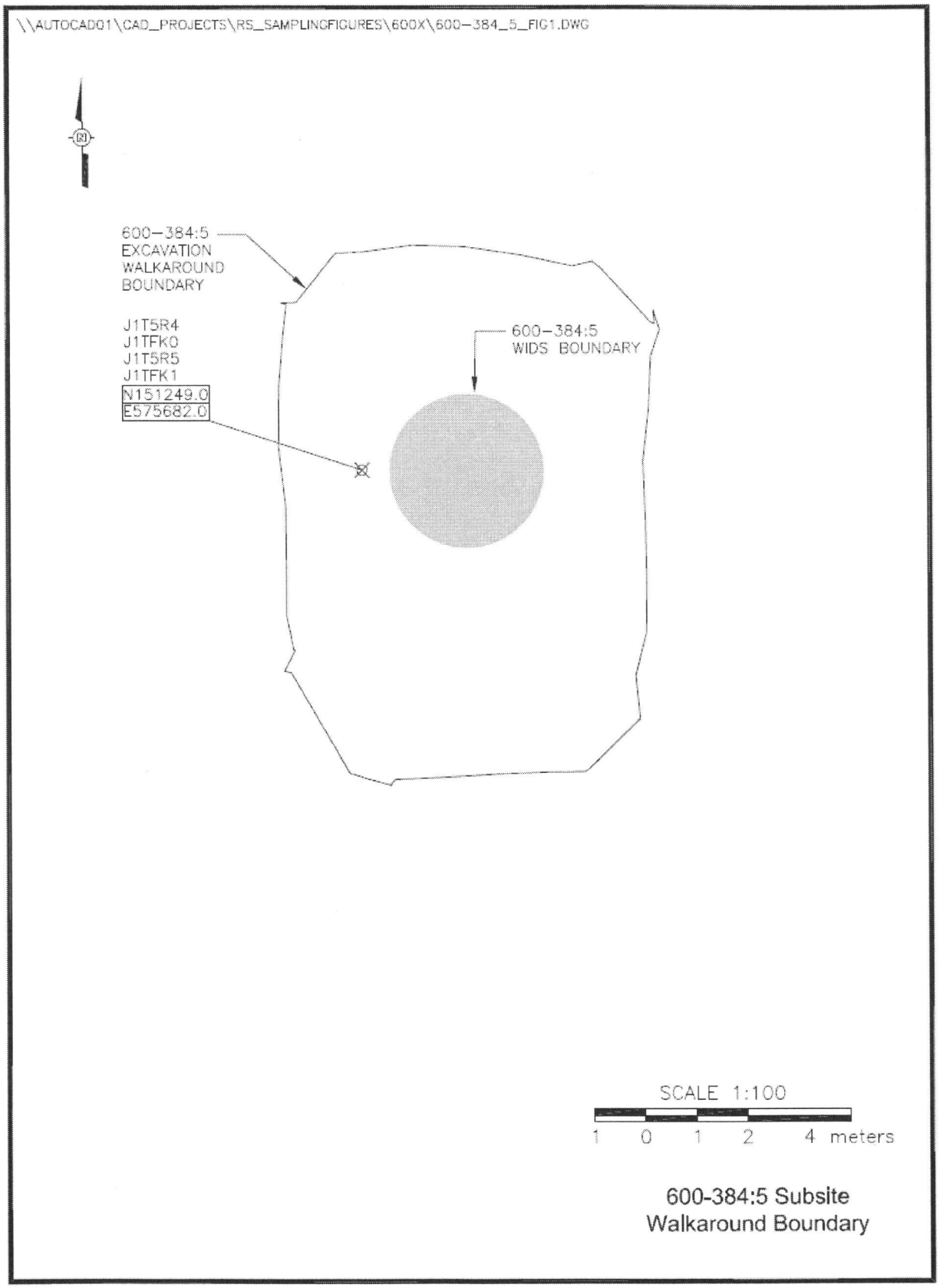


Table 5. 600-384 Waste Site Verification Sampling Summary Table.

Sample Location	Sample Media	HEIS Number	Washington State Plane Coordinates		Sample Analysis
			Northing (m)	Easting (m)	
600-384:1	Soil	J1T5P8	151011	575506	ICP metals [a], mercury, IC anions, cyanide, TPH, PAH, pesticides, herbicides, PCBs
600-384:2a	Soil	J1T5P9	151132	575480	
600-384:2b	Soil	J1T5R0	151141	575484	
600-384:3a	Soil	J1T5R1	152251	575310	
600-384:3b	Soil	J1T5R2	152258	575316	ICP metals [a], mercury, IC anions, cyanide, TPH, PAH, pesticides, herbicides, PCBs
		J1TFJ6			TPH
600-384:4a	Soil	J1T5R3	152210	575510	ICP metals [a], mercury, IC anions, cyanide, TPH, PAH, pesticides, herbicides, PCBs
		J1TFJ4			TPH
600-384:4b	Soil	J1TFJ5	572214.5	575515.4	ICP metals [a], mercury, TPH, PAH, pesticides, herbicides, PCBs
600-384:5	Soil	J1T5R4	151249	575682	ICP metals [a], mercury, IC anions, cyanide, TPH, PAH, pesticides, herbicides, PCBs
		J1TFK0			TPH
Duplicate of J1T5R4	Soil	J1T5R5	151249	575682	ICP metals [a], mercury, IC anions, cyanide, TPH, PAH, pesticides, herbicides, PCBs
Duplicate of J1TFK0		J1TFK1			TPH
Equipment blank	Silica sand	J1T5R6/ J1TFK2	NA	NA	ICP metals [a], mercury

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

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

Table 6. Comparison of Contaminant Concentrations to Action Levels for the 600-384 Excavation Verification 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		
Arsenic	5.71 (<BG)	20 [c]	20 [c]	20 [c]	No	--
Barium	108 (<BG)	5,600	200	400	No	--
Beryllium	0.835 (<BG)	10.4 [d]	1.51 [c]	1.51 [c]	No	--
Boron [e]	3.42	7,200	320	-- [f]	No	--
Cadmium	0.598 (<BG)	13.9 [d]	0.81 [c]	0.81 [c]	No	--
Chromium	12.2 (<BG)	80,000	18.5 [c]	18.5 [c]	No	--
Cobalt	13.4 (<BG)	24	15.7 [c]	-- [f]	No	--
Copper	19.0 (<BG)	2,960	59.2	22.0 [c]	No	--
Lead	80.7	353	10.2 [c]	10.2 [c]	Yes	Yes [g]
Manganese	369 (<BG)	3,760	512 [c]	512 [c]	No	--
Mercury	0.0171 (<BG)	24	0.33 [c]	0.33 [c]	No	--
Molybdenum [e]	0.381	400	8	-- [f]	No	--
Nickel	14.4 (<BG)	1,600	19.1 [c]	27.4	No	--
Silver	0.484 (<BG)	400	8	0.73 [c]	No	--
Vanadium	65.4 (<BG)	560	85.1 [c]	-- [f]	No	--
Zinc	108	24,000	480	67.8 [c]	Yes	Yes [g]
Chloride	13.3 (<BG)	--	25,000	-- [f]	No	--
Cyanide	0.202	1,600	20	1.04	No	--
Fluoride	1.52 (<BG)	4,800	96	400	No	--
Nitrogen in nitrate	14.4	128,000	1,000	2,000	No	--
Nitrogen in nitrite and nitrate	9.27 (<BG)	128,000	1,000	2,000	No	--
Sulfate	359	--	25,000	-- [f]	No	--
TPH – motor oil	8.49	200	200	200	No	--
Anthracene	0.0617	24,000	240	1,920	No	--
Benzo(a)anthracene	0.0720	1.37	0.015 [h]	0.015 [h]	Yes	Yes [g]
Benzo(a)pyrene	0.0760	0.137	0.015 [h]	0.015 [h]	Yes	Yes [g]
Benzo(b)fluoranthene	0.0572	1.37	0.015 [h]	0.015 [h]	Yes	Yes [g]
Benzo(ghi)perylene [i]	0.0499	2,400	48	192	No	--
Benzo(k)fluoranthene	0.0193	1.37	0.015 [h]	0.015 [h]	Yes	Yes [g]
Chrysene	0.0725	13.7	0.12	0.1 [h]	No	--
Dibenz(a,h)anthracene	0.0388	1.37	0.03 [h]	0.03 [h]	Yes	Yes [g]
Fluoranthene	0.122	3,200	64	18.0	No	--
Indeno(1,2,3-cd)pyrene	0.0325	1.37	0.33 [h]	0.33 [h]	No	--
Phenanthrene [i]	0.102	24,000	240	4,200	No	--

Table 6. Comparison of Contaminant Concentrations to Action Levels for the 600-384 Excavation Verification 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		
Pyrene	0.236	2,400	48	192	No	--

[a] RAGs obtained from the 100 Area RDR/RAWP (DOE-RL 2009b).
[b] Maximum value as described in the *600-384 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations* (Appendix C).
[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 2014) or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], Ecology 1996 [Method B for surface waters]).
[g] Based on the RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), residual concentrations of lead, zinc, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and dibenz(a,h)anthracene are not expected to migrate more than 1.8 m (5.9 ft) vertically in 1,000 years (based on the lowest distribution coefficient of the contaminants exceeding the RAGs, lead and zinc, with a distribution coefficient of 30 mL/g). The vadose zone underlying the soil below the 600-384 waste site is a minimum of 5 m (16.4 ft) thick. Therefore, residual concentrations of these constituents are predicted to be protective of groundwater and the Columbia River.
[h] 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.
[i] Toxicity data for this chemical are not available. Cleanup levels are based on surrogate chemicals:
benzo(ghi)perylene; surrogate: pyrene
phenanthrene; surrogate: anthracene.

-- = 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)
TPH = total petroleum hydrocarbons
UCL = upper confidence limit
WAC = *Washington Administrative Code*

DATA EVALUATION

This section demonstrates that contaminant concentrations at the 600-384 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 6 compares the verification sample values to the applicable soil RAGs for direct exposure, protection of groundwater, and protection of the Columbia River.

Three-Part Test for Nonradionuclides

When using a statistical sampling approach, a RAG requirement for nonradionuclides is the WAC 173-340-740(7)(e) three-part test. However, no statistical samples were used in the 600-384 waste site sampling design (WCH 2013c). The verification samples were all focused samples; therefore, the three-part test is not applicable to the data evaluation for the 600-384 waste site.

