Waste Site Reclassification Form

Date Submitted: 5/4/06 **Originator:** R. A. Carlson **Phone:** 948-6650	**Operable Unit(s):** 100-FR-1 **Waste Site ID:** 141-C **Type of Reclassification Action:** Rejected ☐ Closed Out ☐ Interim Closed Out ☒ No Action ☐	**Control Number:** 2006-027 **Lead Agency:** EPA

This form documents agreement among the parties listed below authorizing classification of the subject unit as rejected, closed out, interim closed out, or no action and authorizing backfill of the site, if appropriate. Final removal from the National Priorities List (NPL) of no action, interim closed-out, or closed-out sites will occur at a future date.

Description of current waste site condition:

The 141-C waste site is a former large animal barn and biology laboratory within the 100-F Area experimental animal farm. Strontium-90, arsenic, and multiple polycyclic aromatic hydrocarbons were detected within residual demolition debris at concentrations exceeding cleanup criteria. The site has been remediated by removing approximately 900 bank cubic meters of soil and debris within the former building footprint to the Environmental Restoration Disposal Facility. Confirmatory evaluation, remediation, and verification sampling of this site have been performed in accordance with remedial action objectives and goals established by 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. The selected action involved (1) evaluating the site using available process information and confirmatory sample data, (2) remediating the site, (3) demonstrating through verification sampling that cleanup goals have been met, and (4) proposing the site for classification as interim closed out.

Basis for reclassification:

The 141-C waste site has been remediated to meet the remedial action objectives specified in the Remaining Sites ROD. The results of verification sampling demonstrated 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 showed that residual contaminant concentrations are protective of groundwater and the Columbia River. This site does not have a deep zone; therefore, no deep zone institutional controls are required. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 141-C Large Animal Barn and Biology Laboratory (Hog Barn)* (attached).

D. C. Smith DOE-RL Project Manager	Signature	5/22/06 Date
NA Ecology Project Manager	Signature	Date
R. A. Lobos EPA Project Manager	Signature	5-24-2006 Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 141-C LARGE ANIMAL BARN AND BIOLOGY LABORATORY (HOG BARN)

Attachment to Waste Site Reclassification Form 2006-027

May 2006

REMAINING SITES VERIFICATION PACKAGE FOR THE 141-C LARGE ANIMAL BARN AND BIOLOGY LABORATORY (HOG BARN)

EXECUTIVE SUMMARY

The 141-C waste site, located within the 100-FR-1 Operable Unit, is the site of the former 141-C Large Animal Barn and Biology Laboratory. This facility, part of the former experimental animal farm in the northeastern 100-F Area, was used to house animals during radiobiological studies. The primary isotopes used during experimentation were iodine-131, strontium-90, cesium-137, ruthenium-106, and plutonium-239.

The site was evaluated during September 2004 confirmatory sampling efforts to make a decision as to whether remedial action would be required at the site. Three test trenches were excavated through areas containing concentrated geophysical anomalies and/or suspect contaminant accumulation locations identified on historical drawings. A total of seven focused samples and one field duplicate sample were collected from suspect hazardous materials and soils and analyzed for contaminants of potential concern.

Strontium-90 was detected above the direct exposure dose-equivalence lookup value in the confirmatory samples. Arsenic and multiple polycyclic aromatic hydrocarbons (PAHs) were detected above direct exposure remedial action goals (RAGs) and soil RAGs for groundwater and/or river protection. Additional metals and PAHs were also detected above soil RAGs for groundwater and/or river protection. Based on these results, it was determined that the 141-C site required remedial action.

Site remediation consisted of the removal of the approximate upper 1 m (3 ft) of soil and debris within the building footprint. Approximately 900 bank cubic meters (1,200 bank cubic yards) of material was excavated and disposed at the Environmental Restoration Disposal Facility. Remedial actions were performed so as to not preclude any future uses (as bounded by the rural-residential scenario) and to allow unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep).

Following site remediation, verification soil sampling within the remediation footprint and remediation waste staging pile footprint was conducted on January 30, 2006. The results indicated that the waste removal action achieved compliance with the remedial action objectives for the 141-C waste site. A summary of the cleanup 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 141-C waste site in accordance with the TPA-MP-14 (DOE-RL 1998) procedure.

In accordance with this evaluation, the verification sampling results support a reclassification of this site to interim closed out. The current site conditions achieve the remedial action objectives and the corresponding RAGs established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b) 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). 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. This site does not have a deep zone; therefore, no deep zone institutional controls are required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the site contaminants of concern, contaminants of potential concern, and other constituents. Screening levels were not exceeded for the site constituents, with the exception of barium, boron, and vanadium. Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. It is believed that the presence of these constituents does not pose a risk to ecological receptors as concentrations of barium and vanadium are below site background levels, and boron concentrations are consistent with those seen elsewhere at the Hanford Site (no established background value is available). A baseline risk assessment for the river corridor portion of the Hanford Site began in 2004, which includes a more complete quantitative ecological risk assessment. That baseline risk assessment will be used to support the final closeout decision for the 141-C waste site.

Table ES-1. Summary of Remedial Action Goals for the 141-C Waste Site. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain 15-mrem/yr dose rate above background over 1,000 years.	Only cesium-137 and strontium-90 were detected in verification sampling, at activities significantly below the direct exposure dose-equivalence lookup values.	Yes
Direct Exposure – Nonradionuclides	Attain individual COPC RAGs.	All individual COC/COPC concentrations are below direct exposure RAGs.	Yes
Risk Requirements – Nonradionuclides	Attain a hazard quotient of <1 for all individual noncarcinogens.	All individual hazard quotients are less than 1.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogens.	The cumulative hazard quotient (3.2×10^{-2}) is less than 1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	All individual excess cancer risk values are less than 1×10^{-6}.	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	The total excess cancer risk (9.7×10^{-7}) is less than 1×10^{-5}.	

Table ES-1. Summary of Remedial Action Goals for the 141-C Waste Site. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Radionuclides	Attain single-COPC groundwater and river protection RAGs.	Only cesium-137 and strontium-90 were detected in verification sampling, at activities significantly below the lookup values for protection of groundwater and the Columbia River.	Yes
	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]	No alpha-emitting radionuclides were detected in verification samples.	
	Meet total uranium standard of 30 μg/L (21.2 pCi/L).[c]	Uranium was not identified as a COC/COPC for verification sampling.	N/A
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	Residual concentrations of lead and multiple polycyclic aromatic hydrocarbons are above soil RAGs for groundwater and/or river protection. However, results of the *100 Area Analogous Sites RESRAD Calculations* (BHI 2005) indicate that these constituents will not reach groundwater (and, therefore, the Columbia River) within 1,000 years. Therefore, the residual concentrations achieve the RAOs for groundwater and river protection.	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 Areas, 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).

COC = contaminant of concern
COPC = contaminant of potential concern
MCL = maximum contaminant level
N/A = not applicable
RAG = remedial action goal
RAO = remedial action objective

REMAINING SITES VERIFICATION PACKAGE FOR THE 141-C LARGE ANIMAL BARN AND BIOLOGY LABORATORY (HOG BARN)

STATEMENT OF PROTECTIVENESS

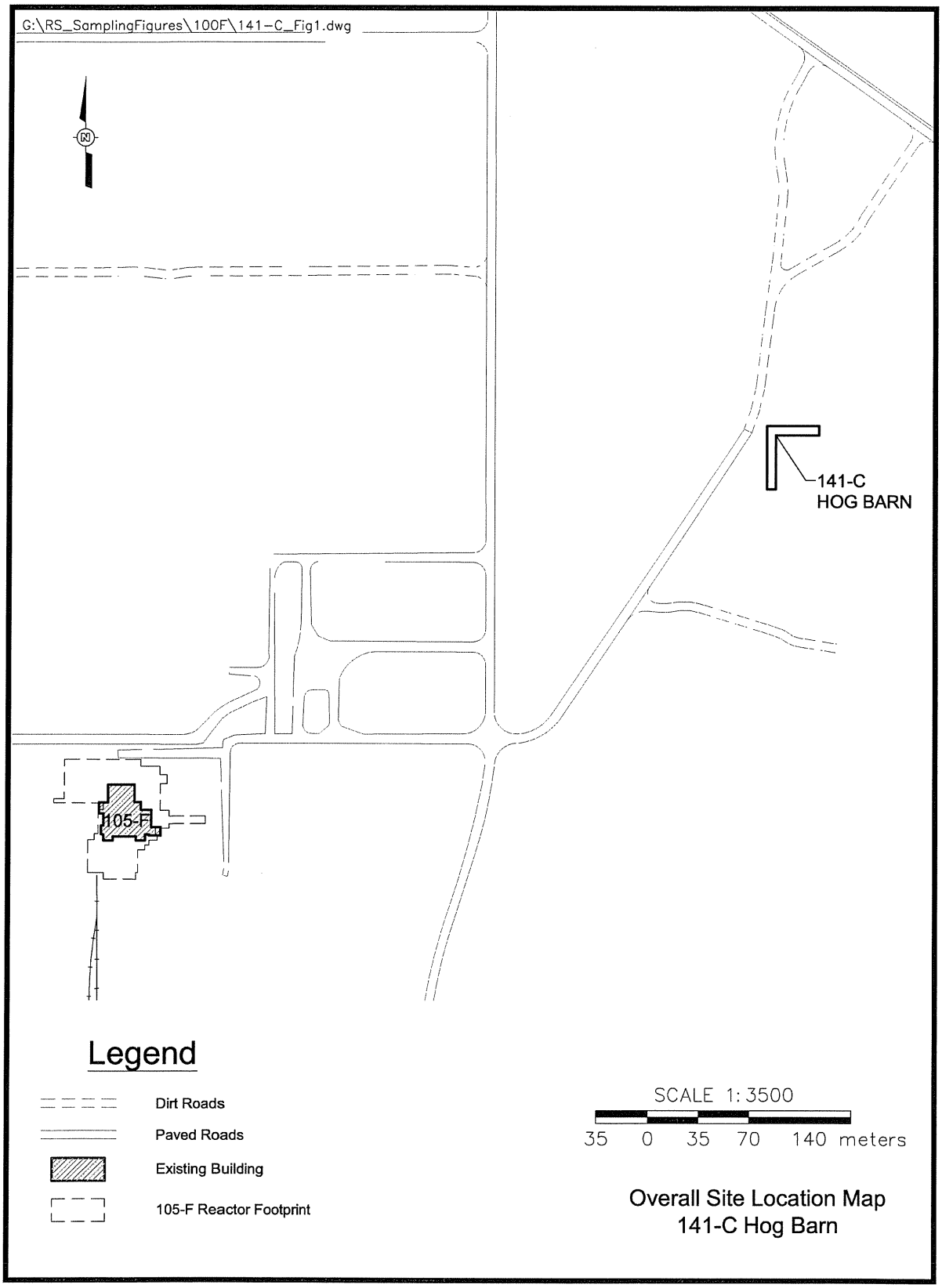
This report demonstrates that the 141-C waste site meets the objectives for interim closure as established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005b) and the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 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). 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. This site does not have a deep zone; therefore, no deep zone institutional controls are required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the site contaminants of concern (COCs), contaminants of potential concern (COPCs), and other constituents. Screening levels were not exceeded for the site constituents, with the exception of barium, boron, and vanadium. Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. It is believed that the presence of these constituents does not pose a risk to ecological receptors as concentrations of barium and vanadium are below site background levels, and boron concentrations are consistent with those seen elsewhere at the Hanford Site (no established background value is available). A baseline risk assessment for the river corridor portion of the Hanford Site began in 2004, which includes a more complete quantitative ecological risk assessment. That baseline risk assessment will be used to support the final closeout decision for the 141-C waste site.

GENERAL SITE INFORMATION AND BACKGROUND

The 141-C waste site, part of the 100-FR-1 Operable Unit, is the former location of the 141-C Large Animal Barn and Biology Laboratory, also referred to as the Chronic Feeding Barn, Hog Barn, and the Strontium-90 Hog Laboratory. Located approximately 500 m (1,640 ft) northeast of the 105-F Reactor Building (Figure 1), the 141-C Building was part of the experimental animal farm at the 100-F Area, used to provide long-term housing for large animals during radiobiological experiments.

Figure 1. Location of the 141-C Waste Site.



Radiological studies involving milk cows, pigs, chickens, ducks, goats, fish, and beagle dogs were conducted at the experimental animal farm from 1945 until 1976, when experimental facilities were relocated to the 300 Area (WHC 1993). Studies on pigs were conducted at the 141-C Building from 1952 to 1976, using similar isotopes to those used for sheep testing at the 132-F-1 Building, including iodine-131, strontium-90, cesium-137, ruthenium-106, and plutonium-239.

The 141-C Building was an "L"-shaped, single-story pre-engineered steel structure on a concrete pad, with each wing measuring 35.4 m (116 ft) long by 6 m (20 ft) wide by 2.4 m (8 ft) high. A common concrete drainage trench served steel stalls equipped with feeding and watering facilities. The facility also contained a biology laboratory and two small appended feed and supply sheds. An addition constructed on the southwest side of the facility in 1959 was used to provide additional housing for large animals exposed to long half-life radioisotopes over extended periods of time.

Contaminated manure and sawdust was removed from the 141-C facility in plastic-lined cardboard radiation boxes and disposed in a trench behind the 105-F Reactor Building. Contaminated manure and sawdust that could not be shoveled out of the animal pens were washed into the sewer, which went to the 141-N sump via a special sewer system designed for handling animal farm waste (AEC-GE 1964, UNI 1978, GE 1959). When the sump became full, the wastewater was pumped through a screen to the Columbia River via the process sewer system (100-F-29) (DOE-RL 1992, WHC 1993). The solids trapped by the screen were dried and sent to the 118-F-5 sawdust pit. In 1963, the 116-F-9 Animal Leach Trench was completed, and the liquid portion of the contaminated pen wash wastewater from the 141-N sump was diverted there.

An unplanned release associated with the 141-C facility occurred in March 1971 when the main sewer line between the 141-C and 141-M Buildings became plugged and animal pen washwater discharged to surrounding soils. Approximately 64,000 L (17,000 gal) of washwater (PNL 1988) containing strontium-90 and plutonium-239 was released over an approximately 150-m^2 (1,600-ft^2) area (DOE-RL 1992). This release area was initially designated as UN-116-F-1 (DOE-RL 1992) and later redesignated as UPR-100-F-1. The area was covered with soil (WHC 1987) and later removed with a portion of the 100-F-29 process sewer line as part of 100-F Area remedial action activities (BHI 2003).

In 1976, a joint survey of the 141-C Building by United Nuclear Industries, Inc. and Pacific Northwest Laboratory detected high radiological contamination in cracks and other accumulation points within the building. The 141-C facility was abandoned when Pacific Northwest Laboratory moved its biological studies to the 300 Area. The building was decontaminated, and all hoods and exhaust ducts were filled with foam and then cut in sections, packaged, and buried in the 200 West Area burial grounds (WHC 1991). All contaminated tile, sections of roof, side walls, and the concrete floor were removed, packaged, and disposed of in the 200 West Area burial grounds (WHC 1991). Demolition of the facility was presumably completed in 1979 with proximate 100-F Area research facilities (WHC 1991), but no specific demolition records have been located.

As part of a comprehensive compliance demonstration program, 50 soil samples were taken after demolition. Compliance with the applicable unrestricted release criteria in U.S. Atomic Energy Commission Regulatory Guide 1.86 (AEC 1974) was demonstrated.

Following detections of elevated strontium-90, metals, and polycyclic aromatic hydrocarbon (PAH) concentrations by confirmatory sampling in 2004 (Feist 2005), the 141-C waste site was remediated in 2005 to an approximate depth of 1 m (3 ft).

CONFIRMATORY SAMPLING ACTIVITIES

The 141-C waste site was evaluated during September 2004 confirmatory sampling efforts to make a decision as to whether remedial action would be required at the site. Based on site visit observations, the geophysical survey information, and the results of confirmatory sampling, a decision was made that remedial action at the site was necessary (Feist 2005). The following subsections provide additional discussion of the information used to develop the confirmatory sampling design. The results of confirmatory sampling are also summarized to provide support for development of the remedial action strategy and verification sample design.

Geophysical Investigation

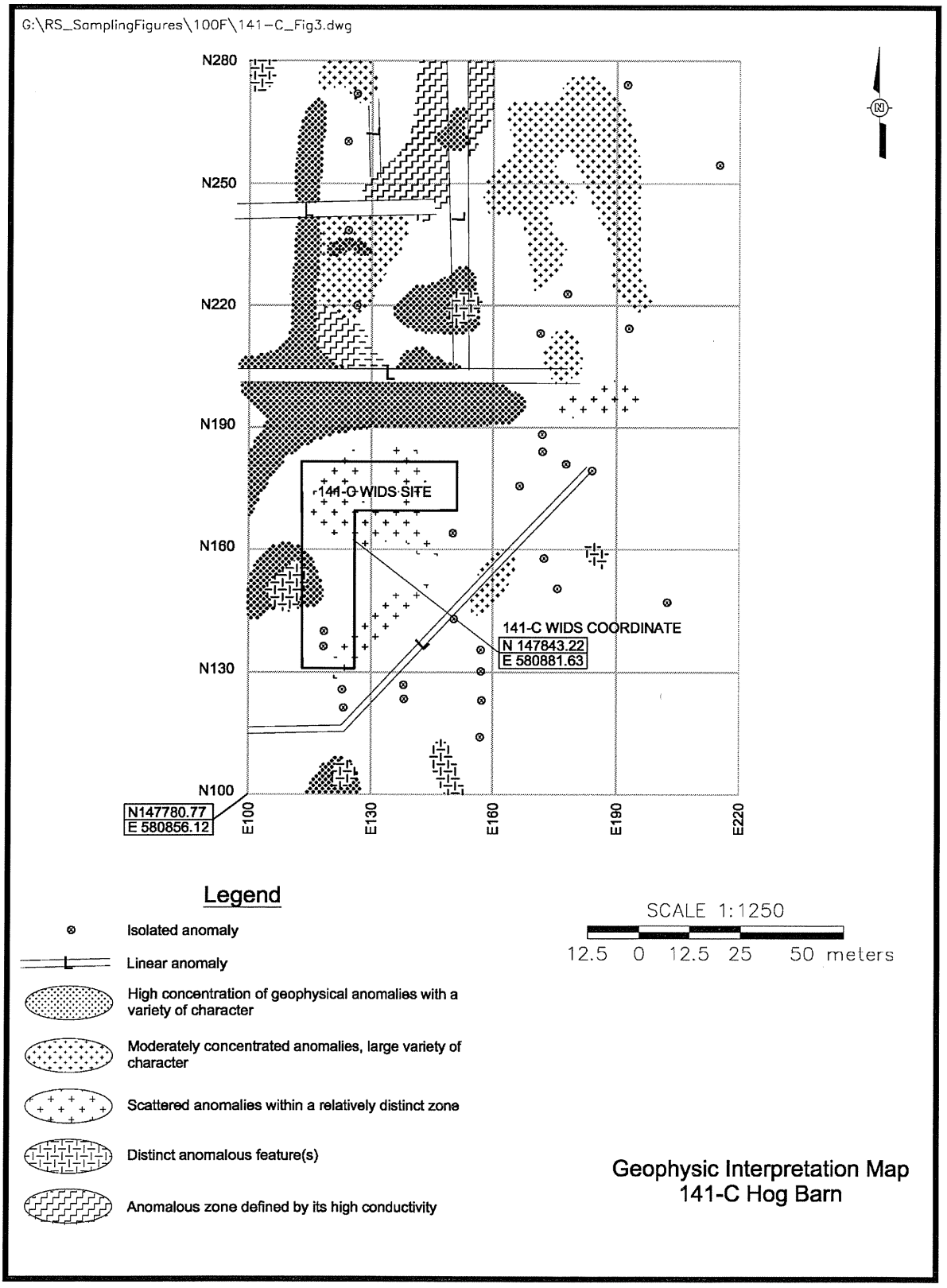
A geophysical survey was performed at the 141-C waste site in April 2004 using electromagnetic induction and magnetometry (Bergstrom et al. 2004). The survey identified subsurface linear anomalies and areas of subsurface debris or other anomalies as shown in Figure 2. The geophysical anomalies north of the 141-C waste site are believed to be related to the 141-M and 141-B Buildings and the 1607-F7 septic system. The geophysically anomalous zone to the west of the 141-C waste site is believed to be related to the 145-F Building. Process history does not suggest residual contamination associated with the 141-B, 141-M, or 145-F buildings, and they are, accordingly, not candidate sites within the Remaining Sites ROD. The 1607-F7 septic system is classified as the 1607-F7 waste site within the Waste Information Data System. This site has been remediated, and will be documented in the associated remaining sites verification package.

No anomalies consistent with large building remnants were observed during the geophysical survey.

Contaminants of Potential Concern for Confirmatory Sampling

The COPCs for the 141-C site were identified based on existing historical information for the site. The COPC list identified in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2005a) includes cesium-137, cobalt-60, europium-152, europium-154, europium-155, plutonium-238, plutonium-239/240, strontium-90, uranium-234, uranium-235, hexavalent chromium, mercury, lead, and PAHs. Based on further site-specific evaluation, americium-241, carbon-14, nickel-63, tritium, arsenic, barium, cadmium, total chromium, silver, and selenium were also included as COPCs (BHI 2004b). Iodine-131 and ruthenium-106 were eliminated as site COPCs based on the short half-life of these isotopes.

Figure 2. Interpreted Results of the Geophysical Survey at the 141-C Waste Site.



Confirmatory Sample Design

Historical data, process knowledge, geophysical survey results, and site visit information were used to develop a stratified confirmatory sampling design with focused sampling of residual debris and soil at the 141-C waste site. Three test trenches were excavated as shown in Figure 3, and samples collected within each trench. Excavation and confirmatory sampling were performed from September 21 through September 29, 2004, per the approved work instruction (BHI 2004b) and as described in the sampler's field logbook (BHI 2004a). Scattered residual debris including concrete, asphalt, aluminum scrap, and wood scrap was encountered in all of the excavations. Field radiological surveys during excavation detected elevated beta activity (up to 7,000 cpm) within the southwestern portion of test trench 1 and focused samples were collected from soil and concrete debris in this area. Samples were also collected from an approximately 1-m (3-ft) length of cast iron pipe discovered in test trench 3. A native soil sample was collected from each of the 3 trenches by combining 15 aliquots of soil taken from along the bottom of the trench into 1 sample for laboratory analysis. No suspect asbestos-containing material was observed during field activities. Elevated organic vapor readings were detected in the southwestern portion of test trench 1, and volatile organic analysis was, therefore, included on the soil samples collected from this trench. A summary of the samples collected and laboratory analyses performed is provided in Table 1.

Confirmatory Sample Results

Confirmatory samples were analyzed using analytical methods approved by the U.S. Environmental Protection Agency (DOE-RL 2005a), and the results were compared against the cleanup criteria specified in the RDR/RAWP (DOE-RL 2005b). The laboratory results were stored in the Environmental Restoration (ENRE) project-specific database prior to archiving in the Hanford Environmental Information System (HEIS) and are provided in Appendix A.

Arsenic and multiple PAHs were detected above direct exposure RAGs in the pipe sample collected from trench 3 (J01VX1). Strontium-90 was also detected above the direct exposure dose-equivalence lookup value in the concrete sample collected from trench 1 (J00219), where elevated beta activity was detected during field activities. Multiple metals were also detected above soil RAGs for the protection of groundwater and/or the Columbia River in confirmatory samples. Based on these exceedances, it was determined that remedial action was necessary at the site (Feist 2005). Tritium and hexavalent chromium analyses were inadvertently excluded from confirmatory sample analyses, and they were, therefore, retained as COPCs for verification sampling (WCH 2005).

Figure 3. Confirmatory Sampling Areas and Test Trench Locations at the 141-C Waste Site.

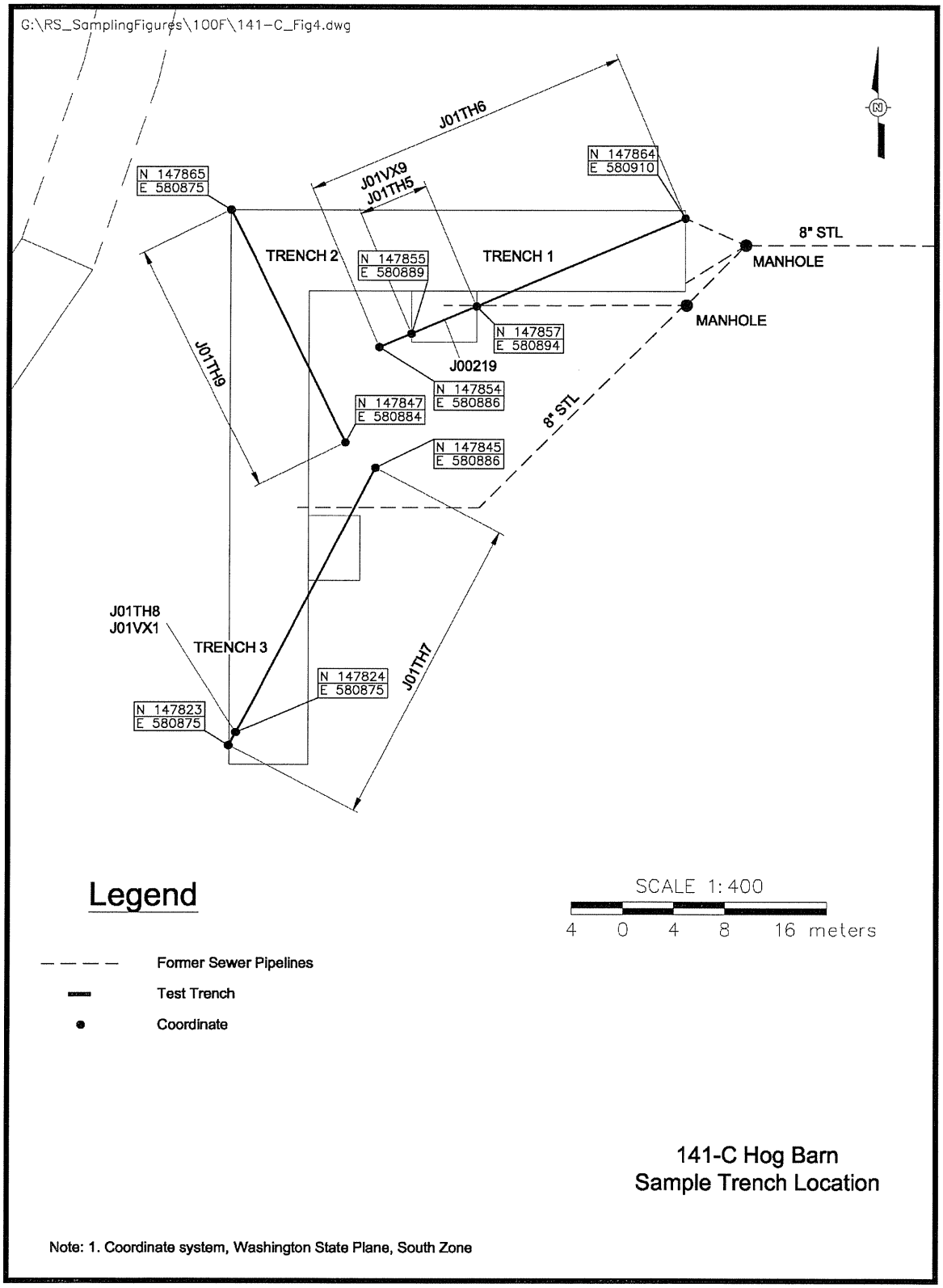


Table 1. Confirmatory Sample Summary for the 141-C Waste Site.

Test Trench	Sample Media	Sample Number	Coordinate Locations	Depth (bgs)	Sample Analysis
1	Soil	J01TH5	N 147855 E 580889 to N 147857 E 580894	0.9-1.8 m (3-6 ft)	ICP metals, mercury, GEA, gross alpha, gross beta, C-14, Ni-63, PAH, and VOA
		J01VX9			Radionuclide screen
	Native soil	J01TH6	N 147864 E 580910 to N 147854 E 580886	1.2 m (4 ft) average	ICP metals, mercury, GEA, gross alpha, gross beta, C-14, Ni-63, PAH, and VOA
	Concrete	J00219	N 147855 E 580889	0.6 m (2 ft)	GEA, gross alpha, gross beta, and Sr-90
2	Native soil	J01TH9	N 147865 E 580875 to N 147847 E 580884	0.9-1.2 m (3-4 ft)	ICP metals, mercury, GEA, gross alpha, gross beta, C-14, Ni-63, and PAH
3	Soil	J01TH7	N 147823 E 580875 to N 147845 E 580886	0.9 m (3 ft) average	ICP metals, mercury, GEA, gross alpha, gross beta, C-14, Ni-63, and PAH
	Soil within pipe	J01TH8	N 147824 E 580875	0.6 m (2 ft)	ICP metals, mercury, GEA, gross alpha, gross beta, Sr-90, C-14, Ni-63, and PAH
	Pipe piece	J01VX1			ICP metals, mercury, GEA, gross alpha, gross beta, Sr-90, C-14, Ni-63, and PAH
Equipment blank	Silica sand	J01TJ2	NA	NA	ICP metals and mercury
Duplicate of J01TH7	Soil	J01TJ1	N 147823 E 580875 to N 147845 E 580886	0.9 m (3 ft) average	ICP metals, mercury, GEA, gross alpha, gross beta, C-14, Ni-63, and PAH

Source: *Remaining Sites Field Sampling*, Logbook EL-1578-2 (BHI 2004a).
bgs = below ground surface
GEA = gamma energy analysis
ICP = inductively coupled plasma
NA = not applicable
PAH = polycyclic aromatic hydrocarbon
VOA = volatile organic analysis

REMEDIAL ACTION SUMMARY

Remediation of the 141-C waste site consisted of the removal of soil and debris within the building footprint to a depth of approximately 1 m (3 ft). Approximately 900 bank cubic meters (1,200 bank cubic yards) of soil and debris was excavated and staged onsite before disposal at the Environmental Restoration Disposal Facility (ERDF). The pre-excavation civil survey for the 141-C waste site is provided in Figure 4; Figure 5 shows the post-excavation civil survey and the footprint of the waste staging pile.

The Waste Information Data System also describes residual potentially contaminated sewer piping and an associated gate valve at the 141-C waste site. The sewer collection line east of the 141-C Building was removed by previous remedial activities up to the eastern edge of the 141-C waste site (Figure 4). Exploratory trenches were excavated during remedial action efforts to confirm that the sewer lines formerly servicing the 141-C Building (Figure 3) were removed during previous decommissioning and demolition activities. No sewer lines were located by these excavations, and field instrumentation did not detect any beta-gamma or alpha activity above background levels.

VERIFICATION SAMPLING ACTIVITIES

Verification sampling at the 141-C waste site was performed on January 30, 2006, to collect data to make a decision as to whether the remedial action objectives had been reached. Based on statistical evaluation of the resulting data, the residual contaminant concentrations meet the cleanup criteria specified in the RDR/RAWP (DOE-RL 2005b) and the Remaining Sites ROD (EPA 1999). The following subsections provide additional discussion of the information used to develop the verification sampling design. The results of verification sampling are also summarized to support interim closure of the site.

Contaminants of Concern and Contaminants of Potential Concern

The results of confirmatory sampling were used to determine the COCs and COPCs for verification sampling. The analyses performed for verification samples, listed in Table 2, are inclusive of the constituents that were detected above direct exposure RAGs or dose-equivalence lookup values and/or above RAGs for the protection of groundwater and the Columbia River.

Figure 4. Pre-Excavation Topographic Survey of the 141-C Waste Site Vicinity.

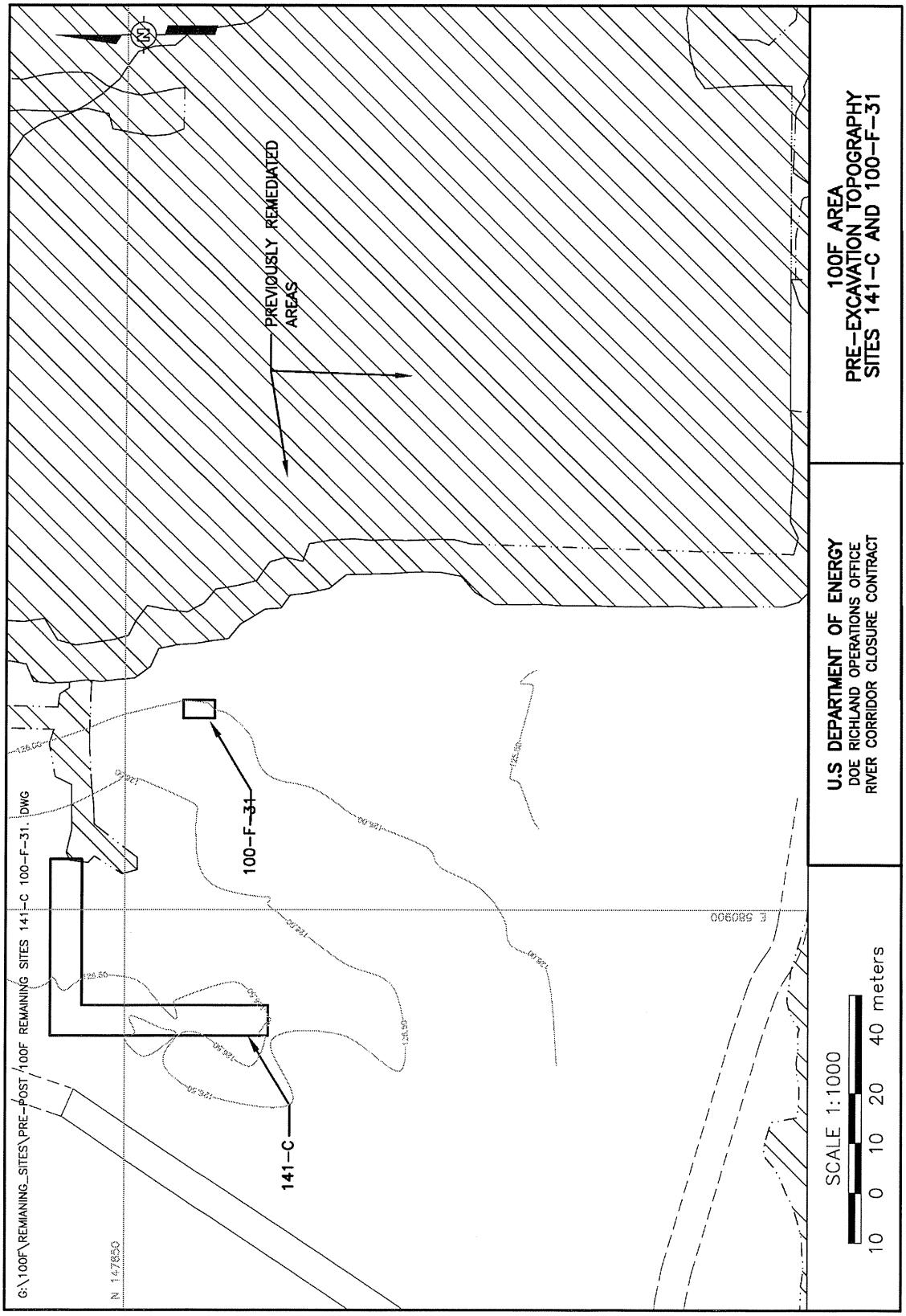


Figure 5. Post-Excavation Civil Survey of the 141-C Waste Site.

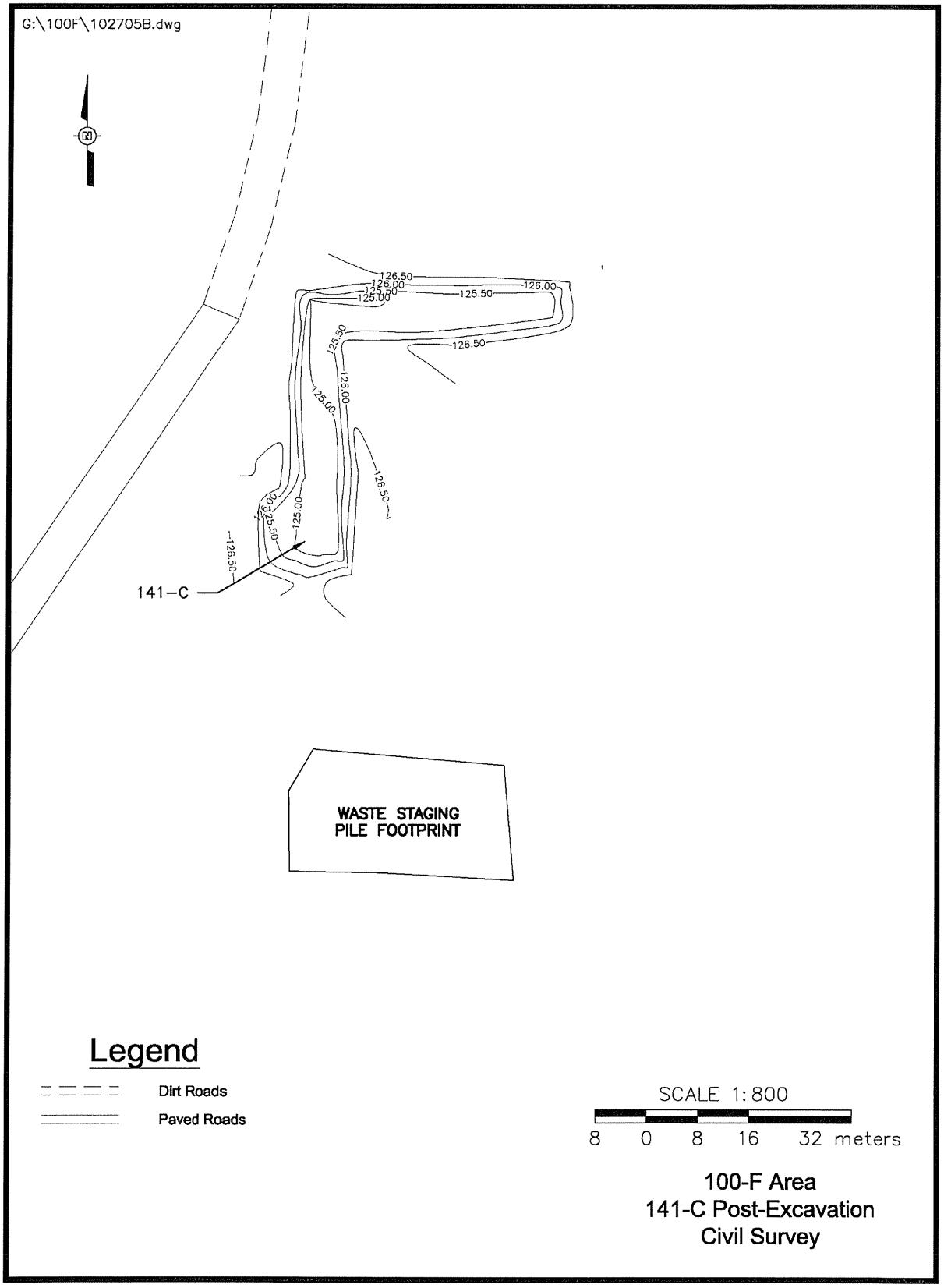


Table 2. Verification Sampling Analyses Performed for the 141-C Waste Site.

Analysis	Basis for Inclusion
Gamma energy analysis	Cesium-137 detected above background in confirmatory samples
Total beta radiostrontium (strontium-90)	Total beta radiostrontium detected above direct exposure dose-equivalence lookup value for strontium-90 in confirmatory sample
Tritium by liquid scintillation	Tritium identified as COPC for confirmatory analysis, but inadvertently omitted from analyses performed; deficiency corrected by retaining tritium as a COPC for verification sampling
ICP metals EPA Method 6010	Arsenic detected above the direct exposure RAG and soil RAGs for the protection of groundwater and the Columbia River in confirmatory sample Barium, cadmium, chromium, copper, lead, manganese, molybdenum, nickel, selenium, and zinc detected above soil RAGs for the protection of groundwater and/or the Columbia River in confirmatory samples
Mercury EPA Method 7471	Inclusion of metals as COPCs for verification sampling (mercury was not detected above background in confirmatory samples)
Hexavalent chromium EPA Method 7196	Hexavalent chromium identified as COPC for confirmatory analysis, but inadvertently omitted from analyses performed; deficiency corrected by retaining hexavalent chromium as a COPC for verification sampling
PAHs EPA Method 8310	Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene detected above direct exposure RAGs and soil RAGs for the protection of groundwater and the Columbia River in confirmatory samples Benzo(k)fluoranthene, chrysene, and fluoranthene detected above soil RAGs for the protection of groundwater and/or the Columbia River in confirmatory sample Anthracene, fluorene, phenanthrene, and pyrene detected in confirmatory samples (below applicable RAGs)

COPC = contaminant of potential concern
EPA = U.S. Environmental Protection Agency
ICP = inductively coupled plasma
PAH = polycylic aromatic hydrocarbon
RAG = remedial action goal

Verification Sample Design

Statistical sampling was performed for the 141-C remediation footprint because the spatial distribution of potential residual soil contamination over the study area was uncertain. The decision rule for demonstrating compliance with the cleanup criteria requires comparison of the true population mean of COCs/COPCs, as estimated by the 95% upper confidence limit on the sample mean, with the cleanup level. The Washington State Department of Ecology publication *Guidance on Sampling and Data Analysis Methods* (Ecology 1995) recommends that systematic sampling with sample locations distributed over the entire study area be used. Therefore, sampling locations were distributed over the entire remediation footprint on a grid basis in an effort to determine the residual presence of contamination.