Nonradionuclide Soil RAGs for Direct Exposure and Groundwater and River Protection Attained

Assessment of the risk requirements for the 600-384 waste site was determined by calculation of the hazard quotient and excess carcinogenic risk values for direct contact (Appendix C). 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 600-384 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 600-384 waste site is 6.3×10^{-3}, which is less than 1.0. All individual cumulative carcinogenic risk values are less than 1×10^{-6}. The cumulative carcinogenic risk value is 7.2×10^{-7}, which is less than 1×10^{-6}. Therefore, nonradionuclide risk requirements are met.

All COPCs were quantified below direct exposure RAGs. All COPCs for the 600-384 waste site were qualified below their respective soil RAGs for groundwater and/or river protection with the exception of lead, zinc, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and dibenz(a,h)anthracene. However, given the soil-partitioning coefficient for these constituents (the lowest is 30 mL/g for lead and zinc), none of these COPCs are expected to migrate more than 1.8 m (5.9 ft) vertically in 1,000 years based on RESidual RADioactivity (RESRAD) modeling discussed in Appendix C of the RDR/RAWP (DOE-RL 2009b). The vadose zone thickness beneath the excavation is approximately 5 m (16.4 ft). Therefore residual concentrations of lead, zinc, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and dibenz(a,h)anthracene are predicted to be protective of groundwater (and thus the Columbia River).

Nonradionuclide Groundwater Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 600-384 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 distribution coefficient (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 5 m (16.4 ft) in thickness at the excavation, a K_d of 14 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 600-384 waste site is 2.3×10^{-2}, which is less than 1.0. The 600-384 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 verification sampling approach (WCH 2013c, 2014a, 2014b), the field logbook (WCH 2014c), and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications. The DQA for the 600-384 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 verification sample analytical data are stored in the WCH project-specific database for data evaluation prior to its archival in the HEIS and are summarized in Appendix C. The detailed DQA is presented in Appendix D.

SUMMARY FOR INTERIM CLOSURE

The 600-384 waste site has been evaluated in accordance with the Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009b). Verification sampling was performed, and the analytical results indicate that the residual concentrations of COPCs at this site meet the RAGs and corresponding RAOs for direct exposure, groundwater protection, and river protection. Contamination above direct exposure levels was not observed in the shallow zone soils and is concluded to not exist in deep zone soils. Institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required. In accordance with this evaluation, the verification sampling results support a reclassification of the 600-384 waste site to Interim Closed Out.

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APPENDIX A

ECOLOGICAL RISK COMPARISON TABLE

Table A-1. Contaminants Exceeding Ecological Screening Levels for the 600-384 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								
Barium	132	500	--	102	--	330	--	2,000	108 (<BG)
Boron [d]	--	0.5	--	--	--	--	--	--	3.42
Cobalt	15.7	20	--	--	13	--	120	230	13.4 (<BG)
Cadmium	0.81	4	20	14	32	140	0.77	0.36	0.598 (<BG)
Lead	10.2	50	500	118	120	1,700	11	56	80.7
Manganese	512	1,100 [e]	--	1,500	220	450	4,300	4,000	369 (<BG)
Vanadium	85.1	2	--	--	--	--	7.8	280	65.4 (<BG)
Zinc	67.8	86 [e]	200	360	160	120	46	79	108

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

WASTE CHARACTERIZATION DATA

Acronyms apply to all tables in this appendix.

B = organics: method blank contamination; inorganics: estimated result, result is less than the reporting limit but greater than the MDL
C = analyte was detected in both the sample and the associated QC blank, and the sample concentration was </= 5x the blank concentration
D = analyte was reported from a dilution
HEIS = Hanford Environmental Information System
J = organics: estimated result, result is less than the RL; inorganics: method blank contamination
M = sample duplicate precision not met
N = MS/MSD or LCS recovery is outside control limits
PQL = practical quantitation limit
Q = qualifier
TCLP = toxicity characteristic leaching procedure
U = undetected
X = more than 40% difference between the primary and confirmation detector results; the lower of the two results is reported

Table B-1. 600-384 Waste Characterization - Metals.

Sample Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium			Boron		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:1	J1RD84	1/30/2013	2870		16.4	1.97	U	1.97	2.84	B	3.28	50		1.64	0.657	U	0.657	6.57	U	6.57
600-384:1	J1RMM2	5/15/2013																		
600-384:2	J1RMM1	5/15/2013	4510	X	1.5	0.37	U	0.37	2.1		0.65	54.3	X	0.075	0.23		0.032	1.6	B	0.96
600-384:3	J1RD83	1/30/2013	7680		14.1	1.41	B	1.69	16.3		2.82	125		1.41	0.348	B	0.564	3.97	B	5.64
600-384:4	J1RD82	1/30/2013	8210		16.0	1.93	U	1.93	6.51		3.21	177		1.60	0.429	B	0.642	6.02	B	6.42
600-384:5	J1RD85	1/30/2013	8930		13.0	1.56	U	1.56	3.08		2.60	74.8		1.30	0.309	B	0.521	1.51	B	5.21

Sample Location	HEIS Number	Sample Date	Cadmium			Calcium			Chromium			Cobalt			Copper		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:1	J1RD84	1/30/2013	0.657	U	0.657	81500		328	6.32		0.66	6.57	U	6.57	5.63		3.28
600-384:1	J1RMM2	5/15/2013															
600-384:2	J1RMM1	5/15/2013	0.12	B	0.04	17400	X	13.8	8.5	X	0.06	2.6		0.10	8.2		0.21
600-384:3	J1RD83	1/30/2013	0.311	B	0.564	4290		282	10.8		0.56	5.59	B	5.64	17.8		2.82
600-384:4	J1RD82	1/30/2013	0.437	B	0.642	5240		321	11.7		0.64	6.16	B	6.42	13.4		3.21
600-384:5	J1RD85	1/30/2013	0.521	U	0.521	3540		260	13.2		0.52	6.82		5.21	13.7		2.60

Table B-2. 600-384 Waste Characterization - TCLP Metals.

Sample Location	HEIS Number	Sample Date	Arsenic			Barium			Cadmium			Chromium			Lead			Mercury		
			mg/L	Q	PQL	mg/L	Q	PQL	mg/L	Q	PQL	mg/L	Q	PQL	mg/L	Q	PQL	mg/L	Q	PQL
600-384:1	J1RD84	1/30/2013	0.075	U	0.075	0.0219		0.005	0.015	U	0.015	0.00293	B	0.025	0.05	U	0.05	0.0002	U	0.0002
600-384:1	J1RMM2	5/15/2013																		
600-384:2	J1RMM1	5/15/2013																		
600-384:3	J1RD83	1/30/2013	0.075	U	0.075	0.0904		0.005	0.015	U	0.015	0.025	U	0.025	0.05	U	0.05	0.0002	U	0.0002
600-384:4	J1RD82	1/30/2013	0.0136	B	0.075	0.101		0.005	0.015	U	0.015	0.025	U	0.025	0.05	U	0.05	0.0002	U	0.0002
600-384:5	J1RD85	1/30/2013	0.075	U	0.075	0.208		0.005	0.015	U	0.015	0.025	U	0.025	0.05	U	0.05	0.0002	U	0.0002

Sample Location	HEIS Number	Sample Date	Selenium			Silver		
			mg/L	Q	PQL	mg/L	Q	PQL
600-384:1	J1RD84	1/30/2013	0.1	U	0.1	0.03	U	0.03
600-384:1	J1RMM2	5/15/2013						
600-384:2	J1RMM1	5/15/2013						
600-384:3	J1RD83	1/30/2013	0.1	U	0.1	0.03	U	0.03
600-384:4	J1RD82	1/30/2013	0.1	U	0.1	0.03	U	0.03
600-384:5	J1RD85	1/30/2013	0.1	U	0.1	0.03	U	0.03

Table B-3. 600-384 Waste Characterization - General Chemistry and Physical.

Sample Location	HEIS Number	Sample Date	Bromide			Chloride			Cyanide			Fluoride			Nitrate			Nitrite		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:1	J1RD84	1/30/2013	1.2	U	1.2	2	B	1.2				1.2	U	1.2	1.2	U	1.2	1.2	U	1.2
600-384:1	J1RMM2	5/15/2013							0.19	BNC	0.11									
600-384:2	J1RMM1	5/15/2013	0.38	U	0.38	5.5		1.9	0.24	BC	0.11	1.4	BNM	0.81						
600-384:3	J1RD83	1/30/2013	1.1	U	1.1	1.2	B	1.1				1.1	U	1.1	6.3		1.1	1.1	U	1.1
600-384:4	J1RD82	1/30/2013	1.1	U	1.1	1.1	B	1.1				1.1	U	1.1	18.7		1.1	1.1	U	1.1
600-384:5	J1RD85	1/30/2013	1.1	U	1.1	1.1	U	1.1				1.1	U	1.1	1.1	U	1.1	1.1	U	1.1

Sample Location	HEIS Number	Sample Date	Nitrogen in Nitrate			Nitrogen in Nitrite and Nitrate			Nitrogen in Nitrite			Phosphate			Phosphorous in phosphate			Sulfate		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:1	J1RD84	1/30/2013				0.12	U	0.12				2.4	U	2.4				17700	D	599
600-384:1	J1RMM2	5/15/2013																		
600-384:2	J1RMM1	5/15/2013	0.91	BN	0.31	0.63	B	0.31	0.33	UN	0.33				1.2	UN	1.2	9230	D	84.8
600-384:3	J1RD83	1/30/2013				1.51		0.11				38.2		2.2				18.1		1.1
600-384:4	J1RD82	1/30/2013				4.68		0.11				2.2	U	2.2				21.9		1.1
600-384:5	J1RD85	1/30/2013				0.11	U	0.11				2.5	B	2.1				7.2		1.1

Sample Location	HEIS Number	Sample Date	Sulfide			Percent Solids			Percent moisture (wet sample)			pH Measurement		
			mg/kg	Q	PQL	%	Q	PQL	%	Q	PQL	pH	Q	PQL
600-384:1	J1RD84	1/30/2013				83		0.1				3.33		0.1
600-384:1	J1RMM2	5/15/2013	2.6	U	2.6				5.7		0			
600-384:2	J1RMM1	5/15/2013	2.4	U	2.4				1.9		0	3.73		0.1
600-384:3	J1RD83	1/30/2013				90.1		0.1				4.74		0.1
600-384:4	J1RD82	1/30/2013				89.9		0.1				5.08		0.1
600-384:5	J1RD85	1/30/2013				92.9		0.1				5.76		0.1

Table B-4. 600-384 Waste Characterization - Organic Detects.