Visual Sample Plan[1] (VSP) was used as a tool to develop the statistical sampling design for the 141-C waste site. The remediation footprint (Figure 5) was delineated in VSP and used as the

[1] Visual Sample Plan is a site map-based user-interface program that may be downloaded at http://dqo.pnl.gov.

basis for location of a systematic grid for verification soil sample collection. Ten soil sample locations were identified using a random-start triangular grid. Additional details concerning the use of VSP to develop the statistical sampling design are provided in the 141-C waste site verification sampling work instruction (WCH 2005).

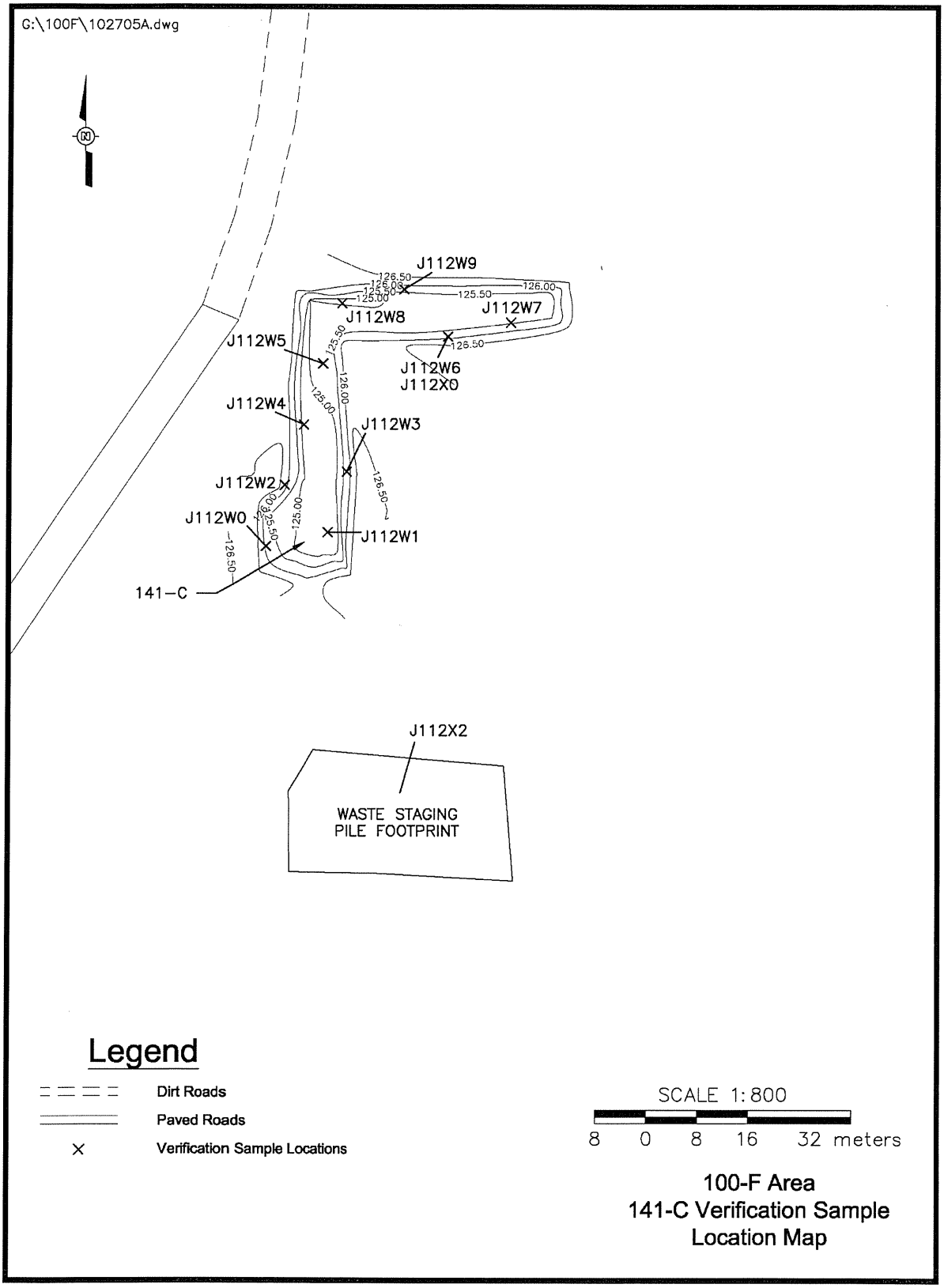
Figure 6 provides a map of the 10 soil sample locations that were determined for verification sampling, with coordinates shown in Table 3. The soil sample locations were surveyed and staked prior to sample collection (WCH 2006a). All sampling was performed in accordance with WCH-EE-01, *Environmental Investigations Procedures*, to fulfill the requirements of the SAP (DOE-RL 2005a). One soil sample was collected at each location by collecting 25 aliquots of surficial soils from within approximately 1 m (3 ft) of the staked location and combining the aliquots into 1 sample. Field quality control (QC) samples consisted of one field duplicate sample and one equipment blank. The duplicate soil sample was collected at location 7. All samples were requested for full protocol laboratory analysis.

Table 3. 141-C Verification Sample Location Coordinates.

Sample Location	HEIS Sample Number	Washington State Plane Coordinates
1	J112W0	N 147824.8 E 580868.3
2	J112W1	N 147827.0 E 580878.1
3	J112W2	N 147834.4 E 580871.3
4	J112W3	N 147836.5 E 580881.1
5	J112W4	N 147843.9 E 580874.3
6	J112W5	N 147853.5 E 580877.3
7[a]	J112W6/J112X0[a]	N 147857.8 E 580896.9
8	J112W7	N 147860.0 E 580906.6
9	J112W8	N 147863.0 E 580880.3
10	J112W9	N 147865.2 E 580890.1
Remediation waste staging pile footprint	J112X2	N/A
Equipment blank	J112X1	N/A

Source: *100-F Area RAWD Sampling*, Logbook EFL-1174-1 (WCH 2006a).
[a] A field duplicate sample was collected at sample location 7.
HEIS = Hanford Environmental Information System
N/A = not applicable

Figure 6. Statistical Verification Sampling Locations at the 141-C Waste Site.



Verification sampling was also performed at the 141-C remediation waste staging pile footprint. As there was no potential for contaminant migration into soils underlying the former staging pile, a sampling design based on professional judgment was used rather than a statistical sampling design (WCH 2005). Sampling at the remediation waste staging pile footprint consisted of one sample composed of 30 aliquots of surficial soils collected from locations distributed across the entire staging area (WCH 2006a).

Verification Sampling Results

Verification samples were analyzed using U.S. Environmental Protection Agency-approved analytical methods. The 95% upper confidence limit on the true population mean for residual concentrations of COCs and COPCs was calculated for the remediation footprint as specified by the RDR/RAWP (DOE-RL 2005b), with calculations provided in Appendix B. When a nonradionuclide COC or COPC was detected in fewer than 50% of the verification samples collected, the maximum detected value was used for comparison against RAGs. If no detections for a given COC/COPC were reported in the data set, then no statistical evaluation or calculations were performed for that COC/COPC. Evaluation of the verification data from the remediation waste staging pile footprint was performed by direct comparison of the sample result for each COC/COPC against cleanup criteria.

Comparisons of the statistical and maximum results for COCs and COPCs and the site RAGs for the remediation footprint and remediation waste staging pile footprint are summarized in Tables 4a and 4b, respectively. Contaminants that were not detected by laboratory analysis are excluded from these tables. Calculated cleanup levels are not presented in the Model Toxics Control Act Cleanup Levels and Risk Calculations database under *Washington Administrative Code* (WAC) 173-340-740(3) for aluminum, calcium, iron, magnesium, potassium, silicon, and sodium; therefore, these constituents are not considered site COPCs. Potassium-40, radium-226, radium-228, thorium-228, and thorium-232 were detected in samples collected at the site, but are not considered within statistical calculations or Tables 4a and 4b, as these isotopes are not related to the operational history of the site. The laboratory-reported data results for all constituents are stored in the ENRE project-specific database prior to archiving in HEIS and are presented in Appendix B.

DATA EVALUATION

Statistical concentrations of lead and multiple PAHs were determined to exceed soil RAGs for the protection of groundwater and the Columbia River within the 141-C site remediation footprint. PAHs were also detected above soil RAGs for the protection of groundwater and the Columbia River in the remediation waste staging pile footprint. Data were not collected on the vertical extent of residual contamination, but, given the soil-partitioning coefficients of lead (30 mL/g) and the PAHs (>360 mL/g), these contaminants would not be expected to migrate more than 3 m (10 ft) vertically in 1,000 years (BHI 2005). The presence of PAHs is likely the result of residual portions of asphalt-paved areas that previously surrounded the site. The vadose zone beneath the 141-C excavation is approximately 13 m (43 ft) thick. Therefore, residual

Table 4a. Comparison of Statistical Contaminant Concentrations to Action Levels for the 141-C Remediation Footprint Verification Sampling Event.[a] (2 Pages)

COC/COPC	Statistical Result (pCi/g)	Generic Site Lookup Values (pCi/g)			Does the Statistical Result Exceed Lookup Values?	Does the Statistical Result Pass RESRAD Modeling?
		Shallow Zone Lookup Value[b]	Groundwater Protection Lookup Value	River Protection Lookup Value		
Cesium-137	0.036	6.2	1,465	1,465	No	--
Strontium-90	0.49	4.5	27.6	27.6	No	--
COC/COPC	**Statistical Result (mg/kg)**	**Remedial Action Goals (mg/kg)**			**Does the Statistical Result Exceed RAGs?**	**Does the Statistical Result Pass RESRAD Modeling?**
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Arsenic	3.5 (<BG)	20[c]	20[c]	20[c]	No	--
Barium	106 (<BG)	5,600[d]	132[e]	224	No	--
Beryllium	0.35 (<BG)	10.4[f]	1.51[e]	1.51[e]	No	--
Boron[g]	5.3	16,000[d]	320	--[h]	No	--
Chromium (total)	9.0 (<BG)	80,000[d]	18.5[e]	18.5[e]	No	--
Chromium (hexavalent)	0.6	2.1[f]	4.8	2	No	--
Cobalt	6.0 (<BG)	1,600[d]	32	--[h]	No	--
Copper	13.0 (<BG)	2,960[d]	59.2	22[e]	No	--
Lead	10.4	353[i]	10.2[e]	10.2[e]	Yes	Yes[j]
Manganese	318 (<BG)	11,200[d]	512[e]	--[h]	No	--
Mercury	0.03 (<BG)	24[d]	0.33[e]	0.33[e]	No	--
Nickel	10.0 (<BG)	1,600[d]	19.1[e]	27.4	No	--
Vanadium	38.6 (<BG)	560[d]	85.1[e]	--[h]	No	--
Zinc	47.8 (<BG)	24,000[d]	480	67.8[e]	No	--
Anthracene	0.065	24,000[d]	240	1,920	No	--
Benzo(a)anthracene	0.05	1.37[k]	0.015[l]	0.015[l]	Yes	Yes[j]
Benzo(a)pyrene	0.05	0.137[k]	0.015[l]	0.015[l]	Yes	Yes[j]
Benzo(b)fluoranthene	0.04	1.37[k]	0.015[l]	0.015[l]	Yes	Yes[j]
Benzo(g,h,i)perylene[m]	0.140	2,400[d]	48	192	No	--
Benzo(k)fluoranthene	0.076	13.7[k]	0.12	0.015[l]	Yes	Yes[j]
Chrysene	0.06	137[k]	1.2	0.10[l]	No	--
Dibenzo(a,h) anthracene	0.024	0.137[k]	0.030[l]	0.030[l]	No	--

Table 4a. Comparison of Statistical Contaminant Concentrations to Action Levels for the 141-C Remediation Footprint Verification Sampling Event.[a] (2 Pages)

COC/COPC	Statistical Result (mg/kg)	Remedial Action Goals (mg/kg)			Does the Statistical Result Exceed RAGs?	Does the Statistical Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Fluoranthene	0.15	3,200[d]	64	18	No	--
Fluorene	0.030	3,200[d]	64	260	No	--
Indeno(1,2,3-cd) pyrene	0.04	1.37[k]	0.030[l]	0.030[l]	Yes	Yes[j]
Phenanthrene[m]	0.09	24,000[d]	240	1,920	No	--
Pyrene	0.14	2,400[d]	48	192	No	--

[a] RAG and lookup values obtained from the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b), as available. When no values were available in DOE-RL (2005b), appropriate values were determined per WAC 173-340-720, 730, and 740 and the most recent available carcinogenicity/toxicity data, unless otherwise noted.

[b] Activity corresponding to a single-radionuclide 15 mrem/yr exposure as calculated using a generic RESRAD model (DOE-RL 2005b).

[c] The cleanup value of 20 mg/kg has been agreed to by Tri-Party project managers. The basis for 20 mg/kg is provided in Section 2.1.2.1 of DOE-RL (2005b).

[d] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), Method B, 1996.

[e] Where cleanup levels are less than background, cleanup levels default to background (WAC 173-340-700[4][d]) (1996).

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

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

[h] No cleanup level is available from the Ecology Cleanup Levels and Risk Calculations tables, and no toxicity values are available to calculate cleanup levels (Ecology 2005).

[i] A WAC 173-340-740(3) (1996) value for lead is not available. This value is based on the *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children* (EPA 1994).

[j] Based on the *100 Area Analogous Sites RESRAD Calculations* (BHI 2005), neither lead nor PAHs are expected to migrate more than 3 m (10 ft) vertically in 1,000 years. The vadose zone underlying the remediation footprint is approximately 13 m (43 ft) thick.

[k] Carcinogenic cleanup level calculated per WAC 173-340-740(3), Method B, 1996.

[l] Where cleanup levels are less than the RDL, cleanup levels default to the RDL (WAC 173-340-707[2], 1996 and DOE-RL 2005b).

[m] Toxicity data for this chemical are not available. RAGs for benzo(g,h,i)perylene and phenanthrene are based on the surrogate chemicals pyrene and anthracene, respectively.

-- = not applicable
BG = background
COC = contaminant of concern
COPC = contaminant of potential concern
PAH = polycyclic aromatic hydrocarbon
RAG = remedial action goal
RESRAD = RESidual RADioactivity (dose assessment model)
RDL = required detection limit
WAC = *Washington Administrative Code*

Table 4b. Comparison of Maximum Contaminant Concentrations to Action Levels for the 141-C Remediation Waste Staging Pile Footprint Verification Sampling Event.[a] (2 Pages)

COC/COPC	Maximum Result (pCi/g)	Generic Site Lookup Values (pCi/g)			Does the Maximum Result Exceed Lookup Values?	Does the Maximum Result Pass RESRAD Modeling?
		Shallow Zone Lookup Value[b]	Groundwater Protection Lookup Value	River Protection Lookup Value		
Cesium-137	0.041	6.2	1,465	1,465	No	--
COC/COPC	**Maximum Result (mg/kg)**	**Remedial Action Goals (mg/kg)**			**Does the Maximum Result Exceed RAGs?**	**Does the Maximum Result Pass RESRAD Modeling?**
		Direct Exposure	**Soil Cleanup Level for Groundwater Protection**	**Soil Cleanup Level for River Protection**		
Arsenic	2.5 (<BG)	20[c]	20[c]	20[c]	No	--
Barium	81.7 (<BG)	5,600[d]	132[e]	224	No	--
Beryllium	0.30 (<BG)	10.4[f]	1.51[e]	1.51[e]	No	--
Boron[g]	2.7	16,000[d]	320	--[h]	No	--
Chromium (total)	7.0 (<BG)	80,000[d]	18.5[e]	18.5[e]	No	--
Cobalt	5.7 (<BG)	1,600[d]	32	--[h]	No	--
Copper	10.9 (<BG)	2,960[d]	59.2	22[e]	No	--
Lead	5.3 (<BG)	353[i]	10.2[e]	10.2[e]	No	--
Manganese	285 (<BG)	11,200[d]	512[e]	--[h]	No	--
Nickel	8.6 (<BG)	1,600[d]	19.1[e]	27.4	No	--
Vanadium	33.4 (<BG)	560[d]	85.1[e]	--[h]	No	--
Zinc	37.5 (<BG)	24,000[d]	480	67.8[e]	No	--
Anthracene	0.0076	24,000[d]	240	1,920	No	--
Benzo(a)anthracene	0.076	1.37[j]	0.015[k]	0.015[k]	Yes	Yes[l]
Benzo(a)pyrene	0.046	0.137[j]	0.015[k]	0.015[k]	Yes	Yes[l]
Benzo(b)fluoranthene	0.048	1.37[j]	0.015[k]	0.015[k]	Yes	Yes[l]
Benzo(g,h,i)perylene[m]	0.034	2,400[d]	48	192	No	--
Benzo(k)fluoranthene	0.017	13.7[j]	0.12	0.015[k]	Yes	Yes[l]
Chrysene	0.20	137[j]	1.2	0.10[k]	Yes	Yes[l]
Fluoranthene	0.088	3,200[d]	64	18	No	--
Indeno(1,2,3-cd) pyrene	0.058	1.37[j]	0.030[k]	0.030[k]	Yes	Yes[l]

Table 4b. Comparison of Maximum Contaminant Concentrations to Action Levels for the 141-C Remediation Waste Staging Pile Footprint Verification Sampling Event.[a] (2 Pages)

COC/COPC	Maximum Result (mg/kg)	Remedial Action Goals (mg/kg)			Does the Maximum Result Exceed RAGs?	Does the Maximum Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Phenanthrene[m]	0.070	24,000[d]	240	1,920	No	--
Pyrene	0.082	2,400[d]	48	192	No	--

[a] RAG and lookup values obtained from the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b), as available. When no values were available in DOE-RL (2005b), appropriate values were determined per WAC 173-340-720, 730, and 740 and the most recent available carcinogenicity/toxicity data, unless otherwise noted.
[b] Activity corresponding to a single-radionuclide 15 mrem/yr exposure as calculated using a generic RESRAD model (DOE-RL 2005b).
[c] The cleanup value of 20 mg/kg has been agreed to by Tri-Party project managers. The basis for 20 mg/kg is provided in Section 2.1.2.1 of the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b).
[d] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), Method B, 1996.
[e] Where cleanup levels are less than background, cleanup levels default to background (WAC 173-340-700[4][d]) (1996).
[f] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3]) (1996).
[g] No Hanford Site-specific or Washington State background value available.
[h] No cleanup level is available from the Ecology Cleanup Levels and Risk Calculations tables, and no toxicity values are available to calculate cleanup levels (Ecology 2005).
[i] A WAC 173-340-740(3) (1996) value for lead is not available. This value is based on the *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children* (EPA 1994).
[j] Carcinogenic cleanup level calculated per WAC 173-340-740(3), Method B, 1996.
[k] Where cleanup levels are less than the RDL, cleanup levels default to the RDL (WAC 173-340-707[2], 1996 and DOE-RL 2005b).
[l] Based on the *100 Area Analogous Sites RESRAD Calculations* (BHI 2005), PAHs are not expected to migrate significantly in 1,000 years. The vadose zone underlying the remediation waste staging pile footprint is approximately 14.5 m (48 ft) thick.
[m] Toxicity data for this chemical are not available. RAGs for benzo(g,h,i)perylene and phenanthrene are based on the surrogate chemicals pyrene and anthracene, respectively.

-- = not applicable
BG = background
COC = contaminant of concern
COPC = contaminant of potential concern
PAH = polycyclic aromatic hydrocarbon
RAG = remedial action goal
RESRAD = RESidual RADioactivity (dose assessment model)
RDL = required detection limit
WAC = *Washington Administrative Code*

concentrations of lead and PAHs at the 141-C waste site are protective of groundwater. The only pathway for contamination to reach the Columbia River is via groundwater migration, so these contaminant concentrations are also protective of river water.

Nonradionuclide risk requirements include a hazard quotient of less than 1.0 for all individual noncarcinogens, a cumulative hazard quotient of less than 1.0, an individual contaminant 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 using the higher of the remediation footprint statistical value and the waste staging pile footprint maximum value for each constituent. Risk values were not calculated for constituents that were not detected or were detected at concentrations below Hanford Site or Washington State background values. All individual hazard quotients were less than 1.0, and all individual cumulative excess carcinogenic risk values were less than 1×10^{-6} (Appendix C). The cumulative hazard quotient for the 141-C waste site is 3.2×10^{-2}, and the cumulative excess carcinogenic risk value is 9.7×10^{-7}. Therefore, nonradionuclide risk requirements are met.

When using a statistical sampling approach, a RAG requirement for nonradionuclides is the WAC 173-340-740(7)(e) three-part test. The application of the three-part test for the 141-C remediation footprint is included in statistical calculations (Appendix B). The three-part test is not applicable to the remediation waste staging pile footprint results since direct evaluation of non-statistical sampling results was used as the compliance basis. All residual COC/COPC concentrations for the 141-C remediation footprint pass the three-part test in comparison against direct exposure RAGs. Residual concentrations of lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene fail the three-part test in comparison against soil RAGs for the protection of groundwater and the Columbia River. However, as described above, none of these contaminants are predicted to reach groundwater (and thus the river) within 1,000 years. Residual concentrations are, therefore, protective of groundwater and the Columbia River.

DATA QUALITY ASSESSMENT

Confirmatory Sampling

A data quality assessment (DQA) review was performed to compare the confirmatory sampling approach and resulting analytical data with the sampling and data requirements specified by the project objectives and performance specifications. The review involved evaluation of the data to determine if they are of the right type, quality, and quantity to support there intended use (i.e., closeout decisions). This assessment review completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process.

This DQA review was performed in accordance with WCH-EE-01, *Environmental Investigations Procedures.* Specific data quality objectives for the site are found in the SAP (DOE-RL 2005a). All samples were collected per the sample design. The sample design allowed for additional samples if required to properly characterize the site. Four additional samples were collected: from a drywell, concrete scabble, cast iron pipe, and soil within the pipe. The data quality requirements in the SAP are used for assessing data from statistical sampling and do not specifically apply to the data sets resulting from the focused sampling performed for remaining sites. However, to ensure quality data sets, the SAP data quality assurance requirements as well as the data validation procedures for chemical and radiochemical analysis (BHI 2000a, 2000b) were followed, where appropriate.

In the volatile organic analysis, a common laboratory contaminant, methylene chloride, was found in the method blank, the matrix spike/matrix spike duplicate (MS/MSD) pair, as well as in all of the samples, all at similar low levels (0.010 mg/kg to 0.023 mg/kg) near the required detection limit. Methylene chloride is a common laboratory solvent. There is reason to believe the methylene chloride came from contamination in the laboratory. There is no reason to believe that the samples contained methylene chloride.

In the PAH analyses, because of high constituent levels in sample J01TH8, it was diluted by a factor of 8 before being analyzed. Naphthalene, acenaphtylene, and acenaphthene are all nondetect with practical quantitation limits (PQLs) of 1.02 mg/kg in sample J01TH8. Also in the PAH analyses, the pipe soil sample J01VX1 had high levels of target analytes and had to be

diluted by a factor of 100. All quality assurance/quality control for this sample was lost due to the dilution. PAH analysis was retained for verification sampling at the 141-C waste site.

In the inductively coupled plasma (ICP) analysis, multiple deficiencies were noted in the method blank, duplicate, and MS/MSD pair. Some samples were diluted because of high concentrations of iron and zinc. The PQLs for silver and selenium were elevated above their required detection limits because of the dilution. Both silver and selenium were nondetect in the sample in question, J01VX1. ICP metals analysis was retained for verification sampling at the 141-C waste site.

The hold time was not met for the mercury analysis in sample J01VX1. The hold time is 28 days, and the sample was held 36 days. Mercury is reported at the PQL (0.02 mg/kg). The sample has been uncontained in the environment for an extended period of time. It is improbable that an extra 8 days sealed in a jar, in an environmentally controlled situation, would impact the data significantly. Mercury analysis was retained for verification sampling at the 141-C waste site.

No other deficiencies were noted. Limited, random, or sample matrix-specific-influenced batch quality control issues such as those noted are a potential for any analysis. The number and types seen in these data sets were within expectations for the matrix types and analyses performed.

The DQA review for the 141-C waste site confirmatory sampling data found the results to be accurate within the standard errors associated with the methods, including sampling and sample handling. The DQA review concludes that the data are of the right type, quality, and quantity to support the intended use. Detection limits, precision, accuracy, and sampling data group completeness were assessed to determine if any analytical results should be rejected as a result of quality assurance and quality control deficiencies. All analytical data were found to be acceptable for decision-making purposes. The confirmatory sample analytical data are stored in the ENRE project-specific database prior to archiving in HEIS and are summarized in Appendix A.

Verification Sampling

A DQA was performed to compare the verification sampling approach and analytical data with the sampling and data requirements specified in the site-specific work instruction (WCH 2005). 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) and completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process.

This DQA was performed in accordance with WCH-EE-01, *Environmental Investigations Procedures*. Specific data quality objectives for the site are found in the SAP (DOE-RL 2005a). To ensure quality data sets, the SAP data quality assurance requirements, as well as the data validation procedures for chemical and radiochemical analysis (BHI 2000a, 2000b), are followed, where appropriate.

A review of the sample design (WCH 2005), the field logbook (WCH 2006a), and applicable analytical data packages has been performed as part of this DQA. All samples were collected per the approved sample design. The statistical sample design in the work instruction was partially based on assumptions about the standard deviation and distribution of residual contaminant populations (WCH 2005). Examination of the verification data set shows that the assumptions made were conservative; the sample design is, therefore, valid.

All data from verification samples collected at the 141-C waste site were provided by the laboratory in sample delivery group (SDG) K0201. Third-party data validation was performed on this SDG (WCH 2006b). SDG K0201 consists of 13 samples from the 141-C waste site analyzed for ICP metals, mercury, hexavalent chromium, PAHs, tritium, total strontium, and by gamma spectroscopy (gamma energy analysis). The samples were J112W0, J112W1, J112W2, J112W3, J112W4, J112W5, J112W6, J112W7, J112W8, J112W9, J112X0, J112X1, and J112X2. The sample J112X0 is the field duplicate of sample J112W6. Sample J112X1 is the equipment (field) blank. Sample J112X2 was collected from the 141-C waste staging area. Ten samples were collected from within the 141-C excavation as indicated in the statistical design presented in the work instruction.

In the ICP metals analysis, the analytes aluminum, barium, beryllium, calcium, chromium, iron, potassium, magnesium, manganese, sodium, lead, antimony, silicon, and zinc were found in the equipment blank (J112X1), all at low concentrations below Hanford Site background values. The MS recovery for antimony was low at 47.1%, and third-party validation accordingly qualified all antimony results as estimated and applied "J" flags to all of the antimony results in SDG K0201. The laboratory control sample recovery for silicon was low at 53.7%; accordingly, third-party validation applied "J" qualifiers to all of the silicon results in SDG K0201.

In the radiological analyses, there was no MS prepared for the analyte tritium. Matrix spikes for some radionuclides are not typically done by the laboratory. Other accuracy measures such as blind audit samples are used to assess laboratory accuracy for radionuclides. Third-party validation qualified tritium results as estimated and applied "J" flags to all of the tritium results in SDG K0201.

The field duplicate pair (J112W6/J112X0) relative percent difference result for thorium-228 and radium-228 was above QC criteria at 32% and 53%, respectively. This is the result of natural heterogeneity in the sample matrix and the presence of thorium-228 and radium-228 at concentrations very near to the analytical detection limit. These isotopes are not related to the operational history of the site, and, therefore, are not considered COPCs. Third-party validation did not assign any qualifiers, and the data remain useable for decision-making purposes.

In the PAH analysis, the MS result for acenaphthene was affected by matrix interference. Third-party validation assigned "J" qualifiers to all acenaphthene results in SDG K0201. The MSD recovery for the analyte indeno(1,2,3-cd)pyrene was below QC criteria at 49%. The MS and laboratory control sample were within criteria. However, the low MSD recovery also resulted in an elevated relative percent difference between the MS and the MSD for indeno(1,2,3-cd)pyrene. Third-party validation accordingly applied "J" qualifiers to all of the indeno(1,2,3-cd)pyrene results in SDG K0201. A matrix interference of the surrogate occurred in the PAH analysis of

sample J112W0. All of the PAH results in sample J112W0 were accordingly qualified "J," as estimated, in the sample. The PAH analytes are naphthalene, acenaphthylene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene.

There were no deficiencies noted in the hexavalent chromium analysis.

Limited, random, or sample matrix-specific influenced batch QC issues such as these are a potential for any analysis. The number and types seen in these data sets were within expectations for the matrix types and analyses performed.

The DQA review for the 141-C verification data found the results to be accurate within the standard errors associated with the methods, including sampling and sample handling. The DQA review for the 141-C verification data concludes that the data reviewed is of the right type, quality, and quantity to support the intended use. Detection limits, precision, accuracy, and sampling data group completeness were assessed to determine if any analytical results should be rejected as a result of quality assurance and quality control deficiencies. All analytical data were found acceptable for decision-making purposes. The verification sample analytical data are stored in the ENRE project-specific database prior to archiving in HEIS and are included in Appendix B.

SUMMARY FOR INTERIM CLOSURE

The 141-C waste site has been evaluated and remediated in accordance with the Remaining Sites ROD (EPA 1999) and the RDR/RAWP (DOE-RL 2005b). Because arsenic, strontium-90, and multiple PAHs were detected above direct exposure RAGs in confirmatory sampling results, the site was remediated by removing approximately 900 bank cubic meters (1,200 bank cubic yards) of soil and debris to the ERDF. Statistical and judgmental sampling to verify the completeness of remediation was performed, and analytical results were shown to meet the cleanup objectives for direct exposure, groundwater protection, and river protection. In accordance with this evaluation, the verification sampling results support a reclassification of the 141-C site to interim closed out. This site does not have a deep zone; therefore, no deep zone institutional controls are required.

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APPENDIX A

CONFIRMATORY SAMPLING ANALYTICAL RESULTS

Note: This appendix contains the sample results for the 141-C waste site that led to a decision that remediation was necessary. Verification sampling results and calculations to support site closeout are provided in Appendix B.

Table A-1. 141-C Confirmatory Data Results. (5 Pages)

Sample Location	HEIS Number	Sample Date	Americium-241 GEA			Carbon-14			Cesium-137			Cobalt-60			Europium-152			Europium-154		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
Dry well	J01TH5	09/21/04	0.32	U	0.32	-1.74	UJ	4.5	0.04	U	0.04	0.044	U	0.044	0.1	U	0.1	0.14	U	0.14
Bottom of trench	J01TH6	09/21/04	0.11	U	0.11	1.95	UJ	4.2	0.028	U	0.028	0.032	U	0.032	0.067	U	0.067	0.11	U	0.11
Bottom of trench	J01TH7	09/22/04	0.1	U	0.1	-0.154	UJ	3.3	0.06		0.032	0.028	U	0.028	0.065	U	0.065	0.093	U	0.093
Duplicate of J01TH7	J01TJ1	09/22/04	0.061	U	0.061	-3.02	UJ	3.3	0.048	U	0.048	0.044	U	0.044	0.12	U	0.12	0.16	U	0.16
Inside iron pipe	J01TH8	09/22/04	0.14	U	0.14	-0.852	UJ	3.7	0.632		0.044	0.036	U	0.036	0.12	U	0.12	0.13	U	0.13
Bottom of trench	J01TH9	09/22/04	0.22	U	0.22	-1.69	UJ	3.8	0.09	U	0.09	0.11	U	0.11	0.21	U	0.21	0.26	U	0.26
Cast iron pipe	J01VX1	09/22/04	0.03	U	0.03	6.44	U	22	0.013	U	0.013	0.012	U	0.012	0.03	U	0.03	0.03	U	0.03
Concrete	J00219	09/29/04	0.37	U	0.37				1.48		0.27	0.19	U	0.19	0.63	U	0.63	0.55	U	0.55

Sample Location	HEIS Number	Sample Date	Europium-155			Gross alpha			Gross beta			Nickel-63			Postassium-40			Radium-226		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
Dry well	J01TH5	09/21/04	0.14	U	0.14	10.8		4	29.3		6.9	-2.22	U	3.4	15.4		0.45	0.623		0.076
Bottom of trench	J01TH6	09/21/04	0.085	U	0.085	10.9		4.2	18.2		6.1	-0.746	U	3.5	14.8		0.29	0.516		0.062
Bottom of trench	J01TH7	09/22/04	0.071	U	0.071	14.4		2.6	19.7		5.2	-1.81	U	3.4	14.2		0.28	0.539		0.057
Duplicate of J01TH7	J01TJ1	09/22/04	0.094	U	0.094	6.57		2.9	18.8		5.6	-4.15	U	3.9	12		0.42	0.11	U	0.11
Inside iron pipe	J01TH8	09/22/04	0.094	U	0.094	8.41		3	24.3		5.4	-2.39	U	3.5	12.3		0.36	0.446		0.073
Bottom of trench	J01TH9	09/22/04	0.2	U	0.2	7.28		3.4	19.4		6.1	-3.03	U	3.5	10.2		1	0.508		0.13
Cast iron pipe	J01VX1	09/22/04	0.03	U	0.03	-0.518	U	3.2	40.2		5.6	-0.165	U	5	0.23	U	0.23	0.023	U	0.023
Concrete	J00219	09/29/04	0.64	U	0.64	5.96	U	4.6	3800		5.5				7.56		1.8	0.46	U	0.46

Sample Location	HEIS Number	Sample Date	Radium-228			Thorium-228 GEA			Thorium-232 GEA			Total beta radiostrontium			Uranium-235 GEA			Uranium-238-GEA		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
Dry well	J01TH5	09/21/04	0.883		0.17	0.67		0.05	0.883		0.17				0.18	U	0.18	5.1	U	5.1
Bottom of trench	J01TH6	09/21/04	0.757		0.14	0.71		0.039	0.757		0.14				0.11	U	0.11	3.8	U	3.8
Bottom of trench	J01TH7	09/22/04	0.771		0.11	0.736		0.034	0.771		0.11				0.098	U	0.098	3.6	U	3.6
Duplicate of J01TH7	J01TJ1	09/22/04	0.25	U	0.25	0.825		0.073	0.25	U	0.25				0.15	U	0.15	5.5	U	5.5
Inside iron pipe	J01TH8	09/22/04	0.597		0.17	0.686		0.046	0.597		0.17	2.73		0.69	0.13	U	0.13	4.8	U	4.8
Bottom of trench	J01TH9	09/22/04	0.588		0.32	0.486		0.095	0.588		0.32				0.3	U	0.3	11	U	11
Cast iron pipe	J01VX1	09/22/04	0.053	U	0.053	0.017	U	0.017	0.053	U	0.053	18.8		0.47	0.044	U	0.044	1.5	U	1.5
Concrete	J00219	09/29/04	0.91	U	0.91	0.526		0.33	0.91	U	0.91	1930		3.4	0.96	U	0.96	24	U	24

Note: Data qualified with B, C, and/or J, are considered acceptable values.

B = blank contamination (organic constituents)
C = blank contamination (inorganic constituents)
GEA = gamma energy analysis
HEIS = Hanford Environmental Information System
J = estimated
MDA = minimum detectable activity
PQL = practical quantitation limit
Q = qualifier
U = undetected

Table A-1. 141-C Confirmatory Data Results. (5 Pages)

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
Dry well	J01TH5	9/21/04	9970		0.83	0.31	UJ	0.31	2.7		0.37	120		0.02	0.37		0.01	8.7		0.52
Bottom of trench	J01TH6	9/21/04	8460		0.8	0.29	UJ	0.29	2.9		0.35	61.1		0.02	0.28		0.01	2.9		0.5
Bottom of trench	J01TH7	9/22/04	8800		0.81	0.3	U	0.3	3		0.36	83		0.02	0.29		0.01	5.2		0.51
Duplicate of J01TH7	J01TJ1	9/22/04	8910		0.82	0.3	UJ	0.3	3.1		0.36	84.4		0.02	0.31		0.01	4.2		0.52
Inside iron pipe	J01TH8	9/22/04	7490		0.74	0.28	U	0.28	2.9		0.33	133		0.02	0.28		0.009	9.8		0.47
Equipment blank	J01TJ2	9/22/04	79.1		0.76	0.28	UJ	0.28	0.34	U	0.34	1		0.02	0.009	U	0.009	0.61		0.48
Bottom of trench	J01TH9	9/22/04	8830		0.8	0.3	U	0.3	3.3		0.36	73		0.02	0.32		0.01	4.3		0.5
Cast iron pipe	J01VX1	9/22/04	4650	C	3.9	2.9		1.5	48.9		1.7	89.7	C	0.1	0.23		0.05	18	C	2.5

Sample Location	HEIS Number	Sample Date	Cadmium			Calcium			Chromium			Cobalt			Copper			Iron		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Dry well	J01TH5	9/21/04	0.08		0.03	5620	C	0.71	14.4	C	0.06	7.6		0.08	14.5		0.05	23000		2.3
Bottom of trench	J01TH6	9/21/04	0.03		0.03	4170	C	0.68	12.9	C	0.06	6.5		0.08	13.9		0.05	20200		2.2
Bottom of trench	J01TH7	9/22/04	0.03	U	0.03	5470	C	0.69	12.8	C	0.06	7.3		0.08	13.6		0.05	22200		2.3
Duplicate of J01TH7	J01TJ1	9/22/04	0.08		0.03	5460	C	0.7	12.5	C	0.06	7.5		0.08	14.7		0.05	22400		2.3
Inside iron pipe	J01TH8	9/22/04	11.8		0.03	13400	C	0.63	13.7	C	0.06	7.8		0.07	33.9		0.05	24700		2.1
Equipment blank	J01TJ2	9/22/04	0.03	U	0.03	25.8	C	0.65	0.21	UJ	0.06	0.07	U	0.07	0.05	U	0.05	132		2.1
Bottom of trench	J01TH9	9/22/04	0.03	U	0.03	5460	C	0.68	12.8	C	0.06	7.4		0.08	15		0.05	21900		2.3
Cast iron pipe	J01VX1	9/22/04	1.1		0.15	10900	C	3.3	67.5	C	0.29	10.4		0.39	218		0.24	156000		11

Sample Location	HEIS Number	Sample Date	Lead			Magnesium			Manganese			Mercury			Molybdenum			Nickel		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Dry well	J01TH5	9/21/04	5		0.19	4740	C	0.68	339	C	0.01	0.02	U	0.02	0.25		0.13	12.9		0.12
Bottom of trench	J01TH6	9/21/04	4.5		0.19	4400	C	0.65	300	C	0.01	0.02	U	0.02	0.21		0.13	11.6		0.12
Bottom of trench	J01TH7	9/22/04	5.3		0.19	4560	C	0.66	335	C	0.01	0.01	U	0.01	0.29		0.13	12.1		0.12
Duplicate of J01TH7	J01TJ1	9/22/04	5.6		0.19	4430	C	0.67	329	C	0.01	0.02	U	0.02	0.35		0.13	11.8		0.12
Inside iron pipe	J01TH8	9/22/04	143		0.17	3630	C	0.61	340	C	0.009	0.05		0.02	1.4		0.12	15.6		0.11
Equipment blank	J01TJ2	9/22/04	0.23		0.18	10.1	C	0.62	2.6	C	0.009	0.01	U	0.01	0.12	U	0.12	0.11	U	0.11
Bottom of trench	J01TH9	9/22/04	4.7		0.19	4660	C	0.65	323	C	0.01	0.01	U	0.01	0.24		0.13	12.2		0.12
Cast iron pipe	J01VX1	9/22/04	9		0.92	3150	C	3.2	757	C	0.05	0.02		0.02	10.2	C	0.63	40.1		0.58

Table A-1. 141-C Confirmatory Data Results. (5 Pages)

Sample Location	HEIS Number	Sample Date	Potassium			Selenium			Silicon			Silver			Sodium			Vanadium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Dry well	J01TH5	9/21/04	1910	C	3.6	0.4	U	0.4	72.8	JC	0.51	0.09	U	0.09	345	C	0.24	53.1		0.06
Bottom of trench	J01TH6	9/21/04	1390	C	3.4	0.38	U	0.38	98.7	JC	0.49	0.09	U	0.09	221	C	0.23	47.9		0.06
Bottom of trench	J01TH7	9/22/04	1620	C	3.5	0.39	U	0.39	64.6	C	0.5	0.09	U	0.09	242	C	0.23	52.9		0.06
Duplicate of J01TH7	J01TJ1	9/22/04	1650	C	3.5	0.39	U	0.39	53.8	JC	0.51	0.09	U	0.09	255	C	0.23	53.8		0.06
Inside iron pipe	J01TH8	9/22/04	1850	C	3.2	0.36	U	0.36	89.3	C	0.46	0.08	U	0.08	265	C	0.21	44		0.06
Equipment blank	J01TJ2	9/22/04	27.8	C	3.3	0.36	U	0.36	76.5	JC	0.47	0.08	U	0.08	9.3	UJ	0.22	0.07		0.06
Bottom of trench	J01TH9	9/22/04	1520	C	3.4	0.39	U	0.39	56	C	0.49	0.09	U	0.09	231	C	0.23	50.7		0.06
Cast iron pipe	J01VX1	9/22/04	1100		16.9	1.9	U	1.9	268	C	2.4	0.44	U	0.44	154	C	1.1	64.5		0.29