Sample Location	HEIS Number	Sample Date	2,4,5-Trichlorophenoxyacetic acid			2-(2,4,5-Trichlorophenoxy)propionic acid			2-(2-methyl-4-chlorophenoxy) propionic acid		
			ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
600-384:1	J1RMM2	5/15/2013	230	JDX	120	200	JDX	74	110000	UD	110000
600-384:2	J1RMM1	5/15/2013	170	JXD	45	52	JD	28	130000	JXD	40000

Sample Location	HEIS Number	Sample Date	2-Methyl-4 chlorophenoxyacetic acid			2-secButyl-4,6-dinitrophenol(DNBP)			4-(2,4-Dichlorophenoxy)butanoic acid		
			ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
600-384:1	J1RMM2	5/15/2013	110000	UD	110000	220	JDX	74	1700	JDX	390
600-384:2	J1RMM1	5/15/2013	53000	JXD	40000	28	UD	28	1100	JD	150

Sample Location	HEIS Number	Sample Date	Dicamba			Dichloroprop		
			ug/kg	Q	PQL	ug/kg	Q	PQL
600-384:1	J1RMM2	5/15/2013	250	JDX	74	170	JDX	170
600-384:2	J1RMM1	5/15/2013	28	UD	28	63	UD	63

Table B-5. 600-384 Waste Characterization - Organics.

CONSTITUENT	CLASS	600-384:2 J1RMM1			600-384:1 J1RMM2		
		5/15/2013			5/15/2013		
		ug/kg	Q	PQL	ug/kg	Q	PQL
2-(2,4,5-Trichlorophenoxy)propionic acid	Herbicide	52	JD	28	200	JDX	74
2-(2-methyl-4-chlorophenoxy) propionic acid	Herbicide	130000	JXD	40000	110000	UD	110000
2,4,5-Trichlorophenoxyacetic acid	Herbicide	170	JXD	45	230	JDX	120
2,4-Dichlorophenoxyacetic acid	Herbicide	280	UD	280	740	UD	740
2-Methyl-4 chlorophenoxyacetic acid	Herbicide	53000	JXD	40000	110000	UD	110000
2-secButyl-4,6-dinitrophenol(DNBP)	Herbicide	28	UD	28	220	JDX	74
4-(2,4-Dichlorophenoxy)butanoic acid	Herbicide	1100	JD	150	1700	JDX	390
Dalapon	Herbicide	28	UD	28	74	UD	74
Dicamba	Herbicide	28	UD	28	250	JDX	74
Dichloroprop	Herbicide	63	UD	63	170	JDX	170
Aldrin	Pesticide	0.25	U	0.25	0.25	U	0.25
Alpha-BHC	Pesticide	0.22	U	0.22	0.22	U	0.22
alpha-Chlordane	Pesticide	0.33	U	0.33	0.33	U	0.33
beta-1,2,3,4,5,6-Hexachlorocyclohexane	Pesticide	0.67	U	0.67	0.67	UN	0.67
Delta-BHC	Pesticide	0.4	U	0.4	0.41	UN	0.41
Dichlorodiphenyldichloroethane	Pesticide	0.55	U	0.55	0.55	U	0.55
Dichlorodiphenyldichloroethylene	Pesticide	0.24	U	0.24	0.24	U	0.24
Dichlorodiphenyltrichloroethane	Pesticide	0.59	U	0.59	0.6	U	0.6
Dieldrin	Pesticide	0.21	U	0.21	0.21	U	0.21
Endosulfan I	Pesticide	0.18	U	0.18	0.18	U	0.18
Endosulfan II	Pesticide	0.29	U	0.29	0.29	UN	0.29
Endosulfan sulfate	Pesticide	0.28	U	0.28	0.28	UN	0.28
Endrin	Pesticide	0.31	U	0.31	0.31	UN	0.31
Endrin aldehyde	Pesticide	0.17	U	0.17	0.17	UN	0.17
Endrin ketone	Pesticide	0.49	U	0.49	0.5	UN	0.5
Gamma-BHC (Lindane)	Pesticide	0.47	U	0.47	0.47	U	0.47
gamma-Chlordane	Pesticide	0.27	U	0.27	0.27	U	0.27
Heptachlor	Pesticide	0.22	U	0.22	0.22	UN	0.22
Heptachlor epoxide	Pesticide	0.43	U	0.43	0.43	UN	0.43
Methoxychlor	Pesticide	0.45	U	0.45	0.46	UN	0.46
Toxaphene	Pesticide	16	U	16	16	U	16

APPENDIX C

CALCULATIONS

APPENDIX C

CALCULATION BRIEFS

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

600-384 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, 0600X-CA-V0178, Rev. 0, Washington Closure Hanford, Richland, Washington.

600-384 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater, 0600X-CA-V0181, Rev. 0, Washington Closure Hanford, Richland, Washington.

DISCLAIMER FOR CALCULATIONS

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

Acrobat 8.0

CALCULATION COVER SHEET

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

Area: 600

Discipline: Environmental *Calculation No: 0600X-CA-V0178

Subject: 600-384 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations

Computer Program: Excel Program No: Excel 2010

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Summary = 6 Attachment = 7 Total = 14	I. B. Berezovskiy	J. D. Skoglie	H. M. Sulloway	S.G.W. Kinsen ~~D. F. Obenauer~~	8/5/14

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:	I. B. Berezovskiy	Date:	4/23/2014	Calc. No.:	0600X-CA-V0178	Rev.:	0
Project:	600 Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	4/23/2014
Subject:	600-384 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 600-384 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 600-384 waste site verification sampling, as necessary.

GIVEN/REFERENCES:

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

2) DOE-RL, 2009b, *Remedial Design Report/Remedial Action Work Plan for the 100 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, 2014, *Remaining Sites Verification Package for the 600-384, Segment 4 Stained Soil Area #3*, Attachment to Waste Site Reclassification Form 2014-008, 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:	I. B. Berezovskiy	Date:	4/23/2014	Calc. No.:	0600X-CA-V0178	Rev.:	0
Project:	600 Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	4/23/2014
Subject:	600-384 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 600-384 waste site consists of 5 subsites/excavations: 600-384:1, 600-384:2, 600-384:3, 600-384:4 and 600-384:5. A total of seven focused samples plus a duplicate were collected from the 600-384 waste site. The direct contact hazard quotient and carcinogenic risk calculations for the 600-384 waste site were conservatively calculated using the maximum results from Attachment 1 as discussed in the RSVP (WCH 2014). Of the contaminants of potential concern (COPCs) and other analytes for this site, boron, cyanide, molybdenum, and the detected polycyclic aromatic hydrocarbons (PAH) require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. Zinc and nitrogen in nitrate require HQ and risk calculations because these analytes were detected above Washington State or Hanford Site background value. Lead was detected above background; however, lead does not have a reference dose for calculation of a hazard quotient because toxic effects of lead are correlated with blood-lead levels rather than exposure levels or daily intake. Although total petroleum hydrocarbons (motor oil) were detected and no background value is available, the risk associated with total petroleum hydrocarbons does 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 3.42 mg/kg, divided by the noncarcinogenic RAG value of 7,200 mg/kg (calculated in accordance with the noncarcinogenic toxics effects formula in WAC 173-340-740[3]), is 4.8×10^{-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 6.3×10^{-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 0.0720 mg/kg, divided by 1.37 mg/kg, and multiplied as indicated, is 5.3×10^{-8}. Comparing this value, and all other individual values, to the requirement of $<1 \times 10^{-6}$, this criterion is met.

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk can be obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual cancer risk values prior to rounding are used for this calculation. The sum of the excess cancer risk values for COPCs is 7.2×10^{-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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	4/23/2014	Calc. No.:	0600X-CA-V0178	Rev.:	0
Project:	600 Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	4/23/2014
Subject:	600-384 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 3 of 6	

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 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 (WCH 2014).

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 verification sampling at the subject site. Additional discussion is provided in the data quality assessment section of the applicable RSVP (WCH 2014), 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 600-384 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 600-384 waste site.

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	4/23/2014	Calc. No.:	0600X-CA-V0178	Rev.:	0
Project:	600 Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	4/23/2014
Subject:	600-384 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 600-384 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	3.42	7,200	4.8E-04	--	--
Lead [c]	80.7	353	--	--	--
Molybdenum	0.381	400	9.5E-04	--	--
Zinc	108	24,000	4.5E-03	--	--
Anions					
Cyanide	0.202	1,600	1.3E-04	--	--
Nitrogen in Nitrate	14.4	128,000	1.1E-04	--	--
Polycyclic Aromatic Hydrocarbons					
Anthracene	0.0617	24,000	2.6E-06	--	--
Benzo(a)anthracene	0.0720	--	--	1.37	5.3E-08
Benzo(a)pyrene	0.0760	--	--	0.137	5.5E-07
Benzo(b)fluoranthene	0.0572	--	--	1.37	4.2E-08
Benzo(ghi)perylene [d]	0.0499	2,400	2.1E-05	--	--
Benzo(k)fluoranthene	0.0193	--	--	1.37	1.4E-08
Chrysene	0.0725	--	--	13.7	5.3E-09
Dibenz(a,h)anthracene	0.0388	--	--	1.37	2.8E-08
Fluoranthene	0.122	3,200	3.8E-05	--	--
Indeno(1,2,3-cd)pyrene	0.0325	--	--	1.37	2.4E-08
Phenanthrene [d]	0.102	24,000	4.3E-06	--	--
Pyrene	0.236	2,400	9.8E-05	--	--
Total Petroleum Hydrocarbons					
TPH - motor oil (high boiling) [e]	8.49	200	--	--	--
Totals					
Cumulative Hazard Quotient:			**6.3E-03**		
Cumulative Excess Cancer Risk:					**7.2E-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] = Value for the noncarcinogenic RAG calculated using Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children, EPA/540/R 93/081, Publication No. 9285.7, U.S. Environmental Protection Agency, Washington, D.C.

[d] = Toxicity data is not available. The cleanup levels are based on use of surrogate chemicals.
benzo(ghi)perylene surrogate: pyrene
phenanthrene surrogate: anthracene

[e] = The risk associated with total petroleum hydrocarbons does not contribute to the cumulative toxicity calculation.
-- = not applicable
RAG = remedial action goal

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	4/23/2014	Calc. No.:	0600X-CA-V0178	Rev.:	0
Project:	600 Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	4/23/2014
Subject:	600-384 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 600-384 Waste Site (2 pages).