Sample Location	HEIS Number	Sample Date	Zinc		
			mg/kg	Q	PQL
Dry well	J01TH5	9/21/04	50.3	C	0.04
Bottom of trench	J01TH6	9/21/04	43.3	C	0.04
Bottom of trench	J01TH7	9/22/04	86.8	C	0.04
Duplicate of J01TH7	J01TJ1	9/22/04	77.1	C	0.04
Inside iron pipe	J01TH8	9/22/04	13600	C	1.8
Equipment blank	J01TJ2	9/22/04	2.8	UJ	0.04
Bottom of trench	J01TH9	9/22/04	46.6	C	0.04
Cast iron pipe	J01VX1	9/22/04	44.9	C	0.19

Table A-1. 141-C Confirmatory Data Results. (5 Pages)

Constituent	J01TH5 Dry well Sample Date 9/21/04			J01TH6 Bottom of trench Sample Date 9/21/04			J01TH7 Bottom of trench Sample Date 9/22/04			J01TH8 Inside iron pipe Sample Date 9/22/04			J01TH9 Bottom of trench Sample Date 9/22/04			J01TJ1 Duplicate of J01TH7 Sample Date 9/22/04			J01VX1 Cast iron pipe Sample Date 9/22/04		
	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
PAHs (polycyclic aromatic hydrocarbons)																					
Acenaphthene	211	UJ	211	205	UJ	205	205	UJ	205	1020	UJ	1020	206	UJ	206	204	UJ	204	705	U	705
Acenaphthylene	211	U	211	205	U	205	205	U	205	1020	U	1020	206	U	206	204	U	204	705	U	705
Anthracene	10.6	U	10.6	10.2	U	10.2	10.2	U	10.2	50.9	U	50.9	10.3	U	10.3	10.2	U	10.2	2300		35
Benzo(a)anthracene	10.6	U	10.6	10.2	U	10.2	13		10.2	50.9	U	50.9	10.3	U	10.3	14		10.2	13000		35
Benzo(a)pyrene	10.6	U	10.6	10.2	U	10.2	15		10.2	50.9	U	50.9	10.3	U	10.3	15		10.2	13000		350
Benzo(b)fluoranthene	11		10.6	12		10.2	35		10.2	29	J	50.9	10.3	U	10.3	31		10.2	21000		350
Benzo(ghi)perylene	10.6	U	10.6	10.2	U	10.2	19		10.2	50.9	U	50.9	10.3	U	10.3	7.7	J	10.2	5300		35
Benzo(k)fluoranthene	10.6	U	10.6	10.2	U	10.2	6.7	J	10.2	50.9	U	50.9	10.3	U	10.3	6.6	J	10.2	4600		35
Chrysene	10.6	U	10.6	10.2	U	10.2	10		10.2	40	J	50.9	10.3	U	10.3	11		10.2	19000		35
Dibenz[a,h]anthracene	10.6	U	10.6	10.2	U	10.2	10.2	U	10.2	50.9	U	50.9	10.3	U	10.3	10.2	U	10.2	1500		35
Fluoranthene	21.1	U	21.1	20.5	U	20.5	65		20.4	200		102	21		20.6	65		20.4	63000		700
Fluorene	10.6	U	10.6	10.2	U	10.2	10.2	U	10.2	50.9	U	50.9	11		10.3	10.2	U	10.2	2500		35
Indeno(1,2,3-cd)pyrene	13		10.6	10.2	U	10.2	16		10.2	45	J	50.9	9.8	J	10.3	17		10.2	8100		35
Naphthalene	211	U	211	205	U	205	205	U	205	1020	U	1020	206	U	206	204	U	204	705	U	705
Phenanthrene	10	J	10.6	7.2	J	10.2	18		10.2	50.9	U	50.9	9.3	J	10.3	15		10.2	24000		350
Pyrene	21.1	U	21.1	20.5	U	20.5	31		20.4	102	U	102	20.6	U	20.6	30		20.4	39000		700

Table A-1. 141-C Confirmatory Data Results. (5 Pages)

Constituent	J01TH5 Dry well			J01TH6 Bottom of trench		
	µg/kg	Q	PQL	µg/kg	Q	PQL
VOAs (volatile organics)						
1,1,1-Trichloroethane	6	U	6	5	U	5
1,1,2,2-Tetrachloroethane	6	U	6	5	U	5
1,1,2-Trichloroethane	6	U	6	5	U	5
1,1-Dichloroethane	6	U	6	5	U	5
1,1-Dichloroethene	6	U	6	5	U	5
1,2-Dichloroethane	6	U	6	5	U	5
1,2-Dichloroethene(Total)	6	U	6	5	U	5
1,2-Dichloropropane	6	U	6	5	U	5
2-Butanone	11	U	11	10	U	10
2-Hexanone	11	U	11	10	U	10
4-Methyl-2-Pentanone	11	U	11	10	U	10
Acetone	10	U	6	10	JB	5
Benzene	6	U	6	5	U	5
Bromodichloromethane	6	U	6	5	U	5
Bromoform	6	U	6	5	U	5
Bromomethane	11	U	11	10	U	10
Carbon disulfide	6	U	6	5	U	5
Carbon tetrachloride	6	U	6	5	U	5
Chlorobenzene	6	U	6	5	U	5
Chloroethane	11	U	11	10	U	10
Chloroform	6	U	6	5	U	5
Chloromethane	11	U	11	10	U	10
cis-1,3-Dichloropropene	6	U	6	5	U	5
Dibromochloromethane	6	U	6	5	U	5
Ethylbenzene	6	U	6	5	U	5
Methylenechloride	12	U	6	19	U	5
Styrene	6	U	6	5	U	5
Tetrachloroethene	6	U	6	5	U	5
Toluene	6	U	6	5	U	5
trans-1,3-Dichloropropene	6	U	6	5	U	5
Trichloroethene	6	U	6	5	U	5
Vinyl chloride	11	U	11	10	U	10
Xylenes (total)	6	U	6	5	U	5

APPENDIX B

CALCULATION OF 95% UCL VALUES FOR VERIFICATION DATA

CALCULATION COVER SHEET

Project Title:	100-F Area Field Remediation	**Job No.**	14655
Area	100-F		
Discipline	Environmental	***Calc. No.**	0100F-CA-V0246
Subject	141-C Waste Site Cleanup Verification 95% UCL Calculations		
Computer Program	Excel	**Program No.**	Excel 2003

The attached calculations have been generated to document compliance with established cleanup levels. These documents 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 = 13 Attm. 1 = 5 Total = 19	J. M. Capron 4/19/06	T. M. Blakley 4/19/06	L. M. Dittmer 4/19/06	S. W. Callison 4-19-06	4-19-06

SUMMARY OF REVISIONS

* Obtain calc no. from DIS

DE01437.03 (12/09/2004)

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC **Date** 04/17/06 **Calc. No.** 0100F-CA-V0246 **Rev. No.** 0
Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley TMB **Date** 4/19/06
Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 1 of 13

Summary

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

Table of Contents:

Sheets 1 to 3 - Calculation Sheet Summary
Sheets 4 to 6 - Calculation Sheet Remediation Footprint Verification Data
Sheet 7 - Calculation Sheet Duplicate Analysis
Sheets 8 to 13 - Ecology Software (MTCAStat) Results
Attachment 1 - 141-C Verification Sampling Results (5 sheets)

Given/References:

1) Sample Results (Attachment 1).
2) Background values and remedial action goals (RAGs) are taken from DOE-RL (2005b), DOE-RL (2001), and Ecology (2005).
3) DOE-RL, 2001, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, DOE/RL-92-24, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) DOE-RL, 2005a, *100 Area Remedial Action Sampling and Analysis Plan* (SAP), DOE/RL-96-22, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
5) DOE-RL, 2005b, *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
6) Ecology, 1992, *Statistical Guidance for Ecology Site Managers*, Publication #92-54, Washington Department of Ecology, Olympia, Washington.
7) Ecology, 1993, *Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-detection Limit or Below-PQL Values (Censored Data Sets),* Publication #92-54, Washington Department of Ecology, Olympia, Washington.
8) Ecology, 2005, *Cleanup Levels and Risk Calculations (CLARC) Database*, Washington State Department of Ecology, Olympia, Washington, <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.
9) 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.
10) WAC 173-340, 1996, "Model Toxic Control Act - Cleanup," *Washington Administrative Code.*

Solution:
Calculation methodology is described in Ecology Pub. #92-54 (Ecology 1992, 1993), below, and in the RDR/RAWP (DOE-RL 2005b). Use data from attached worksheets to perform the 95% UCL calculation for each analyte, the WAC 173-340-740(7)(e) 3-part test for nonradionuclides, and the RPD calculations for each COC/COPC, as required. The hazard quotient and carcinogenic risk calculations are located in a separate calculation brief as an appendix to the Remaining Sites Verification Package (RSVP).

Calculation Description:
The subject calculations were performed on data from soil verification samples from the subject waste site. The data were entered into an EXCEL 2003 spreadsheet and calculations performed by using the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2005b) is documented by this calculation. Duplicate RPD results are used in evaluation of data quality within the RSVP for this site.

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC Date 04/17/06 Calc. No. 0100F-CA-V0246 Rev. No. 0
Project 100-F Area Field Remediation Job No. 14655 Checked T. M. Blakley TMB Date 4/19/06
Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations Sheet No. 2 of 13

Summary (continued)

Methodology:

For nonradioactive analytes with ≤50% of the data below detection limits and all radionuclide analytes, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. The 95% UCL was not calculated for radionuclide data sets with no reported detections. The 95% UCL values were also not calculated for radium-226, radium-228, thorium-228, thorium-232, and potassium-40, as these isotopes are not related to the operational history of the site and thus not considered COPCs. For nonradioactive analytes with >50% of the data below detection limits, the maximum detected value for the data set is used instead of the 95% UCL. The evaluation of the portion of the data set below detection limits was performed by direct inspection of the attached sample results. The 95% UCL values were not calculated for aluminum, calcium, iron, magnesium, potassium, silicon, and silver, as no cleanup values are published in Ecology (2005) under WAC 173-340-740(3), and these constituents are thus not considered site COPCs.

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

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For nonradionuclide small data sets ($n < 10$) and all radionuclide data sets, the calculations are performed assuming nonparametric distribution, so no tests for distribution are performed. For nonradionuclide data sets of ten or greater, as for the subject site, distributional testing and calculation of the 95% UCL is done using Ecology's MTCAStat software (Ecology 1993). Due to differences in addressing censored data between the RDR/RAWP (DOE-RL 2005b) and MTCAStat coding and due to a limitation in the MTCAStat coding (no direct capability to address variable quantitation limits within a data set), substitutions for censored data are performed before software input and the resulting data set treated as uncensored.

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

The WAC 173-340-740(7)(e) 3-part test is not performed for data sets where the statistical value defaults to the maximum value, as direct comparison of the maximum against site RAGs (within the RSVP) is more conservative.

The RPD is calculated when both the primary value and the duplicate are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method, listed in Table II-1 of the SAP (DOE-RL 2005a). Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

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

where, M = main sample value S = split (or duplicate) sample value

For quality assurance/quality control (QA/QC) split and duplicate RPD calculations, a value less than 30% indicates the data compare favorably. 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 cleanup verification of the subject site. Additional discussion is provided in the data quality assessment section of the applicable RSVP, as necessary.

In addition to the statistical samples collected from the remediation footprint at the subject site, a multi-aliquot sample was collected from the remediation waste staging area. Statistical methodology is not applicable to non-statistical sampling, and direct evaluation of maximum detected values within this decision unit will be used as the compliance basis. These maximum detected values are presented in the results summary for use in the RSVP.

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC Date 04/17/06 Calc. No. 0100F-CA-V0246 Rev. No. 0
Project 100-F Area Field Remediation Job No. 14655 Checked T. M. Blakley TMB Date 4/19/06
Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations Sheet No. 3 of 13

Summary (continued)

Results:
The results presented in the summary tables that follow are for use in risk analysis and the RSVP for this site.

Results Summary - Remediation Footprint			
Analyte	95% UCL[a]	Maximum[b]	Units
Cesium-137	0.036		pCi/g
Strontium-90	0.49		pCi/g
Arsenic	3.5		mg/kg
Barium	106		mg/kg
Beryllium	0.35		mg/kg
Boron	5.3		mg/kg
Chromium	9.0		mg/kg
Cobalt	6.0		mg/kg
Copper	13.0		mg/kg
Hexavalent Chromium	0.6		mg/kg
Lead	10.4		mg/kg
Manganese	318		mg/kg
Mercury		0.03	mg/kg
Nickel	10.0		mg/kg
Vanadium	38.6		mg/kg
Zinc	47.8		mg/kg
Anthracene		0.065	mg/kg
Benzo(a)anthracene	0.05		mg/kg
Benzo(a)pyrene	0.05		mg/kg
Benzo(b)fluoranthene	0.04		mg/kg
Benzo(g,h,i)perylene	0.140		mg/kg
Benzo(k)fluoranthene		0.076	mg/kg
Chrysene	0.06		mg/kg
Dibenzo(a,h)anthracene		0.024	mg/kg
Fluoranthene	0.15		mg/kg
Fluorene		0.030	mg/kg
Indeno(1,2,3-cd)pyrene	0.04		mg/kg
Phenanthrene	0.09		mg/kg
Pyrene	0.14		mg/kg

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

WAC 173-340 3-Part Test for most stringent RAG:	
95% UCL > Cleanup Limit?	YES
> 10% above Cleanup Limit?	YES
Any sample > 2x Cleanup Limit?	YES

Because of the "yes" answers to the WAC 173-340 3-part test for lead and multiple PAHs, detailed assessments using RESRAD will be performed. All data sets meet the 3-part test criteria when compared to direct exposure cleanup levels.

Results Summary - Waste Staging Area		
Analyte	Maximum[a]	Units
Cesium-137	0.041	pCi/g
Arsenic	2.5	mg/kg
Barium	81.7	mg/kg
Beryllium	0.30	mg/kg
Boron	2.7	mg/kg
Chromium	7.0	mg/kg
Cobalt	5.7	mg/kg
Copper	10.9	mg/kg
Lead	5.3	mg/kg
Manganese	285	mg/kg
Nickel	8.6	mg/kg
Vanadium	33.4	mg/kg
Zinc	37.5	mg/kg
Anthracene	0.0076	mg/kg
Benzo(a)anthracene	0.076	mg/kg
Benzo(a)pyrene	0.046	mg/kg
Benzo(b)fluoranthene	0.048	mg/kg
Benzo(g,h,i)perylene	0.034	mg/kg
Benzo(k)fluoranthene	0.017	mg/kg
Chrysene	0.20	mg/kg
Fluoranthene	0.088	mg/kg
Indeno(1,2,3-cd)pyrene	0.058	mg/kg
Phenanthrene	0.070	mg/kg
Pyrene	0.082	mg/kg

[a]Verification sampling at the waste staging area was based on multi-aliquot, rather than statistical, sampling.

[a]For nonradionuclides, where ≤ 50% of a data set is censored (below detection limits), the 95% UCL value is used for a given analyte.
[b]Where > 50% of a data set is censored, the statistical value defaults to the maximum detected value in the data set (Attachment 1).
MTCA = *Model Toxic Control Act*
PAH = polycyclic aromatic hydrocarbon
RAG = remedial action goal
RESRAD = RESidual RADioactivity (dose assessment model)
UCL = upper confidence level
WAC = *Washington Adminstrative Code*

Relative Percent Difference Results[a] - QA/QC Analysis	
Analyte	Duplicate Analysis[b]
Barium	2.2%
Chromium	1.1%
Copper	3.7%
Manganese	6.8%
Vanadium	0.85%
Zinc	2.6%

[a]Relative percent difference evaluation was not required for analytes not included in this table.
[b]The significance of relative percent difference values are discussed within the RSVP for the subject site.
QA/QC = quality assurance/quality control
RSVP = remaining sites verification package

Washington Closure Hanford

CALCULATION SHEET

Originator J. M. Capron JMC **Date** 04/17/06 **Calc. No.** 0100F-CA-V0246 **Rev. No.** 0
Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley JMB **Date** 4/19/06
Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 4 of 13

Remediation Footprint Verification Data

Sampling Area	HEIS Number	Sample Date	Cesium-137			Strontium-90			Arsenic			Barium			Beryllium			Boron			Chromium			Cobalt		
			pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
7	J112W6	1/30/2006	0.13	U	0.13	-0.105	U	0.27	1.2		1.1	88.9		0.07	0.33		0.03	2.1		0.90	8.9		0.53	6.2		0.40
Duplicate of J112W6	J112X0	1/30/2006	0.083	U	0.083	0.002	U	0.30	2.7		1.1	90.9		0.07	0.39		0.03	1.7		0.89	9.0		0.53	6.5		0.40
1	J112W0	1/30/2006	0.046	U	0.046	-0.063	U	0.31	7.7		1.0	70.1		0.06	0.32		0.03	1.5		0.83	9.7		0.49	5.4		0.37
2	J112W1	1/30/2006	0.059		0.051	0.092	U	0.30	2.7		1.1	70.2		0.06	0.31		0.03	2.1		0.85	8.8		0.50	5.8		0.38
3	J112W2	1/30/2006	0.024	U	0.024	-0.069	U	0.28	1.1		1.1	86.2		0.06	0.34		0.03	2.6		0.86	8.2		0.51	6.4		0.38
4	J112W3	1/30/2006	0.052	U	0.052	1.70		0.30	1.5		1.0	135		0.06	0.38		0.03	7.4		0.82	8.4		0.49	6.1		0.37
5	J112W4	1/30/2006	0.045	U	0.045	0.122	U	0.35	1.8		1.0	48.4		0.06	0.26		0.03	1.3		0.81	8.1		0.48	5.0		0.36
6	J112W5	1/30/2006	0.038	U	0.038	0.189	U	0.22	2.3		1.1	65.4		0.06	0.25		0.03	1.6		0.84	7.0		0.50	5.5		0.37
8	J112W7	1/30/2006	0.044	U	0.044	0.096	U	0.31	2.1		1.1	47.8		0.06	0.25		0.03	1.1		0.84	8.3		0.50	5.0		0.37
9	J112W8	1/30/2006	0.025	U	0.025	0.080	U	0.30	1.8		0.99	27.9		0.06	0.18		0.03	0.79	U	0.79	7.6		0.47	3.9		0.35
10	J112W9	1/30/2006	0.056	U	0.056	0.049	U	0.32	2.2		1.1	108		0.06	0.38		0.03	4.7		0.87	9.5		0.51	6.3		0.39

Note: Radiological analytical methods use statistically-determined floating calibration curves that are not forced through the origin; therefore, negative values are routinely reported for undetected analytes. This does not diminish the usability of the data.

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Cesium-137	Strontium-90	Arsenic	Barium	Beryllium	Boron	Chromium	Cobalt
			pCi/g	pCi/g	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
7	J112W6/J112X0	1/30/2006	0.053	-0.052	2.0	89.9	0.36	1.9	9.0	6.4
1	J112W0	1/30/2006	0.023	-0.063	7.7	70.1	0.32	1.5	9.7	5.4
2	J112W1	1/30/2006	0.059	0.092	2.7	70.2	0.31	2.1	8.8	5.8
3	J112W2	1/30/2006	0.012	-0.069	1.1	86.2	0.34	2.6	8.2	6.4
4	J112W3	1/30/2006	0.026	1.70	1.5	135	0.38	7.4	8.4	6.1
5	J112W4	1/30/2006	0.023	0.122	1.8	48.4	0.26	1.3	8.1	5.0
6	J112W5	1/30/2006	0.019	0.189	2.3	65.4	0.25	1.6	7.0	5.5
8	J112W7	1/30/2006	0.022	0.096	2.1	47.8	0.25	1.1	8.3	5.0
9	J112W8	1/30/2006	0.013	0.080	1.8	27.9	0.18	0.40	7.6	3.9
10	J112W9	1/30/2006	0.028	0.049	2.2	108	0.38	4.7	9.5	6.3

Statistical Computations

	Cesium-137	Strontium-90	Arsenic	Barium	Beryllium	Boron	Chromium	Cobalt
Statistical value based on	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat normal distribution.
N	10	10	10	10	10	10	10	10
% < Detection limit	90%	90%	0%	0%	0%	10%	0%	0%
Mean	0.028	0.21	2.5	75	0.30	2.5	8.5	5.6
Standard deviation	0.016	0.53	1.9	31	0.07	2.1	0.8	0.8
Z-statistic	1.645	1.645	NA*	NA*	NA*	NA*	NA*	NA*
95% UCL on mean	0.036	0.49	3.5	106	0.35	5.3	9.0	6.0
Maximum detected value	0.059	1.70	7.7	135	0.39	7.4	9.7	6.5
Statistical value	0.036	0.49	3.5	106	0.35	5.3	9.0	6.0
Most Stringent Cleanup Limit for nonradionuclide and RAG type			20 Direct Exposure/GW & River Protection	132 BG/GW Protection	1.51 BG/GW & River Protection	320 GW Protection	18.5 BG/GW & River Protection	32 GW Protection
WAC 173-340 3-PART TEST								
95% UCL > Cleanup Limit?			NO	NO	NA	NO	NA	NA
> 10% above Cleanup Limit?			NO	NO	NA	NO	NA	NA
Any sample > 2X Cleanup Limit?			NO	NO	NA	NO	NA	NA
WAC 173-340 Compliance? **YES**			The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.	Because all values are below background (1.51 mg/kg), the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.	Because all values are below background (18.5 mg/kg), the WAC 173-340 3-part test is not required.	Because all values are below background (15.7 mg/kg), the WAC 173-340 3-part test is not required.

*Calculation of 95% UCL for nonradionuclides performed using MTCAStat software.

BG = background
GW = groundwater
HEIS = Hanford Environmental Information System
MTCA = *Model Toxic Control Act*
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
RAG = remedial action goal
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC
Project 100-F Area Field Remediation
Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations

Date 04/17/06
Job No. 14655

Calc. No. 0100F-CA-V0246
Checked T. M. Blakley TMB

Rev. No. 0
Date 4/19/06
Sheet No. 5 of 13

Remediation Footprint Verification Data (continued)

Sampling Area	HEIS Number	Sample Date	Copper mg/kg	Q	PQL	Hexavalent Chromium mg/kg	Q	PQL	Lead mg/kg	Q	PQL	Manganese mg/kg	Q	PQL	Nickel mg/kg	Q	PQL	Vanadium mg/kg	Q	PQL	Zinc mg/kg	Q	PQL	Benzo(a)anthracene mg/kg	Q	PQL
7	J112W6	1/30/2006	10.7		0.40	0.31		0.23	4.8		1.0	340	C	0.07	9.3		0.43	35.1		0.30	37.5		0.17	0.00388	U	0.00388
Duplicate of J112W6	J112X0	1/30/2006	11.1		0.40	0.45		0.23	5.4		1.0	364	C	0.07	9.9		0.43	35.4		0.30	38.5		0.16	0.00388	U	0.00388
1	J112W0	1/30/2006	14.1		0.37	0.22	U	0.22	22.9		0.95	264	C	0.06	10.3		0.40	35.6		0.28	42.0		0.15	0.069	J	0.00365
2	J112W1	1/30/2006	12.5		0.38	0.26		0.22	6.7		0.97	300	C	0.06	9.7		0.41	37.3		0.28	45.4		0.16	0.15		0.00366
3	J112W2	1/30/2006	10.3		0.38	0.22	U	0.22	4.6		0.99	354	C	0.06	9.0		0.41	38.1		0.29	36.9		0.16	0.0063		0.00372
4	J112W3	1/30/2006	13.4		0.37	0.22	U	0.22	5.9		0.95	299	C	0.06	9.6		0.40	45.7		0.27	65.3		0.15	0.0049		0.00359
5	J112W4	1/30/2006	12.8		0.36	0.39		0.21	4.8		0.93	237	C	0.06	9.1		0.39	30.9		0.27	36.0		0.15	0.0094		0.00353
6	J112W5	1/30/2006	11.7		0.37	1.5		0.22	10.7		0.96	269	C	0.06	8.4		0.40	30.2		0.28	46.1		0.16	0.0055		0.00363
8	J112W7	1/30/2006	11.9		0.37	0.34		0.22	4.0		0.97	252	C	0.06	10.3		0.41	33.3		0.28	34.3		0.16	0.00364	U	0.00364
9	J112W8	1/30/2006	11.0		0.35	0.29		0.21	3.0		0.90	206	C	0.06	8.9		0.38	28.3		0.26	26.0		0.15	0.00346	U	0.00346
10	J112W9	1/30/2006	13.2		0.39	0.29		0.22	5.4		1.0	317	C	0.06	10.6		0.42	39.3		0.29	39.4		0.16	0.0057		0.00375

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Copper mg/kg	Hexavalent Chromium mg/kg	Lead mg/kg	Manganese mg/kg	Nickel mg/kg	Vanadium mg/kg	Zinc mg/kg	Benzo(a)anthracene mg/kg
7	J112W6/J112X0	1/30/2006	10.9	0.38	5.1	352	9.6	35.3	38.0	0.00194
1	J112W0	1/30/2006	14.1	0.11	22.9	264	10.3	35.6	42.0	0.069
2	J112W1	1/30/2006	12.5	0.26	6.7	300	9.7	37.3	45.4	0.15
3	J112W2	1/30/2006	10.3	0.11	4.6	354	9.0	38.1	36.9	0.0063
4	J112W3	1/30/2006	13.4	0.11	5.9	299	9.6	45.7	65.3	0.0049
5	J112W4	1/30/2006	12.8	0.39	4.8	237	9.1	30.9	36.0	0.0094
6	J112W5	1/30/2006	11.7	1.5	10.7	269	8.4	30.2	46.1	0.0055
8	J112W7	1/30/2006	11.9	0.34	4.0	252	10.3	33.3	34.3	0.00182
9	J112W8	1/30/2006	11.0	0.29	3.0	206	8.9	28.3	26.0	0.00173
10	J112W9	1/30/2006	13.2	0.29	5.4	317	10.6	39.3	39.4	0.0057

Statistical Computations

	Copper	Hexavalent Chromium	Lead	Manganese	Nickel	Vanadium	Zinc	Benzo(a)anthracene
Statistical value based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.
N	10	10	10	10	10	10	10	10
% < Detection limit	0%	30%	0%	0%	0%	0%	0%	30%
Mean	12.2	0.4	7.3	285	9.55	35.4	40.9	0.0
Standard deviation	1.2	0.4	5.9	48	0.71	5.1	10.3	0.0
95% UCL on mean	13.0	0.6	10.4	318	10.0	38.6	47.8	0.05
Maximum detected value	14.1	1.5	22.9	364	10.6	45.7	65.3	0.15
Statistical value	13.0	0.6	10.4	318	10.0	38.6	47.8	0.05
Most Stringent Cleanup Limit for nonradionuclide and RAG type	22.0 BG/River Protection	2 River Protection	10.2 BG/GW & River Protection	512 BG/GW Protection	19.1 BG/GW Protection	85.1 BG/GW Protection	67.8 BG/River Protection	0.015 RDL/GW & River Protection
WAC 173-340 3-PART TEST								
95% UCL > Cleanup Limit?	NA	NO	YES	NA	NA	NA	NA	YES
> 10% above Cleanup Limit?	NA	NO	YES	NA	NA	NA	NA	YES
Any sample > 2X Cleanup Limit?	NA	NO	YES	NA	NA	NA	NA	YES
WAC 173-340 Compliance? NO	Because all values are below background (22.0 mg/kg), the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.	Because of the "yes" answers to the 3-part test, a detailed assessment using RESRAD will be performed. The data set meets the 3-part test criteria when compared to direct exposure cleanup levels.	Because all values are below background (512 mg/kg), the WAC 173-340 3-part test is not required.	Because all values are below background (19.1 mg/kg), the WAC 173-340 3-part test is not required.	Because all values are below background (85.1 mg/kg), the WAC 173-340 3-part test is not required.	Because all values are below background (67.8 mg/kg), the WAC 173-340 3-part test is not required.	Because of the "yes" answers to the 3-part test, a detailed assessment using RESRAD will be performed. The data set meets the 3-part test criteria when compared to direct exposure cleanup levels.

BG = background
C = blank contamination
GW = groundwater
HEIS = Hanford Environmental Information System
MTCA = *Model Toxic Control Act*
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
RAG = remedial action goal
RDL = required detection limit
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC | Date 04/17/06 | Calc. No. 0100F-CA-V0246 | Rev. No. 0
Project 100-F Area Field Remediation | Job No. 14655 | Checked T. M. Blakley | Date 4/19/06
Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations | Sheet No. 6 of 13

Remediation Footprint Verification Data (continued)

Sampling Area	HEIS Number	Sample Date	Benzo(a)pyrene			Benzo(b)fluoranthene			Benzo(g,h,i)perylene			Chrysene			Fluoranthene			Indeno(1,2,3-cd)pyrene			Phenanthrene			Pyrene		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
7	J112W6	1/30/2006	0.00388	U	0.00388	0.00388	U	0.00388	0.00388	U	0.00388	0.00388	U	0.00388	0.00777	U	0.00777	0.00388	U	0.00388	0.00388	U	0.00388	0.00777	U	0.00777
Duplicate of J112W6	J112X0	1/30/2006	0.00388	U	0.00388	0.00388	U	0.00388	0.00388	U	0.00388	0.00388	U	0.00388	0.00777	U	0.00777	0.00388	U	0.00388	0.00388	U	0.00388	0.00777	U	0.00777
1	J112W0	1/30/2006	0.070	J	0.00365	0.053	J	0.00365	0.045	J	0.00365	0.0081	J	0.00365	0.28		0.00730	0.052	J	0.00365	0.14	J	0.00365	0.20	J	0.00730
2	J112W1	1/30/2006	0.16		0.00366	0.11		0.00366	0.099		0.00366	0.20		0.00366	0.40		0.00732	0.11		0.00366	0.28		0.00366	0.44		0.00732
3	J112W2	1/30/2006	0.0088		0.00372	0.0064		0.00372	0.016		0.00372	0.0083		0.00372	0.023		0.00744	0.0034	J	0.00372	0.011		0.00372	0.018		0.00744
4	J112W3	1/30/2006	0.0045		0.00359	0.0050		0.00359	0.0088		0.00359	0.0041		0.00359	0.00718	U	0.00718	0.0088	J	0.00359	0.00359	U	0.00359	0.00718	U	0.00718
5	J112W4	1/30/2006	0.011		0.00353	0.010		0.00353	0.014		0.00353	0.0092		0.00353	0.028		0.00706	0.013	J	0.00353	0.0076		0.00353	0.012		0.00706
6	J112W5	1/30/2006	0.00363	U	0.00363	0.0040		0.00363	0.014		0.00363	0.00363	U	0.00363	0.0094		0.00725	0.013	J	0.00363	0.0061		0.00363	0.00725	U	0.00725
8	J112W7	1/30/2006	0.00364	U	0.00364	0.00364	U	0.00364	0.00364	U	0.00364	0.00364	U	0.00364	0.00727	U	0.00727	0.0388	UJ	0.00364	0.00364	U	0.00364	0.00727	U	0.00727
9	J112W8	1/30/2006	0.00346	U	0.00346	0.00346	U	0.00346	0.00346	U	0.00346	0.00346	U	0.00346	0.00692	U	0.00692	0.00346	UJ	0.00346	0.00346	U	0.00346	0.00692	U	0.00692
10	J112W9	1/30/2006	0.00375	U	0.00375	0.00375	U	0.00375	0.0075		0.00375	0.0036	J	0.00375	0.00750	U	0.00750	0.00375	UJ	0.00375	0.00375	U	0.00375	0.0095		0.00750

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Benzo(a)pyrene mg/kg	Benzo(b)fluoranthene mg/kg	Benzo(g,h,i)perylene mg/kg	Chrysene mg/kg	Fluoranthene mg/kg	Indeno(1,2,3-cd)pyrene mg/kg	Phenanthrene mg/kg	Pyrene mg/kg
7	J112W6/J112X0	1/30/2006	0.00194	0.00194	0.00194	0.00194	0.00389	0.00194	0.00194	0.00389
1	J112W0	1/30/2006	0.070	0.053	0.045	0.0081	0.28	0.052	0.14	0.20
2	J112W1	1/30/2006	0.16	0.11	0.099	0.20	0.40	0.11	0.28	0.44
3	J112W2	1/30/2006	0.0088	0.0064	0.016	0.0083	0.023	0.0034	0.011	0.018
4	J112W3	1/30/2006	0.0045	0.0050	0.0088	0.0041	0.00359	0.0088	0.00180	0.00359
5	J112W4	1/30/2006	0.011	0.010	0.014	0.0092	0.028	0.013	0.0076	0.012
6	J112W5	1/30/2006	0.00182	0.0040	0.014	0.00182	0.0094	0.013	0.0061	0.00363
8	J112W7	1/30/2006	0.00182	0.00182	0.00182	0.00182	0.00364	0.00182	0.00182	0.00364
9	J112W8	1/30/2006	0.00173	0.00173	0.00173	0.00173	0.00346	0.00173	0.00173	0.00346
10	J112W9	1/30/2006	0.00188	0.00188	0.0075	0.0036	0.00375	0.00188	0.00188	0.0095

Statistical Computations

	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Chrysene	Fluoranthene	Indeno(1,2,3-cd)pyrene	Phenanthrene	Pyrene
Statistical value based on	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.
N	10	10	10	10	10	10	10	10
% < Detection limit	50%	40%	30%	40%	50%	40%	50%	50%
Mean	0.03	0.02	0.021	0.02	0.08	0.02	0.05	0.07
Standard deviation	0.05	0.04	0.030	0.06	0.14	0.03	0.09	0.14
95% UCL on mean	0.05	0.04	0.140	0.06	0.15	0.04	0.09	0.14
Maximum detected value	0.16	0.11	0.099	0.20	0.40	0.11	0.28	0.44
Statistical value	0.05	0.04	0.140	0.06	0.15	0.04	0.09	0.14
Most Stringent Cleanup Limit for nonradionuclide and RAG type	0.015 RDL/GW & River Protection	0.015 RDL/GW & River Protection	48 GW Protection	0.10 RDL/River Protection	18 River Protection	0.030 RDL/GW & River Protection	240 GW Protection	48 GW Protection
WAC 173-340 3-PART TEST								
95% UCL > Cleanup Limit?	YES	YES	NO	NO	NO	YES	NO	NO
> 10% above Cleanup Limit?	YES	YES	NO	NO	NO	YES	NO	NO
Any sample > 2X Cleanup Limit?	YES	YES	NO	NO	NO	YES	NO	NO
WAC 173-340 Compliance? NO	Because of the "yes" answers to the 3-part test, a detailed assessment using RESRAD will be performed. The data set meets the 3-part test criteria when compared to direct exposure cleanup levels.	Because of the "yes" answers to the 3-part test, a detailed assessment using RESRAD will be performed. The data set meets the 3-part test criteria when compared to direct exposure cleanup levels.	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.	Because of the "yes" answers to the 3-part test, a detailed assessment using RESRAD will be performed. The data set meets the 3-part test criteria when compared to direct exposure cleanup levels.	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.

GW = groundwater
HEIS = Hanford Environmental Information System
MTCA = *Model Toxic Control Act*
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
RAG = remedial action goal
RDL = required detection limit
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC **Date** 04/17/06 **Calc. No.** 0100F-CA-V0246 **Rev. No.** 0

Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley TMB **Date** 4/19/06

Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 7 of 13

Duplicate Analysis

Sampling Area	HEIS Number	Sample Date	Arsenic			Barium			Beryllium			Boron			Chromium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
7	J112W6	1/30/2006	1.2		1.1	88.9		0.07	0.33		0.03	2.1		0.90	8.9		0.53
Duplicate of J112W6	J112X0	1/30/2006	2.7		1.1	90.9		0.07	0.39		0.03	1.7		0.89	9.0		0.53

Analysis:

TDL		10	2	0.5	2	1
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	No-Stop (acceptable)	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**
	RPD		2.2%			1.1%

Sampling Area	HEIS Number	Sample Date	Cobalt			Copper			Hexavalent Chromium			Lead			Manganese		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
7	J112W6	1/30/2006	6.2		0.40	10.7		0.40	0.31		0.23	4.8		1.0	340	C	0.07
Duplicate of J112W6	J112X0	1/30/2006	6.5		0.40	11.1		0.40	0.45		0.23	5.4		1.0	364	C	0.07

Analysis:

TDL		2	1	0.5	5	5
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	No-Stop (acceptable)	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**
	RPD		3.7%			6.8%

Sampling Area	HEIS Number	Sample Date	Nickel			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
7	J112W6	1/30/2006	9.3		0.43	35.1		0.30	37.5		0.17
Duplicate of J112W6	J112X0	1/30/2006	9.9		0.43	35.4		0.30	38.5		0.16

Analysis:

TDL		4	2.5	1
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**
	RPD		0.85%	2.6%

C = blank contamination

HEIS = Hanford Environmental Information System

PQL = practical quantitation limit

Q = qualifier

RPD = relative percent difference

TDL = target detection limit

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC **Date** 04/17/06 **Calc. No.** 0100F-CA-V0246 **Rev. No.** 0

Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley JMB **Date** 4/19/06

Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 8 of 13

Ecology Software (MTCAStat) Results

DATA	ID	Arsenic 95% UCL Calculation			
2.0	J112W6/J112X0				
7.7	J112W0				
2.7	J112W1	Number of samples		Uncensored values	
1.1	J112W2	Uncensored	10	Mean	2.5
1.5	J112W3	Censored		Lognormal mean	2.5
1.8	J112W4	Detection limit or PQL		Std. devn.	1.9
2.3	J112W5	Method detection limit		Median	2.0
2.1	J112W7	TOTAL	10	Min.	1.1
1.8	J112W8			Max.	7.7
2.2	J112W9				

Lognormal distribution? Normal distribution?
r-squared is: 0.795 r-squared is: 0.563
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 3.5

DATA	ID	Barium 95% UCL Calculation			
89.9	J112W6/J112X0				
70.1	J112W0				
70.2	J112W1	Number of samples		Uncensored values	
86.2	J112W2	Uncensored	10	Mean	75
135	J112W3	Censored		Lognormal mean	76
48.4	J112W4	Detection limit or PQL		Std. devn.	31
65.4	J112W5	Method detection limit		Median	70
47.8	J112W7	TOTAL	10	Min.	27.9
27.9	J112W8			Max.	135
108	J112W9				

Lognormal distribution? Normal distribution?
r-squared is: 0.960 r-squared is: 0.968
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 106

DATA	ID	Beryllium 95% UCL Calculation			
0.36	J112W6/J112X0				
0.32	J112W0				
0.31	J112W1	Number of samples		Uncensored values	
0.34	J112W2	Uncensored	10	Mean	0.30
0.38	J112W3	Censored		Lognormal mean	0.30
0.26	J112W4	Detection limit or PQL		Std. devn.	0.07
0.25	J112W5	Method detection limit		Median	0.32
0.25	J112W7	TOTAL	10	Min.	0.18
0.18	J112W8			Max.	0.38
0.38	J112W9				

Lognormal distribution? Normal distribution?
r-squared is: 0.903 r-squared is: 0.939
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.35

DATA	ID	Boron 95% UCL Calculation			
1.9	J112W6/J112X0				
1.5	J112W0				
2.1	J112W1	Number of samples		Uncensored values	
2.6	J112W2	Uncensored	10	Mean	2.5
7.4	J112W3	Censored		Lognormal mean	2.6
1.3	J112W4	Detection limit or PQL		Std. devn.	2.1
1.6	J112W5	Method detection limit		Median	1.8
1.1	J112W7	TOTAL	10	Min.	0.40
0.40	J112W8			Max.	7.4
4.7	J112W9				

Lognormal distribution? Normal distribution?
r-squared is: 0.945 r-squared is: 0.779
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 5.3

PQL = practical quantitation limit
UCL = upper confidence limit

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC **Date** 04/17/06 **Calc. No.** 0100F-CA-V0246 **Rev. No.** 0

Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley TMB **Date** 4/19/06

Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 9 of 13

Ecology Software (MTCAStat) Results

DATA	ID	Chromium 95% UCL Calculation			
9.0	J112W6/J112X0				
9.7	J112W0				
8.8	J112W1	Number of samples		Uncensored values	
8.2	J112W2	Uncensored	10	Mean	8.5
8.4	J112W3	Censored		Lognormal mean	8.5
8.1	J112W4	Detection limit or PQL		Std. devn.	0.8
7.0	J112W5	Method detection limit		Median	8.4
8.3	J112W7	TOTAL	10	Min.	7.0
7.6	J112W8			Max.	9.7
9.5	J112W9				

Lognormal distribution? Normal distribution?
r-squared is: 0.971 r-squared is: 0.977
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 9.0