Duplicate Analysis - 600-384 Waste Site

Sampling Area	HEIS Number	Sample Date	Aluminum			Arsenic			Barium			Beryllium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:5	J1T5R4	1/29/2014	6680	M	7.18	3.41		0.528	78.7		0.106	0.776		0.106
Duplicate of J1T5R4	J1T5R5	1/29/2014	7040	M	7.39	3.11	B	0.543	80.3		0.109	0.835		0.109

Analysis:

TDL		5	10	2	0.2
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)
	RPD	5.2%		2.0%	
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	No - acceptable

Duplicate Analysis - 600-384 Waste Site

Sampling Area	HEIS Number	Sample Date	Calcium			Chromium			Cobalt			Copper		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:5	J1T5R4	1/29/2014	4570		8.44	11.6		0.158	12.8	D	1.58	15.8		0.317
Duplicate of J1T5R4	J1T5R5	1/29/2014	4440		8.69	10.8		0.163	13.4	D	1.63	16.8		0.326

Analysis:

TDL		100	1	2	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	Yes (calc RPD)	Yes (calc RPD)	Yes (calc RPD)
	RPD	2.9%	7.1%	4.6%	6.1%
	Difference > 2 TDL?	Not applicable	Not applicable	Not applicable	Not applicable

Duplicate Analysis - 600-384 Waste Site

Sampling Area	Sample Number	Sample Date	Iron			Lead			Magnesium			Manganese		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:5	J1T5R4	1/29/2014	23000		8.44	9.70	BD	3.48	5050		8.97	340		0.211
Duplicate of J1T5R4	J1T5R5	1/29/2014	24500		8.69	6.36	BD	3.59	5110		9.24	366		0.217

Analysis:

TDL		5	5	75	5
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD	6.3%		1.2%	7.4%
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	Not applicable

Duplicate Analysis - 600-384 Waste Site

Sampling Area	Sample Number	Sample Date	Nickel			Potassium			Silicon			Sodium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:5	J1T5R4	1/29/2014	12.5		0.158	1820	D	67.5	415	*NJ	1.58	150		7.39
Duplicate of J1T5R4	J1T5R5	1/29/2014	12.6		0.163	1750	D	69.6	489	*NJ	1.63	149		7.61

Analysis:

TDL		4	400	2	50
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)
	RPD			16.4%	
	Difference > 2 TDL?	No - acceptable	No - acceptable	Not applicable	No - acceptable

Duplicate Analysis - 600-384 Waste Site

Sampling Area	Sample Number	Sample Date	Vanadium			Zinc			Chloride			Fluoride		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:5	J1T5R4	1/29/2014	63.6	D	1.06	47.2	D	4.22	1.32	B	0.749	1.34		0.369
Duplicate of J1T5R4	J1T5R5	1/29/2014	65.4	D	1.09	49.2	D	4.35	1.20	B	0.738	1.18		0.364

Analysis:

TDL		2.5	1	2	5
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	2.8%	4.1%		
	Difference > 2 TDL?	Not applicable	Not applicable	No - acceptable	No - acceptable

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	4/23/2014	Calc. No.:	0600X-CA-V0178	Rev.:	0
Project:	600 Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	4/23/2014
Subject:	600-384 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 6 of 6	

Table 2. Relative Percent Difference Calculations for the 600-384 Waste Site (2 pages).

Duplicate Analysis - 600-384 Waste Site

Sampling Area	Sample Number	Sample Date	Nitrogen in Nitrate			Phosphorous in phosphate			Sulfate			Benzo(ghi)perylene		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	ug/kg	Q	PQL
600-384:5	J1T5R4	1/29/2014	1.65	J	0.369	1.04	BJ	0.749	4.56		1.49	28.9	PX	0.597
Duplicate of J1T5R4	J1T5R5	1/29/2014	1.65	J	0.364	1.30	BJ	0.738	4.45		1.47	20.0	PX	0.591

Analysis:

TDL		0.75	10	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 - 600-384 Waste Site

Sampling Area	Sample Number	Sample Date	TPH - motor oil (high boiling)		
			ug/kg	Q	PQL
600-384:5	J1TFK0	3/10/2014	2570	J	2210
Duplicate of J1TFK0	J1TFK1	3/10/2014	3350	J	2210

Analysis:

TDL		5000
Duplicate Analysis	Both > PQL?	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)
	RPD	
	Difference > 2 TDL?	No - acceptable

CONCLUSION:

The calculations in Tables 1 and 2 demonstrate that the 600-384 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. 600-384 Waste Site Verification Sample Results (Metals).

LOCATION	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:5	J1T5R4	1/29/2014	6680	M	7.18	3.48	DU	3.48	3.41		0.528	78.7		0.106	0.776		0.106
Duplicate of J1T5R4	J1T5R5	1/29/2014	7040	M	7.39	3.59	DU	3.59	3.11	B	0.543	80.3		0.109	0.835		0.109
600-384:1	J1T5P8	1/29/2014	4690	M	7.06	3.43	DU	3.43	1.51	B	0.519	48.2		0.104	0.701		0.104
600-384:2a	J1T5P9	1/29/2014	5050	M	6.63	3.22	DU	3.22	2.40	B	0.488	54.1		0.0975	0.603		0.0975
600-384:2b	J1T5R0	1/29/2014	5050	M	6.91	3.35	DU	3.35	2.51	B	0.508	53.4		0.102	0.671		0.102
600-384:3a	J1T5R1	1/29/2014	7900	M	7.68	3.73	DU	3.73	5.65		0.565	92.4		0.113	0.785		0.113
600-384:3b	J1T5R2	1/29/2014	6880	M	6.79	3.29	DU	3.29	5.71		0.499	108		0.0998	0.677		0.0998
600-384:4a	J1T5R3	1/29/2014	6320	M	7.87	3.82	DU	3.82	4.64		0.579	96.5		0.116	0.681		0.116
600-384:4b	J1TFJ5	3/6/2014	7590		7.64	1.85	DU	1.85	4.68		0.562	85.1		0.112	0.463	B	0.112
Equipment Blank 1	J1T5R6	1/29/2014	82.4	M	6.54	0.317	U	0.317	0.481	U	0.481	1.35		0.0962	0.0962	U	0.0962
Equipment Blank 2	J1TFK2	3/10/2014	130	N	6.59	0.320	U	0.320	0.672	BC	0.485	1.79		0.0969	0.0969	U	0.0969

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
600-384:5	J1T5R4	1/29/2014	1.06	U	1.06	0.106	U	0.106	4570		8.44	11.6		0.158	12.8	D	1.58
Duplicate of J1T5R4	J1T5R5	1/29/2014	1.09	U	1.09	0.125	B	0.109	4440		8.69	10.8		0.163	13.4	D	1.63
600-384:1	J1T5P8	1/29/2014	1.04	U	1.04	0.104	U	0.104	4950		8.30	8.21		0.156	11.5	D	1.56
600-384:2a	J1T5P9	1/29/2014	0.975	U	0.975	0.0975	U	0.0975	3620		7.80	9.74		0.146	9.44	D	1.46
600-384:2b	J1T5R0	1/29/2014	1.02	U	1.02	0.102	U	0.102	4540		8.13	9.62		0.152	11.4	D	1.52
600-384:3a	J1T5R1	1/29/2014	1.13	U	1.13	0.113	U	0.113	3490		9.04	12.2		0.170	12.3	D	1.70
600-384:3b	J1T5R2	1/29/2014	1.46	B	0.998	0.269	B	0.0998	4570		7.98	11.2		0.150	10.7	D	1.50
600-384:4a	J1T5R3	1/29/2014	1.16	U	1.16	0.169	B	0.116	4040		9.26	10.8		0.174	9.50		0.174
600-384:4b	J1TFJ5	3/6/2014	3.42	B	1.12	0.598		0.112	5390		8.99	12.0		0.169	9.51	D	0.843
Equipment Blank 1	J1T5R6	1/29/2014	0.962	U	0.962	0.0962	U	0.0962	26.1		7.69	0.144	U	0.144	0.144	U	0.144
Equipment Blank 2	J1TFK2	3/10/2014	0.969	U	0.969	0.0969	U	0.0969	32.2		7.75	0.286	B	0.145	0.145	U	0.145

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, T and/or X are considered acceptable values.

* duplicate analysis not within control limits.

B = blank contamination (inorganic constituents)

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

D = results reported from a diluted aliquot of sample

HEIS = Hanford Environmental Information System

HERB = herbicide

J = estimate

M = sample duplicate precision not met.

N = recovery exceeds upper or lower control limit.

P = aroclor target analyte with greater than 20% difference between column analyses.

PAH = polycyclic aromatic hydrocarbons

PCB = polychlorinated biphenyls

PEST = pesticide

PQL = practical quantitation limit

Q = qualifier

R = rejected.

RAG = remedial action goal

T = spike and/or spike duplicatesample recovery is outside control limit.

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 7
Originator	I. B. Berezovskiy	Date	4/22/2014
Checked	J. D. Skoglie	Date	4/22/2014
Calc. No.	0600X-CA-V0178	Rev. No.	0

Attachment 1. 600-384 Waste Site Verification Sample Results (Metals).

LOCATION	HEIS Number	Sample Date	Copper			Iron			Lead			Magnesium			Manganese		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:5	J1T5R4	1/29/2014	15.8		0.317	23000		8.44	9.70	BD	3.48	5050		8.97	340		0.211
Duplicate of J1T5R4	J1T5R5	1/29/2014	16.8		0.326	24500		8.69	6.36	BD	3.59	5110		9.24	366		0.217
600-384:1	J1T5P8	1/29/2014	11.6		0.311	20300		8.30	4.62	BD	3.43	3990		8.82	265		0.208
600-384:2a	J1T5P9	1/29/2014	12.0		0.293	18700		7.80	3.22	DU	3.22	4080		8.29	265		0.195
600-384:2b	J1T5R0	1/29/2014	11.7		0.305	20400		8.13	3.35	DU	3.35	4120		8.64	281		0.203
600-384:3a	J1T5R1	1/29/2014	14.4		0.339	23100		9.04	7.43	BD	3.73	5160		9.61	360		0.226
600-384:3b	J1T5R2	1/29/2014	19.0		0.299	20100		7.98	80.7	D	3.29	4180		8.48	369		0.200
600-384:4a	J1T5R3	1/29/2014	12.5		0.347	18500		9.26	26.4		0.382	4170		9.84	342		0.231
600-384:4b	J1TFJ5	3/6/2014	16.3		0.337	21200		8.99	18.1	D	1.85	4580		9.55	337		0.225
Equipment Blank 1	J1T5R6	1/29/2014	0.288	U	0.288	183		7.69	0.317	U	0.317	8.17	U	8.17	4.15		0.192
Equipment Blank 2	J1TFK2	3/10/2014	0.291	U	0.291	232	N	7.75	0.320	U	0.320	18.8	B	8.24	4.51		0.194

LOCATION	HEIS Number	Sample Date	Mercury			Molybdenum			Nickel			Potassium			Selenium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:5	J1T5R4	1/29/2014	0.00443	U	0.00443	0.381	B	0.211	12.5		0.158	1820	D	67.5	0.339	DU	0.339
Duplicate of J1T5R4	J1T5R5	1/29/2014	0.00417	U	0.00417	0.217	U	0.217	12.6		0.163	1750	D	69.6	0.334	DU	0.334
600-384:1	J1T5P8	1/29/2014	0.00431	U	0.00431	0.240	B	0.208	9.42		0.156	1320	D	66.4	0.351	DU	0.351
600-384:2a	J1T5P9	1/29/2014	0.00427	U	0.00427	0.249	B	0.195	11.0		0.146	1080	D	62.4	0.303	DU	0.303
600-384:2b	J1T5R0	1/29/2014	0.00408	U	0.00408	0.328	B	0.203	10.6		0.152	1190	D	65.0	0.317	DU	0.317
600-384:3a	J1T5R1	1/29/2014	0.00457	U	0.00457	0.282	B	0.226	12.7		0.170	2420	D	72.3	0.326	DU	0.326
600-384:3b	J1T5R2	1/29/2014	0.0115	B	0.00400	0.365	B	0.200	14.4		0.150	2410	D	63.9	0.355	DU	0.355
600-384:4a	J1T5R3	1/29/2014	0.0171		0.00432	0.375	B	0.231	11.6		0.174	2260		7.41	0.364	DU	0.364
600-384:4b	J1TFJ5	3/6/2014	0.00507	B	0.00452	0.225	U	0.225	11.7		0.169	2360		7.19	0.376	DU	0.376
Equipment Blank 1	J1T5R6	1/29/2014	0.00393	U	0.00393	0.192	U	0.192	0.144	U	0.144	51.5		6.15	0.297	DU	0.297
Equipment Blank 2	J1TFK2	3/10/2014	0.00393	U	0.00393	0.212	B	0.194	0.183	B	0.145	38.3		6.20	0.319	DU	0.319

Attachment	1	Sheet No.	2 of 7
Originator	I. B. Berezovskiy	Date	4/22/2014
Checked	J. D. Skoglie	Date	4/22/2014
Calc. No.	0600X-CA-V0178	Rev. No.	0

Attachment 1. 600-384 Waste Site Verification Sample Results (Metals and Anions).

LOCATION	HEIS Number	Sample Date	Silicon			Silver			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:5	J1T5R4	1/29/2014	415	*NJ	1.58	0.106	U	0.106	150		7.39	63.6	D	1.06	47.2	D	4.22
Duplicate of J1T5R4	J1T5R5	1/29/2014	489	*NJ	1.63	0.109	U	0.109	149		7.61	65.4	D	1.09	49.2	D	4.35
600-384:1	J1T5P8	1/29/2014	508	*NJ	1.56	0.104	U	0.104	170		7.27	62.6	D	1.04	39.7	D	4.15
600-384:2a	J1T5P9	1/29/2014	804	*NJ	1.46	0.0975	U	0.0975	119		6.83	48.3	D	0.975	35.8	D	3.90
600-384:2b	J1T5R0	1/29/2014	404	*NJ	1.52	0.102	U	0.102	139		7.11	61.1	D	1.02	39.4	D	4.06
600-384:3a	J1T5R1	1/29/2014	686	*NJ	1.70	0.113	U	0.113	155		7.91	55.4	D	1.13	45.9	D	4.52
600-384:3b	J1T5R2	1/29/2014	1080	*NJ	1.50	0.0998	U	0.0998	149		6.99	48.7	D	0.998	108	D	3.99
600-384:4a	J1T5R3	1/29/2014	452	*NJ	1.74	0.116	U	0.116	150		8.10	41.7		0.116	53.7		0.463
600-384:4b	J1TFJ5	3/6/2014	926	*N	1.69	0.484	B	0.112	137		7.86	56.4	D	0.562	54.5	D	2.25
Equipment Blank 1	J1T5R6	1/29/2014	96.4	*NUJ	1.44	0.0962	U	0.0962	7.68	BUJ	6.73	0.189	B	0.0962	2.02	CUJ	0.385
Equipment Blank 2	J1TFK2	3/10/2014	186		1.45	0.0969	U	0.0969	6.79	U	6.79	0.228	B	0.0969	1.21		0.388

LOCATION	HEIS Number	Sample Date	Bromide			Chloride			Cyanide			Fluoride			Nitrogen in Nitrate		
			mg/kg	Q	PQL	mg/kg	Q	PQL	ug/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:5	J1T5R4	1/29/2014	0.749	U	0.749	1.32	B	0.749	88.1	U	88.1	1.34		0.369	1.65	J	0.369
Duplicate of J1T5R4	J1T5R5	1/29/2014	0.738	U	0.738	1.20	B	0.738	72.6	U	72.6	1.18		0.364	1.65	J	0.364
600-384:1	J1T5P8	1/29/2014	0.714	U	0.714	5.96		0.714	77.7	U	77.7	1.52		0.352	1.06	BJ	0.352
600-384:2a	J1T5P9	1/29/2014	0.711	U	0.711	0.799	B	0.711	83.6	U	83.6	0.675	B	0.350	0.350	UJ	0.350
600-384:2b	J1T5R0	1/29/2014	0.705	U	0.705	0.750	B	0.705	76.6	U	76.6	0.910	B	0.347	0.454	BJ	0.347
600-384:3a	J1T5R1	1/29/2014	0.753	U	0.753	0.844	B	0.753	81.1	U	81.1	0.498	B	0.371	0.371	UJ	0.371
600-384:3b	J1T5R2	1/29/2014	0.722	U	0.722	13.3		0.722	161	B	89.5	0.550	B	0.356	14.4	J	0.356
600-384:4a	J1T5R3	1/29/2014	0.781	U	0.781	1.22	B	0.781	202	B	88.9	0.732	B	0.385	2.24	J	0.385

Attachment	1	Sheet No.	3 of 7
Originator	I. B. Berezovskiy	Date	4/22/2014
Checked	J. D. Skoglie	Date	4/22/2014
Calc. No.	0600X-CA-V0178	Rev. No.	0

Attachment 1. 600-384 Waste Site Verification Sample Results (Anions and TPH).

LOCATION	HEIS Number	Sample Date	Nitrogen in Nitrite and Nitrate			Nitrogen in Nitrite			Phosphorous in phosphate			Sulfate		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-384:5	J1T5R4	1/29/2014	0.638	U	0.184	0.369	UJ	0.369	1.04	BJ	0.749	4.56		1.49
Duplicate of J1T5R4	J1T5R5	1/29/2014	0.636	U	0.174	0.364	UJ	0.364	1.30	BJ	0.738	4.45		1.47
600-384:1	J1T5P8	1/29/2014	0.184	U	0.184	0.352	UJ	0.352	0.714	UJ	0.714	169		1.42
600-384:2a	J1T5P9	1/29/2014	0.175	U	0.175	0.350	UJ	0.350	0.711	UJ	0.711	359	D	7.06
600-384:2b	J1T5R0	1/29/2014	0.176	U	0.176	0.347	UJ	0.347	0.705	UJ	0.705	169		1.40
600-384:3a	J1T5R1	1/29/2014	0.192	U	0.192	0.371	UJ	0.371	0.753	UJ	0.753	2.53	B	1.49
600-384:3b	J1T5R2	1/29/2014	9.27		0.180	0.356	UJ	0.356	9.55	J	0.722	40.1		1.43
600-384:4a	J1T5R3	1/29/2014	1.75		0.201	0.385	UJ	0.385	9.44	J	0.781	8.68		1.55

LOCATION	HEIS Number	Sample Date	TPH - Diesel range			TPH - motor oil (high boiling)		
			ug/kg	Q	PQL	ug/kg	Q	PQL
600-384:5 resample	J1TFK0	3/10/2014	2210	U	2210	2570	J	2210
Duplicate of J1TFK0 resample	J1TFK1	3/10/2014	2210	U	2210	3350	J	2210
600-384:1	J1T5P8	1/29/2014	2340	U	2340	8490		2340
600-384:2a	J1T5P9	1/29/2014	2300	U	2300	4570	J	2300
600-384:2b	J1T5R0	1/29/2014	2300	U	2300	5100	J	2300
600-384:3a	J1T5R1	1/29/2014	2480	U	2480	2480	U	2480
600-384:3b resample	J1TFJ6	3/6/2014	2230	U	2230	4840	J	2230
600-384:4a resample	J1TFJ4	3/6/2014	2220	U	2220	2790	J	2220
600-384:4b	J1TFJ5	3/6/2014	2470	U	2470	7890		2470
600-384:3b	J1T5R2	1/29/2014	164000	DJ	118000	918000	DJ	118000
600-384:4a	J1T5R3	1/29/2014	40300	DJ	25800	261000	DJ	25800
600-384:5	J1T5R4	1/29/2014	60600	DUJ	60600	1000000	DJ	60600
Duplicate of J1T5R4	J1T5R5	1/29/2014	48200	DUJ	48200	508000	DJ	48200

Attachment	1	Sheet No.	4 of 7
Originator	I. B. Berezovskiy	Date	4/22/2014
Checked	J. D. Skoglie	Date	4/22/2014
Calc. No.	0600X-CA-V0178	Rev. No.	0

Attachment 1. 600-384 Waste Site Verification Sample Results (Organics).