DATA	ID	Cobalt 95% UCL Calculation			
6.4	J112W6/J112X0				
5.4	J112W0				
5.8	J112W1	Number of samples		Uncensored values	
6.4	J112W2	Uncensored	10	Mean	5.6
6.1	J112W3	Censored		Lognormal mean	5.6
5.0	J112W4	Detection limit or PQL		Std. devn.	0.8
5.5	J112W5	Method detection limit		Median	5.7
5.0	J112W7	TOTAL	10	Min.	3.9
3.9	J112W8			Max.	6.4
6.3	J112W9				

Lognormal distribution? Normal distribution?
r-squared is: 0.866 r-squared is: 0.904
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 6.0

DATA	ID	Copper 95% UCL Calculation			
10.9	J112W6/J112X0				
14.1	J112W0				
12.5	J112W1	Number of samples		Uncensored values	
10.3	J112W2	Uncensored	10	Mean	12.2
13.4	J112W3	Censored		Lognormal mean	12.2
12.8	J112W4	Detection limit or PQL		Std. devn.	1.2
11.7	J112W5	Method detection limit		Median	12.2
11.9	J112W7	TOTAL	10	Min.	10.3
11.0	J112W8			Max.	14.1
13.2	J112W9				

Lognormal distribution? Normal distribution?
r-squared is: 0.981 r-squared is: 0.983
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 13.0

DATA	ID	Hexavalent Chromium 95% UCL Calculation			
0.38	J112W6/J112X0				
0.11	J112W0				
0.26	J112W1	Number of samples		Uncensored values	
0.11	J112W2	Uncensored	10	Mean	0.4
0.11	J112W3	Censored		Lognormal mean	0.4
0.39	J112W4	Detection limit or PQL		Std. devn.	0.4
1.5	J112W5	Method detection limit		Median	0.3
0.34	J112W7	TOTAL	10	Min.	0.11
0.29	J112W8			Max.	1.5
0.29	J112W9				

Lognormal distribution? Normal distribution?
r-squared is: 0.857 r-squared is: 0.581
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.6

PQL = practical quantitation limit
UCL = upper confidence limit

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC **Date** 04/17/06 **Calc. No.** 0100F-CA-V0246 **Rev. No.** 0

Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley JMB **Date** 4/19/06

Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 10 of 13

Ecology Software (MTCAStat) Results

Lead 95% UCL Calculation

DATA	ID
5.1	J112W6/J112X0
22.9	J112W0
6.7	J112W1
4.6	J112W2
5.9	J112W3
4.8	J112W4
10.7	J112W5
4.0	J112W7
3.0	J112W8
5.4	J112W9

Number of samples		Uncensored values	
Uncensored	10	Mean	7.3
Censored		Lognormal mean	7.2
Detection limit or PQL		Std. devn.	5.9
Method detection limit		Median	5.3
TOTAL	10	Min.	3.0
		Max.	22.9

Lognormal distribution? Normal distribution?
r-squared is: 0.849 r-squared is: 0.629
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 10.4

Manganese 95% UCL Calculation

DATA	ID
352	J112W6/J112X0
264	J112W0
300	J112W1
354	J112W2
299	J112W3
237	J112W4
269	J112W5
252	J112W7
206	J112W8
317	J112W9

Number of samples		Uncensored values	
Uncensored	10	Mean	285
Censored		Lognormal mean	285
Detection limit or PQL		Std. devn.	48
Method detection limit		Median	284
TOTAL	10	Min.	206
		Max.	354

Lognormal distribution? Normal distribution?
r-squared is: 0.972 r-squared is: 0.974
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 318

Nickel 95% UCL Calculation

DATA	ID
9.6	J112W6/J112X0
10.3	J112W0
9.7	J112W1
9.0	J112W2
9.6	J112W3
9.1	J112W4
8.4	J112W5
10.3	J112W7
8.9	J112W8
10.6	J112W9

Number of samples		Uncensored values	
Uncensored	10	Mean	9.6
Censored		Lognormal mean	9.6
Detection limit or PQL		Std. devn.	0.7
Method detection limit		Median	9.6
TOTAL	10	Min.	8.4
		Max.	10.6

Lognormal distribution? Normal distribution?
r-squared is: 0.964 r-squared is: 0.965
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 10.0

Vanadium 95% UCL Calculation

DATA	ID
35.3	J112W6/J112X0
35.6	J112W0
37.3	J112W1
38.1	J112W2
45.7	J112W3
30.9	J112W4
30.2	J112W5
33.3	J112W7
28.3	J112W8
39.3	J112W9

Number of samples		Uncensored values	
Uncensored	10	Mean	35.4
Censored		Lognormal mean	35.4
Detection limit or PQL		Std. devn.	5.1
Method detection limit		Median	35.4
TOTAL	10	Min.	28.3
		Max.	45.7

Lognormal distribution? Normal distribution?
r-squared is: 0.976 r-squared is: 0.959
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 38.6

PQL = practical quantitation limit
UCL = upper confidence limit

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron **Date** 04/17/06 **Calc. No.** 0100F-CA-V0246 **Rev. No.** 0

Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley **Date** 4/19/06

Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 11 of 13

Ecology Software (MTCAStat) Results

Zinc 95% UCL Calculation

DATA	ID
38.0	J112W6/J112X0
42.0	J112W0
45.4	J112W1
36.9	J112W2
65.3	J112W3
36.0	J112W4
46.1	J112W5
34.3	J112W7
26.0	J112W8
39.4	J112W9

Number of samples		Uncensored values	
Uncensored	10	Mean	40.9
Censored		Lognormal mean	41.0
Detection limit or PQL		Std. devn.	10.3
Method detection limit		Median	38.7
TOTAL	10	Min.	26.0
		Max.	65.3

Lognormal distribution? Normal distribution?
r-squared is: 0.916 r-squared is: 0.855
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 47.8

Benzo(a)anthracene 95% UCL Calculation

DATA	ID
0.00194	J112W6/J112X0
0.069	J112W0
0.15	J112W1
0.0063	J112W2
0.0049	J112W3
0.0094	J112W4
0.0055	J112W5
0.00182	J112W7
0.00173	J112W8
0.0057	J112W9

Number of samples		Uncensored values	
Uncensored	10	Mean	0.03
Censored		Lognormal mean	0.02
Detection limit or PQL		Std. devn.	0.05
Method detection limit		Median	0.01
TOTAL	10	Min.	0.00173
		Max.	0.15

Lognormal distribution? Normal distribution?
r-squared is: 0.843 r-squared is: 0.548
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.05

Benzo(a)pyrene 95% UCL Calculation

DATA	ID
0.00194	J112W6/J112X0
0.070	J112W0
0.16	J112W1
0.0088	J112W2
0.0045	J112W3
0.011	J112W4
0.00182	J112W5
0.00182	J112W7
0.00173	J112W8
0.00188	J112W9

Number of samples		Uncensored values	
Uncensored	10	Mean	0.03
Censored		Lognormal mean	0.02
Detection limit or PQL		Std. devn.	0.05
Method detection limit		Median	0.00
TOTAL	10	Min.	0.00173
		Max.	0.16

Lognormal distribution? Normal distribution?
r-squared is: 0.807 r-squared is: 0.547
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.05

Benzo(b)fluoranthene 95% UCL Calculation

DATA	ID
0.00194	J112W6/J112X0
0.053	J112W0
0.11	J112W1
0.0064	J112W2
0.0050	J112W3
0.010	J112W4
0.0040	J112W5
0.00182	J112W7
0.00173	J112W8
0.00188	J112W9

Number of samples		Uncensored values	
Uncensored	10	Mean	0.02
Censored		Lognormal mean	0.02
Detection limit or PQL		Std. devn.	0.04
Method detection limit		Median	0.00
TOTAL	10	Min.	0.00173
		Max.	0.11

Lognormal distribution? Normal distribution?
r-squared is: 0.843 r-squared is: 0.568
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.04

PQL = practical quantitation limit

UCL = upper confidence limit

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron **Date** 04/17/06 **Calc. No.** 0100F-CA-V0246 **Rev. No.** 0

Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley **Date** 4/19/06

Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 12 of 13

Ecology Software (MTCAStat) Results

Benzo(g,h,i)perylene 95% UCL Calculation

DATA	ID
0.00194	J112W6/J112X0
0.045	J112W0
0.099	J112W1
0.016	J112W2
0.0088	J112W3
0.014	J112W4
0.014	J112W5
0.00182	J112W7
0.00173	J112W8
0.0075	J112W9

Number of samples		Uncensored values	
Uncensored	10	Mean	0.021
Censored		Lognormal mean	0.024
Detection limit or PQL		Std. devn.	0.030
Method detection limit		Median	0.011
TOTAL	10	Min.	0.00173
		Max.	0.099

Lognormal distribution? Normal distribution?
r-squared is: 0.934 r-squared is: 0.649
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.140

Chrysene 95% UCL Calculation

DATA	ID
0.00194	J112W6/J112X0
0.0081	J112W0
0.20	J112W1
0.0083	J112W2
0.0041	J112W3
0.0092	J112W4
0.00182	J112W5
0.00182	J112W7
0.00173	J112W8
0.0036	J112W9

Number of samples		Uncensored values	
Uncensored	10	Mean	0.02
Censored		Lognormal mean	0.02
Detection limit or PQL		Std. devn.	0.06
Method detection limit		Median	0.004
TOTAL	10	Min.	0.00173
		Max.	0.20

Lognormal distribution? Normal distribution?
r-squared is: 0.746 r-squared is:
Recommendations:
Reject BOTH lognormal and normal distributions.
Unable to analyze probability plot for normal case.

UCL (based on Z-statistic) is 0.06

Fluoranthene 95% UCL Calculation

DATA	ID
0.00389	J112W6/J112X0
0.28	J112W0
0.40	J112W1
0.023	J112W2
0.00359	J112W3
0.028	J112W4
0.0094	J112W5
0.00364	J112W7
0.00346	J112W8
0.00375	J112W9

Number of samples		Uncensored values	
Uncensored	10	Mean	0.08
Censored		Lognormal mean	0.08
Detection limit or PQL		Std. devn.	0.14
Method detection limit		Median	0.01
TOTAL	10	Min.	0.00346
		Max.	0.40

Lognormal distribution? Normal distribution?
r-squared is: 0.799 r-squared is: 0.576
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.15

Indeno(1,2,3-cd)pyrene 95% UCL Calculation

DATA	ID
0.00194	J112W6/J112X0
0.052	J112W0
0.11	J112W1
0.0034	J112W2
0.0088	J112W3
0.013	J112W4
0.013	J112W5
0.00182	J112W7
0.00173	J112W8
0.00188	J112W9

Number of samples		Uncensored values	
Uncensored	10	Mean	0.02
Censored		Lognormal mean	0.02
Detection limit or PQL		Std. devn.	0.03
Method detection limit		Median	0.01
TOTAL	10	Min.	0.00173
		Max.	0.11

Lognormal distribution? Normal distribution?
r-squared is: 0.882 r-squared is: 0.607
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.04

PQL = practical quantitation limit

UCL = upper confidence limit

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron **Date** 04/17/06 **Calc. No.** 0100F-CA-V0246 **Rev. No.** 0

Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley **Date** 4/19/06

Subject 141-C Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 13 of 13

Ecology Software (MTCAStat) Results

	DATA	ID	Phenanthrene 95% UCL Calculation				DATA	ID	Pyrene 95% UCL Calculation			
1	DATA	ID	Phenanthrene 95% UCL Calculation				DATA	ID	Pyrene 95% UCL Calculation			
2	0.00194	J112W6/J112X0					0.00389	J112W6/J112X0				
3	0.14	J112W0					0.20	J112W0				
4	0.28	J112W1	Number of samples		Uncensored values		0.44	J112W1	Number of samples		Uncensored values	
5	0.011	J112W2	Uncensored	10	Mean	0.05	0.018	J112W2	Uncensored	10	Mean	0.07
6	0.00180	J112W3	Censored		Lognormal mean	0.04	0.00359	J112W3	Censored		Lognormal mean	0.06
7	0.0076	J112W4	Detection limit or PQL		Std. devn.	0.09	0.012	J112W4	Detection limit or PQL		Std. devn.	0.14
8	0.0061	J112W5	Method detection limit		Median	0.004	0.00363	J112W5	Method detection limit		Median	0.007
9	0.00182	J112W7	TOTAL	10	Min.	0.00173	0.00364	J112W7	TOTAL	10	Min.	0.00346
10	0.00173	J112W8			Max.	0.28	0.00346	J112W8			Max.	0.44
11	0.00188	J112W9					0.0095	J112W9				
12												
13			Lognormal distribution?		Normal distribution?				Lognormal distribution?		Normal distribution?	
14			r-squared is: 0.782		r-squared is: 0.540				r-squared is: 0.768		r-squared is: 0.530	
15			Recommendations:						Recommendations:			
16			Reject BOTH lognormal and normal distributions.						Reject BOTH lognormal and normal distributions.			
17												
18												
19			UCL (based on Z-statistic) is 0.09						UCL (based on Z-statistic) is 0.14			
20												

PQL = practical quantitation limit

UCL = upper confidence limit

Attachment 1. 141-C Verification Sampling Results.

Sample Location	HEIS Number	Sample Date	Americium-241			Cesium-137			Cobalt-60			Europium-152			Europium-154			Europium-155		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
1	J112W0	1/30/06	0.25	U	0.25	0.046	U	0.046	0.042	U	0.042	0.17	U	0.17	0.15	U	0.15	0.17	U	0.17
2	J112W1	1/30/06	0.54	U	0.54	0.059		0.051	0.049	U	0.049	0.13	U	0.13	0.15	U	0.15	0.18	U	0.18
3	J112W2	1/30/06	0.15	U	0.15	0.024	U	0.024	0.025	U	0.025	0.061	U	0.061	0.078	U	0.078	0.088	U	0.088
4	J112W3	1/30/06	0.18	U	0.18	0.052	U	0.052	0.058	U	0.058	0.12	U	0.12	0.17	U	0.17	0.13	U	0.13
5	J112W4	1/30/06	0.31	U	0.31	0.045	U	0.045	0.045	U	0.045	0.088	U	0.088	0.13	U	0.13	0.13	U	0.13
6	J112W5	1/30/06	0.33	U	0.33	0.038	U	0.038	0.042	U	0.042	0.10	U	0.10	0.14	U	0.14	0.13	U	0.13
7	J112W6	1/30/06	0.29	U	0.29	0.13	U	0.13	0.17	U	0.17	0.42	U	0.42	0.54	U	0.54	0.30	U	0.30
Duplicate of J112W6	J112X0	1/30/06	0.35	U	0.35	0.083	U	0.083	0.11	U	0.11	0.22	U	0.22	0.29	U	0.29	0.26	U	0.26
8	J112W7	1/30/06	0.43	U	0.43	0.044	U	0.044	0.043	U	0.043	0.11	U	0.11	0.16	U	0.16	0.17	U	0.17
9	J112W8	1/30/06	0.14	U	0.14	0.025	U	0.025	0.026	U	0.026	0.062	U	0.062	0.085	U	0.085	0.081	U	0.081
10	J112W9	1/30/06	0.21	U	0.21	0.056	U	0.056	0.065	U	0.065	0.15	U	0.15	0.20	U	0.20	0.15	U	0.15
Waste staging area	J112X2	1/30/06	0.17	U	0.17	0.041		0.032	0.030	U	0.030	0.079	U	0.079	0.095	U	0.095	0.097	U	0.097

Sample Location	HEIS Number	Sample Date	Potassium-40			Radium-226			Radium-228			Silver-108m			Thorium-228			Thorium-232		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
1	J112W0	1/30/06	6.91		0.39	0.272		0.078	0.471		0.18	0.034	U	0.034	0.702		0.081	0.471		0.18
2	J112W1	1/30/06	26.3		0.44	0.988		0.097	1.35		0.21	0.035	U	0.035	1.30		0.065	1.35		0.21
3	J112W2	1/30/06	13.8		0.23	0.498		0.043	0.775		0.12	0.019	U	0.019	0.660		0.030	0.775		0.12
4	J112W3	1/30/06	13.9		0.54	0.529		0.11	0.933		0.24	0.034	U	0.034	0.684		0.054	0.933		0.24
5	J112W4	1/30/06	14.1		0.29	0.459		0.078	0.635		0.16	0.025	U	0.025	0.569		0.041	0.635		0.16
6	J112W5	1/30/06	14.3		0.36	0.566		0.068	0.756		0.17	0.028	U	0.028	0.676		0.052	0.756		0.17
7	J112W6	1/30/06	8.07		1.7	0.408		0.25	0.71	U	0.71	0.099	U	0.099	0.940		0.20	0.71	U	0.71
Duplicate of J112W6	J112X0	1/30/06	11.5		0.97	0.699		0.18	0.680		0.37	0.065	U	0.065	0.599		0.12	0.680		0.37
8	J112W7	1/30/06	26.1		0.39	0.916		0.091	1.40		0.18	0.032	U	0.032	1.20		0.061	1.40		0.18
9	J112W8	1/30/06	15.2		0.24	0.345		0.053	0.466		0.11	0.018	U	0.018	0.444		0.030	0.466		0.11
10	J112W9	1/30/06	13.3		0.63	0.661		0.11	0.747		0.34	0.038	U	0.038	0.746		0.073	0.747		0.34
Waste staging area	J112X2	1/30/06	12.9		0.32	0.540		0.058	0.770		0.14	0.021	U	0.021	0.641		0.037	0.770		0.14

Note: The following abbreviations apply to all Attachment 1 tables.

Note: Data qualified with C or J are considered acceptable values.

C = blank contamination (inorganic constituents)

HEIS = Hanford Environmental Information System

J = estimated

MDA = minimum detectable activity

PQL = practical quantitation limit

Q = qualifier

U = undetected

Attachment	1	Sheet No.	1 of 5
Originator	J. M. Capron	Date	04/17/06
Checked	T. M. Blakley	Date	4/19/06
Calc. No.	0100F-CA-V0246	Rev. No.	0

Attachment 1. 141-C Verification Sampling Results.

Sample Location	HEIS Number	Sample Date	Total Beta Radiostrontium			Tritium			Uranium-235			Uranium-238		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
1	J112W0	1/30/06	-0.063	U	0.31	0.259	UJ	3.0	0.23	U	0.23	5.3	U	5.3
2	J112W1	1/30/06	0.092	U	0.30	0.480	UJ	3.1	0.25	U	0.25	6.2	U	6.2
3	J112W2	1/30/06	-0.069	U	0.28	-1.55	UJ	3.2	0.11	U	0.11	3.0	U	3.0
4	J112W3	1/30/06	1.70		0.30	-0.456	UJ	3.3	0.18	U	0.18	6.2	U	6.2
5	J112W4	1/30/06	0.122	U	0.35	-1.28	UJ	3.3	0.17	U	0.17	5.0	U	5.0
6	J112W5	1/30/06	0.189	U	0.22	-0.996	UJ	3.2	0.16	U	0.16	4.9	U	4.9
7	J112W6	1/30/06	-0.105	U	0.27	0.131	UJ	3.0	0.44	U	0.44	17	U	17
Duplicate of J112W6	J112X0	1/30/06	0.002	U	0.30	0.416	UJ	3.2	0.33	U	0.33	11	U	11
8	J112W7	1/30/06	0.096	U	0.31	-1.38	UJ	3.1	0.19	U	0.19	5.6	U	5.6
9	J112W8	1/30/06	0.080	U	0.30	-0.385	UJ	2.9	0.096	U	0.096	3.2	U	3.2
10	J112W9	1/30/06	0.049	U	0.32	-0.237	UJ	3.0	0.21	U	0.21	7.9	U	7.9
Waste staging area	J112X2	1/30/06	0.134	U	0.31	0.289	UJ	3.0	0.12	U	0.12	3.7	U	3.7

Attachment	1	Sheet No.	2 of 5
Originator	J. M. Capron	Date	04/17/06
Checked	T. M. Blakley	Date	
Calc. No.	0100F-CA-V0246	Rev. No.	0

Attachment 1. 141-C Verification Sampling Results.