CONSTITUENT	CLASS	J1T5R4, 600-384:5			J1T5R5, Duplicate of J1T5R4			J1T5P8, 600-384:1		
		1/29/2014			1/29/2014			1/29/2014		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
2-(2,4,5-Trichlorophenoxy)propionic acid	HERB	18.5	DU	18.5	18.5	DU	18.5	1.79	U	1.79
2-(2-methyl-4-chlorophenoxy) propionic acid	HERB	2230	DU	2230	2220	DU	2220	216	U	216
2,4,5-Trichlorophenoxyacetic acid	HERB	18.5	DU	18.5	18.5	DU	18.5	1.79	U	1.79
2,4-Dichlorophenoxyacetic acid	HERB	18.5	TDU	18.5	18.5	TDU	18.5	1.79	TU	1.79
2-Methyl-4 chlorophenoxyacetic acid	HERB	2560	DU	2560	2560	DU	2560	248	U	248
2-secButyl-4,6-dinitrophenol(DNBP)	HERB	18.5	DUJ	18.5	18.5	DUJ	18.5	1.79	UJ	1.79
4-(2,4-Dichlorophenoxy)butanoic acid	HERB	18.5	DU	18.5	18.5	DU	18.5	1.79	U	1.79
Dalapon	HERB	390	DU	390	389	DU	389	37.8	U	37.8
Dicamba	HERB	22.3	DU	22.3	22.2	DU	22.2	2.16	U	2.16
Dichloroprop	HERB	25.2	DU	25.2	25.1	DU	25.1	2.44	U	2.44
Acenaphthene	PAH	5.59	U	5.59	5.54	U	5.54	5.38	U	5.38
Acenaphthylene	PAH	5.59	U	5.59	5.54	U	5.54	5.38	U	5.38
Anthracene	PAH	1.86	U	1.86	1.85	U	1.85	1.79	U	1.79
Benzo(a)anthracene	PAH	0.597	U	0.597	0.591	U	0.591	0.574	U	0.574
Benzo(a)pyrene	PAH	0.597	U	0.597	0.591	U	0.591	0.821	J	0.574
Benzo(b)fluoranthene	PAH	0.597	U	0.597	0.591	U	0.591	0.574	U	0.574
Benzo(ghi)perylene	PAH	28.9	PX	0.597	20.00	PX	0.591	0.904	J	0.574
Benzo(k)fluoranthene	PAH	19.3	PX	0.298	0.30	U	0.296	0.287	U	0.287
Chrysene	PAH	0.597	U	0.597	0.591	U	0.591	0.574	U	0.574
Dibenz[a,h]anthracene	PAH	0.597	U	0.597	0.591	U	0.591	0.574	U	0.574
Fluoranthene	PAH	0.597	U	0.597	0.591	U	0.591	0.574	U	0.574
Fluorene	PAH	5.59	U	5.59	5.54	U	5.54	5.38	U	5.38
Indeno(1,2,3-cd)pyrene	PAH	0.597	U	0.597	0.591	U	0.591	0.574	U	0.574
Naphthalene	PAH	5.59	U	5.59	5.54	U	5.54	5.38	U	5.38
Phenanthrene	PAH	5.59	U	5.59	5.54	U	5.54	5.38	U	5.38
Pyrene	PAH	0.597	U	0.597	0.591	U	0.591	0.574	U	0.574
Aroclor-1016	PCB	6.20	DU	6.20	6.17	DU	6.17	1.20	U	1.20
Aroclor-1221	PCB	6.20	DU	6.20	6.17	DU	6.17	1.20	U	1.20
Aroclor-1232	PCB	6.20	DU	6.20	6.17	DU	6.17	1.20	U	1.20
Aroclor-1242	PCB	6.20	DU	6.20	6.17	DU	6.17	1.20	U	1.20
Aroclor-1248	PCB	6.20	DU	6.20	6.17	DU	6.17	1.20	U	1.20
Aroclor-1254	PCB	6.20	DU	6.20	6.17	DU	6.17	1.20	U	1.20
Aroclor-1260	PCB	6.20	DU	6.20	6.17	DU	6.17	1.20	U	1.20
Aldrin	PEST	1.86	DU	1.86	1.85	DU	1.85	0.180	U	0.180
Alpha-BHC	PEST	1.86	DU	1.86	1.85	DU	1.85	0.180	U	0.180
alpha-Chlordane	PEST	1.86	DU	1.86	1.85	DU	1.85	0.180	U	0.180
beta-1,2,3,4,5,6-Hexachlorocyclohexane	PEST	1.86	DU	1.86	1.85	DU	1.85	0.180	U	0.180
Delta-BHC	PEST	1.86	DU	1.86	1.85	DU	1.85	0.180	U	0.180
Dichlorodiphenyldichloroethane	PEST	3.72	DU	3.72	3.70	DU	3.70	0.360	U	0.360
Dichlorodiphenyldichloroethylene	PEST	3.72	DU	3.72	3.70	DU	3.70	0.360	U	0.360
Dichlorodiphenyltrichloroethane	PEST	3.72	DU	3.72	3.70	DU	3.70	0.360	U	0.360
Dieldrin	PEST	3.72	DU	3.72	3.70	DU	3.70	0.360	U	0.360
Endosulfan I	PEST	1.86	DU	1.86	1.85	DU	1.85	0.180	U	0.180
Endosulfan II	PEST	3.72	DU	3.72	3.70	DU	3.70	0.360	U	0.360
Endosulfan sulfate	PEST	3.72	DU	3.72	3.70	DU	3.70	0.360	U	0.360
Endrin	PEST	3.72	DU	3.72	3.70	DU	3.70	0.360	U	0.360
Endrin aldehyde	PEST	3.72	DU	3.72	3.70	DU	3.70	0.360	U	0.360
Endrin ketone	PEST	3.72	DU	3.72	3.70	DU	3.70	0.360	U	0.360
Gamma-BHC (Lindane)	PEST	1.86	DU	1.86	1.85	DU	1.85	0.180	U	0.180
gamma-Chlordane	PEST	1.86	DU	1.86	1.85	DU	1.85	0.180	U	0.180
Heptachlor	PEST	1.86	DU	1.86	1.85	DU	1.85	0.180	U	0.180
Heptachlor epoxide	PEST	1.86	DU	1.86	1.85	DU	1.85	0.180	U	0.180
Methoxychlor	PEST	18.6	DU	18.6	18.5	DU	18.5	1.80	U	1.80
Toxaphene	PEST	62.0	DUJ	62.0	61.7	DUJ	61.7	5.99	UJ	5.99

Attachment	1	Sheet No.	5 of 7
Originator	I. B. Berezovskiy	Date	04/22/14
Checked	J. D. Skoglie	Date	04/22/14
Calc. No.	0600X-CA-V0178	Rev. No.	0

Attachment 1. 600-384 Waste Site Verification Sample Results (Organics).

CONSTITUENT	CLASS	J1T5P9, 600-384:2a			J1T5R0, 600-384:2b			J1T5R1, 600-384:3a		
		1/29/2014			1/29/2014			1/29/2014		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
2-(2,4,5-Trichlorophenoxy)propionic acid	HERB	1.76	U	1.76	1.77	U	1.77	1.90	U	1.90
2-(2-methyl-4-chlorophenoxy) propionic acid	HERB	212	U	212	213	U	213	229	U	229
2,4,5-Trichlorophenoxyacetic acid	HERB	1.76	U	1.76	1.77	U	1.77	1.90	U	1.90
2,4-Dichlorophenoxyacetic acid	HERB	1.76	TU	1.76	1.77	TU	1.77	1.90	TU	1.90
2-Methyl-4 chlorophenoxyacetic acid	HERB	244	U	244	245	U	245	263	U	263
2-secButyl-4,6-dinitrophenol(DNBP)	HERB	1.76	UJ	1.76	1.77	UJ	1.77	1.90	UJ	1.90
4-(2,4-Dichlorophenoxy)butanoic acid	HERB	1.76	U	1.76	1.77	U	1.77	1.90	U	1.90
Dalapon	HERB	37.1	U	37.1	37.3	U	37.3	40.1	U	40.1
Dicamba	HERB	2.12	U	2.12	2.13	U	2.13	2.29	U	2.29
Dichloroprop	HERB	2.40	U	2.40	2.41	U	2.41	2.59	U	2.59
Acenaphthene	PAH	5.30	U	5.30	5.32	U	5.32	5.73	U	5.73
Acenaphthylene	PAH	5.30	U	5.30	5.32	U	5.32	5.73	U	5.73
Anthracene	PAH	1.77	U	1.77	1.77	U	1.77	1.91	U	1.91
Benzo(a)anthracene	PAH	0.566	U	0.566	0.568	U	0.568	0.611	U	0.611
Benzo(a)pyrene	PAH	0.566	U	0.566	0.568	U	0.568	0.611	U	0.611
Benzo(b)fluoranthene	PAH	0.566	U	0.566	0.568	U	0.568	0.611	U	0.611
Benzo(ghi)perylene	PAH	0.566	U	0.566	0.568	U	0.568	0.611	U	0.611
Benzo(k)fluoranthene	PAH	0.283	U	0.283	0.284	U	0.284	0.305	U	0.305
Chrysene	PAH	0.566	U	0.566	0.568	U	0.568	0.611	U	0.611
Dibenz[a,h]anthracene	PAH	0.566	U	0.566	0.568	U	0.568	0.611	U	0.611
Fluoranthene	PAH	0.566	U	0.566	0.568	U	0.568	0.611	U	0.611
Fluorene	PAH	5.30	U	5.30	5.32	U	5.32	5.73	U	5.73
Indeno(1,2,3-cd)pyrene	PAH	0.566	U	0.566	0.568	U	0.568	0.611	U	0.611
Naphthalene	PAH	5.30	U	5.30	5.32	U	5.32	5.73	U	5.73
Phenanthrene	PAH	5.30	U	5.30	5.32	U	5.32	5.73	U	5.73
Pyrene	PAH	0.566	U	0.566	0.568	U	0.568	0.611	U	0.611
Aroclor-1016	PCB	1.17	U	1.17	1.18	U	1.18	1.27	U	1.27
Aroclor-1221	PCB	1.17	U	1.17	1.18	U	1.18	1.27	U	1.27
Aroclor-1232	PCB	1.17	U	1.17	1.18	U	1.18	1.27	U	1.27
Aroclor-1242	PCB	1.17	U	1.17	1.18	U	1.18	1.27	U	1.27
Aroclor-1248	PCB	1.17	U	1.17	1.18	U	1.18	1.27	U	1.27
Aroclor-1254	PCB	1.17	U	1.17	1.18	U	1.18	1.27	U	1.27
Aroclor-1260	PCB	1.17	U	1.17	1.18	U	1.18	1.27	U	1.27
Aldrin	PEST	0.177	U	0.177	0.177	U	0.177	0.190	U	0.190
Alpha-BHC	PEST	0.177	U	0.177	0.177	U	0.177	0.190	U	0.190
alpha-Chlordane	PEST	0.177	U	0.177	0.177	U	0.177	0.190	U	0.190
beta-1,2,3,4,5,6-Hexachlorocyclohexane	PEST	0.177	U	0.177	0.177	U	0.177	0.190	U	0.190
Delta-BHC	PEST	0.177	U	0.177	0.177	U	0.177	0.190	U	0.190
Dichlorodiphenyldichloroethane	PEST	0.354	U	0.354	0.354	U	0.354	0.381	U	0.381
Dichlorodiphenyldichloroethylene	PEST	0.354	U	0.354	0.354	U	0.354	0.381	U	0.381
Dichlorodiphenyltrichloroethane	PEST	0.354	U	0.354	0.354	U	0.354	0.381	U	0.381
Dieldrin	PEST	0.354	U	0.354	0.354	U	0.354	0.381	U	0.381
Endosulfan I	PEST	0.177	U	0.177	0.177	U	0.177	0.190	U	0.190
Endosulfan II	PEST	0.354	U	0.354	0.354	U	0.354	0.381	U	0.381
Endosulfan sulfate	PEST	0.354	U	0.354	0.354	U	0.354	0.381	U	0.381
Endrin	PEST	0.354	U	0.354	0.354	U	0.354	0.381	U	0.381
Endrin aldehyde	PEST	0.354	U	0.354	0.354	U	0.354	0.381	U	0.381
Endrin ketone	PEST	0.354	U	0.354	0.354	U	0.354	0.381	U	0.381
Gamma-BHC (Lindane)	PEST	0.177	U	0.177	0.177	U	0.177	0.190	U	0.190
gamma-Chlordane	PEST	0.177	U	0.177	0.177	U	0.177	0.190	U	0.190
Heptachlor	PEST	0.177	U	0.177	0.177	U	0.177	0.190	U	0.190
Heptachlor epoxide	PEST	0.177	U	0.177	0.177	U	0.177	0.190	U	0.190
Methoxychlor	PEST	1.77	U	1.77	1.77	U	1.77	1.90	U	1.90
Toxaphene	PEST	5.89	UJ	5.89	5.89	UJ	5.89	6.34	UJ	6.34

Attachment	1	Sheet No.	6 of 7
Originator	I. B. Berezovskiy	Date	04/22/14
Checked	J. D. Skoglie	Date	04/22/14
Calc. No.	0600X-CA-V0178	Rev. No.	0

Attachment 1. 600-384 Waste Site Verification Sample Results (Organics).

CONSTITUENT	CLASS	J1T5R2, 600-384:3b			J1T5R3, 600-384:4a			J1TFJ5, 600-384:4b		
		1/29/2014			1/29/2014			3/6/2014		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
2-(2,4,5-Trichlorophenoxy)propionic acid	HERB	18.2	DU	18.2	9.88	DU	9.88	1.90	U	1.90
2-(2-methyl-4-chlorophenoxy) propionic acid	HERB	2190	DU	2190	1190	DU	1190	229	U	229
2,4,5-Trichlorophenoxyacetic acid	HERB	18.2	DU	18.2	9.88	DU	9.88	1.90	U	1.90
2,4-Dichlorophenoxyacetic acid	HERB	18.2	TDU	18.2	9.88	TDU	9.88	1.90	U	1.90
2-Methyl-4 chlorophenoxyacetic acid	HERB	2510	DU	2510	1370	DU	1370	264	U	264
2-secButyl-4,6-dinitrophenol(DNBP)	HERB	18.2	DUJ	18.2	9.88	DUJ	9.88	1.90	UJ	1.90
4-(2,4-Dichlorophenoxy)butanoic acid	HERB	18.2	DU	18.2	9.88	DU	9.88	1.90	U	1.90
Dalapon	HERB	383	DU	383	208	DU	208	40.2	U	40.2
Dicamba	HERB	21.9	DU	21.9	11.9	DU	11.9	2.29	U	2.29
Dichloroprop	HERB	24.7	DU	24.7	13.4	DU	13.4	2.59	U	2.59
Acenaphthene	PAH	10.9	DU	10.9	5.93	U	5.93	5.72	U	5.72
Acenaphthylene	PAH	10.9	DU	10.9	5.93	U	5.93	5.72	U	5.72
Anthracene	PAH	61.7	D	3.63	7.44	J	1.98	1.91	U	1.91
Benzo(a)anthracene	PAH	10.9	DU	1.16	72.0		0.632	18.6		0.610
Benzo(a)pyrene	PAH	71.3	D	1.16	76.0		0.632	14.7		0.610
Benzo(b)fluoranthene	PAH	10.9	DU	1.16	57.2		0.632	13.8		0.610
Benzo(ghi)perylene	PAH	10.9	DU	1.16	49.9		0.632	11.3		0.610
Benzo(k)fluoranthene	PAH	10.9	DU	0.581	0.316	U	0.316	0.305	U	0.305
Chrysene	PAH	10.9	DU	1.16	72.5		0.632	16.3		0.610
Dibenz[a,h]anthracene	PAH	10.9	DU	1.16	38.8		0.632	1.38	J	0.610
Fluoranthene	PAH	10.9	DU	1.16	122		0.632	21.4		0.610
Fluorene	PAH	10.9	DU	10.9	5.93	U	5.93	5.72	U	5.72
Indeno(1,2,3-cd)pyrene	PAH	32.5	D	1.16	0.632	U	0.632	0.610	U	0.610
Naphthalene	PAH	10.9	DU	10.9	5.93	U	5.93	5.72	U	5.72
Phenanthrene	PAH	10.9	DU	10.9	102		5.93	10.4	J	5.72
Pyrene	PAH	236	BD	1.16	162	B	0.632	29.7		0.610
Aroclor-1016	PCB	6.07	DUJ	6.07	1.32	U	1.32	1.27	U	1.27
Aroclor-1221	PCB	6.07	DUJ	6.07	1.32	U	1.32	1.27	U	1.27
Aroclor-1232	PCB	6.07	DUJ	6.07	1.32	U	1.32	1.27	U	1.27
Aroclor-1242	PCB	6.07	DUJ	6.07	1.32	U	1.32	1.27	U	1.27
Aroclor-1248	PCB	6.07	DUJ	6.07	1.32	U	1.32	1.27	U	1.27
Aroclor-1254	PCB	6.07	DUJ	6.07	1.32	U	1.32	1.27	U	1.27
Aroclor-1260	PCB	6.07	DUJ	6.07	1.32	U	1.32	1.27	U	1.27
Aldrin	PEST	3.64	DU	3.64	0.397	DU	0.397	0.191	U	0.191
Alpha-BHC	PEST	3.64	DU	3.64	0.397	DU	0.397	0.191	U	0.191
alpha-Chlordane	PEST	3.64	DU	3.64	0.397	DU	0.397	0.191	U	0.191
beta-1,2,3,4,5,6-Hexachlorocyclohexane	PEST	3.64	DU	3.64	0.397	DU	0.397	0.191	U	0.191
Delta-BHC	PEST	3.64	DU	3.64	0.397	DU	0.397	0.191	U	0.191
Dichlorodiphenyldichloroethane	PEST	7.28	DU	7.28	0.794	DU	0.794	0.383	U	0.383
Dichlorodiphenyldichloroethylene	PEST	7.28	DU	7.28	0.794	DU	0.794	0.383	U	0.383
Dichlorodiphenyltrichloroethane	PEST	7.28	DU	7.28	0.794	DU	0.794	0.383	U	0.383
Dieldrin	PEST	7.28	DU	7.28	0.794	DU	0.794	0.383	U	0.383
Endosulfan I	PEST	3.64	DU	3.64	0.397	DU	0.397	0.191	U	0.191
Endosulfan II	PEST	7.28	DU	7.28	0.794	DU	0.794	0.383	U	0.383
Endosulfan sulfate	PEST	7.28	DU	7.28	0.794	DU	0.794	0.383	U	0.383
Endrin	PEST	7.28	DU	7.28	0.794	DU	0.794	0.383	U	0.383
Endrin aldehyde	PEST	7.28	DU	7.28	0.794	DU	0.794	0.383	U	0.383
Endrin ketone	PEST	7.28	DU	7.28	0.794	DU	0.794	0.383	U	0.383
Gamma-BHC (Lindane)	PEST	3.64	DU	3.64	0.397	DU	0.397	0.191	U	0.191
gamma-Chlordane	PEST	3.64	DU	3.64	0.397	DU	0.397	0.191	U	0.191
Heptachlor	PEST	3.64	DU	3.64	0.397	DU	0.397	0.191	U	0.191
Heptachlor epoxide	PEST	3.64	DU	3.64	0.397	DU	0.397	0.191	U	0.191
Methoxychlor	PEST	36.4	DU	36.4	3.97	DU	3.97	1.91	U	1.91
Toxaphene	PEST	121	DUJ	121	13.2	DUJ	13.2	6.37	UJ	6.37

Attachment	1	Sheet No.	7 of 7
Originator	I. B. Berezovskiy	Date	04/22/14
Checked	J. D. Skoglie	Date	04/22/14
Calc. No.	0600X-CA-V0178	Rev. No.	0

Acrobat 8.0

CALCULATION COVER SHEET

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

Area: 600

Discipline: Environmental *Calculation No: 0600X-CA-V0181

Subject: 600-384 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater

Computer Program: Excel Program No: Excel 2010

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 3 Total = 4	I. B. Berezovskiy	J. D. Skoglie	H. M. Sulloway	S.G. Wilkinson ~~D. F. Obenauer~~	8/5/14

SUMMARY OF REVISION

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

Washington Closure Hanford, LLC CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	5/12/2014	Calc. No.:	0600X-CA-V0181	Rev.:	0
Project:	600 Area Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	5/12/2014
Subject:	600-384 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 600-384 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, 2014, *600-384 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations*, 0600X-CA-V0178, Rev. 0, Washington Closure Hanford, 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, LLC CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	5/12/2014	Calc. No.:	0600X-CA-V0181	Rev.:	0
Project:	600 Area Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	5/12/2014
Subject:	600-384 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No. 2 of 3	

METHODOLOGY:

The 600-384 waste site consists of 5 subsites/excavations: 600-384:1, 600-384:2, 600-384:3, 600-384:4 and 600-384:5. A total of seven focused samples plus a duplicate were collected from the 600-384 waste site. Hazard quotient and carcinogenic risk calculations for potential impact to groundwater at the 600-384 waste site were conservatively calculated for the entire waste site using the maximum value for each analyte from WCH (2014). Based on this model and a vadose zone of approximately 5 m (16.4 ft) thickness, a K_d value of 14 mL/g is adequate to show no migration to groundwater in 1,000 years using the generic RESRAD model (BHI 2005). Of the contaminants of potential concern (COPCs) for this site, boron and cyanide 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 nitrate require HQ and risk calculations because this analyte was detected above a Washington State or Hanford Site background value, and has a K_d of less than 14. Although sulfate was detected above background, and has a Kd of less than 14, the sulfate standard is non-toxicity based. All other site nonradionuclide COPCs were not detected, quantified below background levels, or have a K_d greater than or equal to 14. 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 3.4 mg/kg, divided by the noncarcinogenic RAG value of 320 mg/kg produces an HQ value of 1.1×10^{-2}. Comparing this value to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation.) The cumulative HQ for the 600-384 waste site is 2.3×10^{-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 600-384 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 ground water at the site." When the "100 times rule" values are exceeded, RESRAD was used to demonstrate that higher soil concentrations may be protective of groundwater.

Washington Closure Hanford, LLC CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	5/12/2014	Calc. No.:	0600X-CA-V0181	Rev.:	0
Project:	600 Area Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	5/12/2014
Subject:	600-384 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No. 3 of 3	

RESULTS:

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

Table 1 shows the results of the calculations.

Table 1. Hazard Quotient and Excess Cancer Risk Results for the 600-384 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	3.4	320	1.1E-02	--	--
Anions					
Cyanide	0.202	32	6.3E-03	--	--
Nitrate as nitrogen	14.4	2,560	5.6E-03	--	--
Sulfate[c]	359	25,000	--	--	--
Totals					
Cumulative Hazard Quotient:			**2.3E-02**		
Cumulative Excess Cancer Risk:					**0.0E+00**

Notes:
[a] = From WCH (2014).
[b] = Value obtained from the Cleanup Levels and Risk Calculations (CLARC) database using Groundwater, Method B, results and the "100 times" model.
[c] = Sulfate clean-up standard is non-toxicity based; therefore, HQ is not calculated for this constituent.
-- = not applicable
RAG = remedial action goal

CONCLUSION:

The calculation in Table 1 demonstrates that the 600-384 waste site meets the requirements for the hazard quotient and excess carcinogenic risk for protection of groundwater as identified in the RDR/RAWP (DOE-RL 2009).

APPENDIX D

DATA QUALITY ASSESSMENT

APPENDIX D

DATA QUALITY ASSESSMENT

VERIFICATION SAMPLING

A data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WCH 2013, 2014a, 2014b). This DQA was performed in accordance with site specific data quality objectives found in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2009).

The 600-384 waste site consists of five subsites, including 600-384:1, 600-384:2, 600-384:3, 600-384:4 and 600-384:5. A review of the sample design (WCH 2013, 2014a, 2014b), the field logbook (WCH 2014c), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design except as described below, with minimal alterations, as warranted by field conditions. Two focused samples, instead of one, were collected from the 600-384:4 subsite excavation for verification sampling due to an increase of the area of the excavation following additional remediation. The ion chromatograph (IC) anions and total cyanide analyses were inadvertently not requested on the additional sample that was collected from the 600-384:4 subsite excavation.

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

Verification sample data collected at the 600-384 waste site were provided by the laboratories in three sample delivery groups (SDGs): SDG XP0044, SDG XP0056, and SDG XP0057. SDG XP0044 was submitted for third-party validation. No major deficiencies were identified in the analytical data set. Minor deficiencies are discussed for the 600-384 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.

MINOR DEFICIENCIES

SDG XP0044

This SDG comprises seven focused soil samples (J1T5P8, J1T5P9, and J1T5R0 through J1T5R4) collected from 600-384:1, 600-384:2, 600-384:3, 600-384:4, and 600-384:5 subsite excavations. This SDG includes a field duplicate pair (J1T5R4/J1T5R5). All samples were analyzed for inductively coupled plasma (ICP) metals, mercury, IC anions, nitrate/nitrite, total cyanide, total petroleum hydrocarbons (TPH), pesticides, herbicides, polychlorinated

biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAH). In addition, one equipment blank (J1T5R6) was collected and analyzed for ICP metals and mercury. SDG XP0044 was submitted for third-party validation. Minor deficiencies are as follows.

In the IC anions analysis, the holding times for nitrate, nitrite, and orthophosphate using EPA method 300.0 were exceeded by less than twice the limit in SDG XP0044. Third-party validation qualified all nitrate, nitrite, and orthophosphate data in SDG XP0044 as estimates, with "J" flags. Estimated data are usable for decision-making purposes.

In the IC anions analysis, due to method blank (MB) contamination, third-party validation qualified all nitrate/nitrite data in samples J1T5R4 and J1T5R5 as undetected, with "U" flags. Data are usable for decision-making purposes.

In the TPH analysis, the surrogate recovery for samples J1T5R2, J1T5R3, J1T5R4, and J1T5R5 was diluted out, resulting in a recovery of 0%. Third-party validation qualified all diesel range organics and motor oil results for samples J1T5R2, J1T5R3, J1T5R4, and J1T5R5 as estimates, with "J' flags. Estimated data are usable for decision-making purposes.

In the pesticide analysis, due to the lack of matrix spike (MS), matrix spike duplicate (MSD), and laboratory control sample (LCS) analysis, third-party validation qualified all toxaphene results as estimates, with "J" flags. Estimated data are usable for decision-making purposes.

In the herbicide analysis, the MSD recovery was below the quality control (QC) limit for dinoseb (48.9%). Third-party validation qualified all dinoseb results as estimates, with "J" flags. Estimated data are usable for decision-making purposes.

In the PCB analysis, the MS and MSD recoveries for surrogate were below the QC limits at 11.0% and 17.1%, respectively. Third-party validation qualified all PCB results in sample J1T5R2 as estimates, with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, sodium and zinc were detected in the MB. Due to MB contamination, third-party validation qualified all sodium and zinc results in sample J1T5R6, as undetected, with "UJ" flags. Data are usable for decision-making purposes.

In the ICP metals analysis, the MS recovery was below the QC limit for silicon (55.1%). Third-party validation qualified all silicon results in SDG XP0044 as estimates, with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP analysis, the relative percent difference (RPD) was above the QC limit for silicon (48.9%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. All silicon results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

SDG XP0056

This SDG comprises three focused soil samples (J1TFJ4 through J1TFJ6) collected from the 600-384:3 and 600-384:4 subsite excavations following additional remediation. Sample J1TFJ5 was analyzed for ICP metals, mercury, IC anions, nitrate/nitrite, total cyanide, TPH, pesticides, herbicides, PCBs, and PAH. Samples J1TFJ4 and J1TFJ6 were analyzed for TPH only. Minor deficiencies are as follows.

In the herbicide analysis, the LCS, MS, and MSD recoveries were below the project QC limit for dalapon, 44.2%, 30.5%, and 33.3%, respectively. Although not qualified for LCS, MS, and MSD recoveries below the QC limit, all dalapon data in sample J1TFJ5 may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the RPD for boron and silicon is above the acceptance criteria of 30%, at 39.5% and 35.0%, respectively. Elevated RPDs in environmental soil samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the RPDs above the QC limits, all boron and silicon results in SDG XP0056 may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, arsenic and nickel were detected in MB at very low levels, less than $1/25^{th}$ of the detected field sample result. Although not qualified for the MB contamination, all arsenic and nickel results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the MS recoveries are out of project acceptance criteria for silicon (0%). Post-spike (PS) was performed for silicon (16.9%), and the recovery was below the project acceptance criteria. Although not qualified for MS recovery outside of QC limits, silicon results for SDG XP0056 may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory duplicate RPD for silver is above the acceptance criteria of 30%, at 99%. Elevated RPDs in environmental soil samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the RPDs above the QC limits, all silicon results in SDG XP0056 may be considered estimated. Estimated data are usable for decision-making purposes.

SDG XP0057

This SDG comprises one focused soil sample (J1TFK0) collected from the 600-384:5 subsite excavation following additional remediation. This SDG includes a field duplicate pair (J1TFK0\J1TFK1). Samples J1TFK0 and J1TFK1 were analyzed for TPH only. In addition, one equipment blank (J1TFK2) was collected and analyzed for ICP metals and mercury. The equipment blank results are reported in Appendix C for completeness. However, because sample J1TFK0 was not analyzed for ICP metals, the results of the equipment blank J1TFK2 will not be assessed. No minor deficiencies affecting the quality of the data were found in SDG XP0057.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

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

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

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

Sample Area	Main Sample	Duplicate Sample
600-384:5 subsite excavation	J1T5R4	J1T5R5
600-384:5 following additional remediation	J1TFK0	J1TFK1

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

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 TDL, including undetected analytes. In these cases, a control limit of ±2 times the TDL is used (Appendix B) to indicate that a visual check of the data is required by the reviewer. No sample results required this check. A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are usable for decision-making purposes.

SUMMARY

Limited, random, or sample matrix-specific influenced batch QC issues such as those discussed above are a potential for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 600-384 waste site verification sampling data found that the analytical results are accurate within the standard errors associated with the analytical methods, sampling, and sample handling.

The DQA review for 600-384 waste site concludes that the reviewed data are of the right type, quality, and quantity to support the intended use. The analytical data were found acceptable for decision-making purposes.

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

REFERENCES

BHI, 2000, *Data Validation Procedure for Chemical Analysis*, BHI-01435, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

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

EPA, 2006, *Guidance on Systematic Planning using the Data Quality Objectives Process*, EPA QA/G-4, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

WCH, 2013, *Work Instruction for Verification Sampling of the 600-384, Segment 4 Stained Soil Area #3,* 0600X-WI-G0078, Rev. 0, Washington Closure Hanford, Richland, Washington.

WCH, 2014a, "Collect Two samples at 600-384:4 (Regulatory Concurrence)" CCN 175598, to T. Howell, Washington Closure Hanford, and E. Glossbrenner, U.S. Department of Energy, Richland Operations Office, from A. Kapell, Washington State Department of Ecology, Richland, Washington, March 5.

WCH, 2014b, "DOE Concurrence to Collect Two Samples at 600-384:4" CCN 175608, to T. Howell, Washington Closure Hanford, and A. Kapell, Washington State Department of Ecology, from E. Glossbrenner, U.S. Department of Energy, Richland Operations Office, Richland, Washington, March 5.

WCH, 2014c *IU-2/6 and Segment 4 Miscellaneous Restoration Sites*, Logbook EL-1666-01, pp. 68-73, 91-96, Washington Closure Hanford, Richland, Washington.