Sample Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium			Boron			Cadmium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
1	J112W0	1/30/06	6450		5.6	1.2	UJ	1.2	7.7		1.0	70.1		0.06	0.32		0.03	1.5		0.83	0.21	U	0.21
2	J112W1	1/30/06	6060		5.7	1.3	UJ	1.3	2.7		1.1	70.2		0.06	0.31		0.03	2.1		0.85	0.22	U	0.22
3	J112W2	1/30/06	6260		5.8	1.3	UJ	1.3	1.1		1.1	86.2		0.06	0.34		0.03	2.6		0.86	0.22	U	0.22
4	J112W3	1/30/06	6830		5.6	1.2	UJ	1.2	1.5		1.0	135		0.06	0.38		0.03	7.4		0.82	0.21	U	0.21
5	J112W4	1/30/06	4650		5.5	1.2	UJ	1.2	1.8		1.0	48.4		0.06	0.26		0.03	1.3		0.81	0.21	U	0.21
6	J112W5	1/30/06	4810		5.7	1.2	UJ	1.2	2.3		1.1	65.4		0.06	0.25		0.03	1.6		0.84	0.22	U	0.22
7	J112W6	1/30/06	6510		6.1	1.3	UJ	1.3	1.2		1.1	88.9		0.07	0.33		0.03	2.1		0.90	0.23	U	0.23
Duplicate of J112W6	J112X0	1/30/06	6620		6.0	1.3	UJ	1.3	2.7		1.1	90.9		0.07	0.39		0.03	1.7		0.89	0.23	U	0.23
8	J112W7	1/30/06	5380		5.7	1.2	UJ	1.2	2.1		1.1	47.8		0.06	0.25		0.03	1.1		0.84	0.22	U	0.22
9	J112W8	1/30/06	4240		5.3	1.2	UJ	1.2	1.8		0.99	27.9		0.06	0.18		0.03	0.79	U	0.79	0.20	U	0.20
10	J112W9	1/30/06	6910		5.9	1.3	UJ	1.3	2.2		1.1	108		0.06	0.38		0.03	4.7		0.87	0.22	U	0.22
Waste staging area	J112X2	1/30/06	5170		5.7	1.2	UJ	1.2	2.5		1.1	81.7		0.06	0.30		0.03	2.7		0.84	0.22	U	0.22
Equipment blank	J112X1	1/30/06	138		5.1	1.4	J	1.1	0.95	U	0.95	3.5		0.06	0.04		0.03	0.75	U	0.75	0.19	U	0.19

Sample Location	HEIS Number	Sample Date	Calcium			Chromium			Cobalt			Copper			Hexavalent Chromium			Iron			Lead		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
1	J112W0	1/30/06	3710	C	3.7	9.7		0.49	5.4		0.37	14.1		0.37	0.22	U	0.22	16200		9.9	22.9		0.95
2	J112W1	1/30/06	4330	C	3.7	8.8		0.50	5.8		0.38	12.5		0.38	0.26		0.22	16500		10.1	6.7		0.97
3	J112W2	1/30/06	3030	C	3.8	8.2		0.51	6.4		0.38	10.3		0.38	0.22	U	0.22	17100		10.2	4.6		0.99
4	J112W3	1/30/06	7940	C	3.6	8.4		0.49	6.1		0.37	13.4		0.37	0.22	U	0.22	18900		9.8	5.9		0.95
5	J112W4	1/30/06	3470	C	3.6	8.1		0.48	5.0		0.36	12.8		0.36	0.39		0.21	13300		9.6	4.8		0.93
6	J112W5	1/30/06	3910	C	3.7	7.0		0.50	5.5		0.37	11.7		0.37	1.5		0.22	13700		10	10.7		0.96
7	J112W6	1/30/06	3090	C	4.0	8.9		0.53	6.2		0.40	10.7		0.40	0.31		0.23	16100		10.7	4.8		1.0
Duplicate of J112W6	J112X0	1/30/06	3110	C	3.9	9.0		0.53	6.5		0.40	11.1		0.40	0.45		0.23	17000		10.6	5.4		1.0
8	J112W7	1/30/06	3560	C	3.7	8.3		0.50	5.0		0.37	11.9		0.37	0.34		0.22	14100		10.0	4.0		0.97
9	J112W8	1/30/06	5120	C	3.5	7.6		0.47	3.9		0.35	11.0		0.35	0.29		0.21	11500		9.4	3.0		0.90
10	J112W9	1/30/06	4330	C	3.8	9.5		0.51	6.3		0.39	13.2		0.39	0.29		0.22	17900		10.3	5.4		1.0
Waste staging area	J112X2	1/30/06	3420	C	3.7	7.0		0.50	5.7		0.37	10.9		0.37	0.22	U	0.22	14200		10	5.3		0.96
Equipment blank	J112X1	1/30/06	85.5	C	3.3	0.71		0.44	0.33	U	0.33	0.33	U	0.33				307		8.9	1.4		0.86

Attachment	1	Sheet No.	3 of 5
Originator	J. M. Capron	Date	04/17/06
Checked	T. M. Blakley	Date	
Calc. No.	0100F-CA-V0246	Rev. No.	0

Attachment 1. 141-C Verification Sampling Results.

Sample Location	HEIS Number	Sample Date	Magnesium			Manganese			Mercury			Molybdenum			Nickel			Potassium			Selenium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
1	J112W0	1/30/06	3920		4.1	264	C	0.06	0.02	U	0.02	0.40	U	0.40	10.3		0.40	1090		17.0	1.1	U	1.1
2	J112W1	1/30/06	3780		4.2	300	C	0.06	0.01	U	0.01	0.41	U	0.41	9.7		0.41	1160		17.4	1.1	U	1.1
3	J112W2	1/30/06	3540		4.3	354	C	0.06	0.01	U	0.01	0.41	U	0.41	9.0		0.41	1470		17.7	1.1	U	1.1
4	J112W3	1/30/06	4010		4.1	299	C	0.06	0.03		0.02	0.40	U	0.40	9.6		0.40	1300		16.9	1.1	U	1.1
5	J112W4	1/30/06	3370		4.0	237	C	0.06	0.02	U	0.02	0.39	U	0.39	9.1		0.39	807		16.6	1.1	U	1.1
6	J112W5	1/30/06	3270		4.2	269	C	0.06	0.02	U	0.02	0.40	U	0.40	8.4		0.40	1040		17.2	1.1	U	1.1
7	J112W6	1/30/06	3660		4.5	340	C	0.07	0.02	U	0.02	0.43	U	0.43	9.3		0.43	1550		18.4	1.2	U	1.2
Duplicate of J112W6	J112X0	1/30/06	3750		4.5	364	C	0.07	0.02	U	0.02	0.43	U	0.43	9.9		0.43	1600		18.3	1.2	U	1.2
8	J112W7	1/30/06	3690		4.2	252	C	0.06	0.02	U	0.02	0.41	U	0.41	10.3		0.41	864		17.3	1.1	U	1.1
9	J112W8	1/30/06	3460		3.9	206	C	0.06	0.01	U	0.01	0.38	U	0.38	8.9		0.38	525		16.1	1.0	U	1.0
10	J112W9	1/30/06	4050		4.3	317	C	0.06	0.02	U	0.02	0.42	U	0.42	10.6		0.42	1360		17.8	1.2	U	1.2
Waste staging area	J112X2	1/30/06	3300		4.2	285	C	0.06	0.02	U	0.02	0.40	U	0.40	8.6		0.40	1190		17.2	1.1	U	1.1
Equipment blank	J112X1	1/30/06	23.1		3.8	9.7	C	0.06	0.01	U	0.01	0.36	U	0.36	0.36	U	0.36	62.8		15.4	1.0	U	1.0

Sample Location	HEIS Number	Sample Date	Silicon			Silver			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
1	J112W0	1/30/06	569	J	2.5	0.43	U	0.43	115	C	0.52	35.6		0.28	42.0		0.15
2	J112W1	1/30/06	812	J	2.6	0.44	U	0.44	118	C	0.53	37.3		0.28	45.4		0.16
3	J112W2	1/30/06	531	J	2.6	0.45	U	0.45	127	C	0.54	38.1		0.29	36.9		0.16
4	J112W3	1/30/06	656	J	2.5	0.43	U	0.43	228	C	0.52	45.7		0.27	65.3		0.15
5	J112W4	1/30/06	522	J	2.5	0.42	U	0.42	89.4	C	0.51	30.9		0.27	36.0		0.15
6	J112W5	1/30/06	628	J	2.5	0.43	U	0.43	110	C	0.53	30.2		0.28	46.1		0.16
7	J112W6	1/30/06	687	J	2.7	0.47	U	0.47	111	C	0.57	35.1		0.30	37.5		0.17
Duplicate of J112W6	J112X0	1/30/06	839	J	2.7	0.46	U	0.46	106	C	0.56	35.4		0.30	38.5		0.16
8	J112W7	1/30/06	1080	J	2.6	0.44	U	0.44	105	C	0.53	33.3		0.28	34.3		0.16
9	J112W8	1/30/06	401	J	2.4	0.41	U	0.41	92.3	C	0.50	28.3		0.26	26.0		0.15
10	J112W9	1/30/06	614	J	2.6	0.45	U	0.45	175	C	0.55	39.3		0.29	39.4		0.16
Waste staging area	J112X2	1/30/06	600	J	2.5	0.44	U	0.44	101	C	0.53	33.4		0.28	37.5		0.16
Equipment blank	J112X1	1/30/06	146	J	2.3	0.39	U	0.39	26.3	C	0.47	0.25	U	0.25	2.7		0.14

Attachment	1	Sheet No.	4 of 5
Originator	J. M. Capron	Date	04/17/06
Checked	T. M. Blakley	Date	
Calc. No.	0100F-CA-V0246	Rev. No.	0

Attachment 1. 141-C Verification Sampling Results.

Constituent	J112W0 Sample Location 1 Sample Date 1/30/06			J112W1 Sample Location 2 Sample Date 1/30/06			J112W2 Sample Location 3 Sample Date 1/30/06			J112W3 Sample Location 4 Sample Date 1/30/06		
	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
Polyaromatic Hydrocarbons												
Acenaphthene	36.5	UJ	36.5	36.6	UJ	36.6	37.2	UJ	37.2	35.9	UJ	35.9
Acenaphthylene	36.5	UJ	36.5	36.6	U	36.6	37.2	U	37.2	35.9	U	35.9
Anthracene	26	J	3.65	65		3.66	3.72	U	3.72	3.59	U	3.59
Benzo(a)anthracene	69	J	3.65	150		3.66	6.3		3.72	4.9		3.59
Benzo(a)pyrene	70	J	3.65	160		3.66	8.8		3.72	4.5		3.59
Benzo(b)fluoranthene	53	J	3.65	110		3.66	6.4		3.72	5.0		3.59
Benzo(g,h,i)perylene	45	J	3.65	99		3.66	16		3.72	8.8		3.59
Benzo(k)fluoranthene	35	J	3.65	76		3.66	0.00		3.72	3.59	U	3.59
Chrysene	81	J	3.65	200		3.66	8.3		3.72	4.1		3.59
Dibenzo(a,h)anthracene	10	J	3.65	24		3.66	3.72	U	3.72	3.59	U	3.59
Fluoranthene	280	J	7.30	400		7.32	23		7.44	7.18	U	7.18
Fluorene	11	J	3.65	30		3.66	3.72	U	3.72	3.59	U	3.59
Indeno(1,2,3-cd)pyrene	52	J	3.65	110	J	3.66	3.4	J	3.72	8.8	J	3.59
Naphthalene	36.5	UJ	36.5	36.6	U	36.6	37.2	U	37.2	35.9	U	35.9
Phenanthrene	140	J	3.65	280		3.66	11		3.72	3.59	U	3.59
Pyrene	200	J	7.30	440		7.32	18		7.44	7.18	U	7.18

Constituent	J112W4 Sample Location 5 Sample Date 1/30/06			J112W5 Sample Location 6 Sample Date 1/30/06			J112W6 Sample Location 7 Sample Date 1/30/06			J112X0 Duplicate of J112W6 Sample Date 1/30/06		
	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
Polyaromatic Hydrocarbons												
Acenaphthene	35.3	UJ	35.3	36.3	UJ	36.3	38.8	UJ	38.8	38.8	UJ	38.8
Acenaphthylene	35.3	U	35.3	36.3	U	36.3	38.8	U	38.8	38.8	U	38.8
Anthracene	3.53	U	3.53	3.63	U	3.63	3.88	U	3.88	3.88	U	3.88
Benzo(a)anthracene	9.4		3.53	5.5		3.63	3.88	U	3.88	3.88	U	3.88
Benzo(a)pyrene	11		3.53	3.63	U	3.63	3.88	U	3.88	3.88	U	3.88
Benzo(b)fluoranthene	10		3.53	4.0		3.63	3.88	U	3.88	3.88	U	3.88
Benzo(g,h,i)perylene	14		3.53	14		3.63	3.88	U	3.88	3.88	U	3.88
Benzo(k)fluoranthene	4.2		3.53	3.63	U	3.63	3.88	U	3.88	3.88	U	3.88
Chrysene	9.2		3.53	3.63	U	3.63	3.88	U	3.88	3.88	U	3.88
Dibenzo(a,h)anthracene	3.53	U	3.53	3.63	U	3.63	3.88	U	3.88	3.88	U	3.88
Fluoranthene	28		7.06	9.4		7.25	7.77	U	7.77	7.77	U	7.77
Fluorene	4.6		3.53	3.63	U	3.63	3.88	U	3.88	3.88	U	3.88
Indeno(1,2,3-cd)pyrene	13	J	3.53	13	J	3.63	3.88	UJ	3.88	3.88	UJ	3.88
Naphthalene	35.3	U	3.53	36.3	U	36.3	38.8	U	38.8	38.8	U	38.8
Phenanthrene	7.6		3.53	6.1		3.63	3.88	U	3.88	3.88	U	3.88
Pyrene	12		7.06	7.25	U	7.25	7.77	U	7.77	7.77	U	7.77

Constituent	J112W7 Sample Location 8 Sample Date 1/30/06			J112W8 Sample Location 9 Sample Date 1/30/06			J112W9 Sample Location 10 Sample Date 1/30/06			J112X2 Waste Staging Area Sample Date 1/30/06		
	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
Polyaromatic Hydrocarbons												
Acenaphthene	36.4	UJ	36.4	34.6	UJ	34.6	37.5	UJ	37.5	100	J	36.3
Acenaphthylene	36.4	U	36.4	34.6	U	34.6	37.5	U	37.5	36.3	U	36.3
Anthracene	3.64	U	3.64	3.46	U	3.46	3.75	U	3.75	7.6		3.63
Benzo(a)anthracene	3.64	U	3.64	3.46	U	3.46	5.7		3.75	76		3.63
Benzo(a)pyrene	3.64	U	3.64	3.46	U	3.46	3.75	U	3.75	46		3.63
Benzo(b)fluoranthene	3.64	U	3.64	3.46	U	3.46	3.75	U	3.75	48		3.63
Benzo(g,h,i)perylene	3.64	U	3.64	3.46	U	3.46	7.5		3.75	34		3.63
Benzo(k)fluoranthene	3.64	U	3.64	3.46	U	3.46	3.75	U	3.75	17		3.63
Chrysene	3.64	U	3.64	3.46	U	3.46	3.6	J	3.75	200		3.63
Dibenzo(a,h)anthracene	3.64	U	3.64	3.46	U	3.46	3.75	U	3.75	3.63	U	3.63
Fluoranthene	7.27	U	7.27	6.92	U	6.92	7.50	U	7.50	88		7.26
Fluorene	3.64	U	3.64	3.46	U	3.46	3.75	U	3.75	3.63	U	3.63
Indeno(1,2,3-cd)pyrene	3.64	UJ	3.64	3.46	UJ	3.46	3.75	UJ	3.75	58	J	3.63
Naphthalene	36.4	U	36.4	34.6	U	34.6	37.5	U	37.5	36.3	U	36.3
Phenanthrene	3.64	U	3.64	3.46	U	3.46	3.75	U	3.75	70		3.63
Pyrene	7.27	U	7.27	6.92	U	6.92	9.5		7.50	82		7.26

Attachment	1	Sheet No.	5 of 5
Originator	J. M. Capron	Date	04/17/06
Checked	T. M. Blakley	Date	
Calc. No.	0100F-CA-V0246	Rev. No.	0

APPENDIX C

CALCULATION OF HAZARD QUOTIENTS AND EXCESS CARCINOGENIC RISK VALUES

CALCULATION COVER SHEET

Project Title 100-F Area Field Remediation Closure **Job No.** 14655
Area 100-F
Discipline Environmental *Calc. No. 0100F-CA-V0247
Subject 141-C Waste Site Hazard Quotient and Carcinogenic Risk Calculations
Computer Program Excel **Program No.** Excel 2003

The attached calculations have been generated to document compliance with established cleanup levels. These documents 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 = 3 Total = 4	J. M. Capron 4/24/06	T. M. Blakley 4/25/06	L. M. Dittmer 4/25/06	R. A. Carlson 4/25/06	

SUMMARY OF REVISION

*Obtain Calc. No. from DIS

DE01437.03 (12/09/2004)

Washington Closure Hanford CALCULATION SHEET

Originator:	J. M. Capron	Date:	04/24/06	Calc. No.:	0100F-CA-V0247	Rev.:	0
Project:	100-F Area Field Remediation	Job No:	14655	Checked:	T. M. Blakley	Date:	4/25/06
Subject:	141-C Waste Site Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	1 of 3

PURPOSE:

Provide documentation to support the calculation of the hazard quotient (HQ) and carcinogenic (excess cancer) risk values for the 141-C remediation verification sampling results. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2005), the following criteria must be met:

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

GIVEN/REFERENCES:

1) DOE-RL, 2005, *Remedial Design Report/Remedial Action Work Plan for the 100 Areas,* DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

2) EPA, 1994, *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children*, EPA/540/R-93/081, Publication No. 9285.7-15-1, U.S. Environmental Protection Agency, Washington, D.C.

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

4) WCH, 2006, Waste Site Reclassification Form 2006-027, and Attachment *Remaining Sites Verification Package for the 141-C Large Animal Barn and Biology Laboratory (Hog Barn)*, Washington Closure Hanford, Richland, Washington.

SOLUTION:

1) Calculate an HQ for each noncarcinogenic constituent detected above background and compare to the individual HQ of <1.0 (DOE-RL 2005).

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

3) Calculate an excess cancer risk value for each carcinogenic constituent detected above background and compare to the individual excess cancer risk criterion of $<1 \times 10^{-6}$ (DOE-RL 2005).

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

METHODOLOGY:

Hazard quotient and carcinogenic risk calculations were performed for the 141-C waste site using the higher of the remediation footprint statistical value and waste staging area maximum value for each

Washington Closure Hanford CALCULATION SHEET

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analyte detected above background. Of the contaminants of concern (COCs) and contaminants of potential concern (COPCs) for the site, boron requires the HQ and risk calculations because it was detected and a Washington State or Hanford Site background value is not available. Lead is included because it was quantified at a concentration above the Hanford Site background value. Hexavalent chromium and multiple polycyclic aromatic hydrocarbons are included because they were detected by laboratory analysis and cannot be attributed to natural occurrence. All other site nonradionuclide COCs/COPCs were not detected or were detected below background levels. An example of the HQ and risk calculations is presented below:

1) For example, the statistical value for boron is 5.3 mg/kg, divided by the noncarcinogenic RAG value of 16,000 mg/kg (boron is identified as a noncarcinogen in WAC 173-340-740[3]), is 3.3×10^{-4}. Comparing this value, and all other individual values, to the requirement of <1.0, this criterion is met.

2) After the HQ calculations are completed for the appropriate analytes, the cumulative HQ is obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation.) The sum of the HQ values is 3.2×10^{-2}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the 95% upper confidence limit or maximum value is divided by the carcinogenic RAG value, then multiplied by 1×10^{-6}. For example, the maximum value for benzo(a)anthracene is 0.076 mg/kg; divided by 1.37 mg/kg and multiplied as indicated is 5.5×10^{-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 carcinogenic risk is obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual values prior to rounding are used for this calculation.) The sum of the excess carcinogenic risk values is 9.7×10^{-7}. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

RESULTS:

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

Table 1 shows the results of the calculations for the 141-C waste site.

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Table 1. Hazard Quotient and Excess Cancer Risk Results for the 141-C Waste Site.

Contaminants of Concern / Contaminants of Potential Concern	95% UCL or Maximum Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG[b] (mg/kg)	Carcinogenic Risk
Metals					
Boron	5.3	16,000	3.3E-04	--	--
Chromium, hexavalent[c]	0.6	240	2.5E-03	2.1	2.9E-07
Lead[d]	10.4	353	2.9E-02	--	--
Semivolatiles					
Anthracene	0.065	24,000	2.7E-06	--	--
Benzo(a)anthracene	0.076	--	--	1.37	5.5E-08
Benzo(a)pyrene	0.05	--	--	0.137	3.6E-07
Benzo(b)fluoranthene	0.048	--	--	1.37	3.5E-08
Benzo(k)fluoranthene	0.076	--	--	13.7	5.5E-09
Benzo(g,h,i)perylene[e]	0.140	2,400	5.8E-05	--	--
Chrysene	0.20	--	--	137	1.5E-09
Dibenzo(a,h)anthracene	0.024	--	--	0.137	1.8E-07
Fluoranthene	0.15	3,200	4.7E-05	--	--
Fluorene	0.030	3,200	9.4E-06	--	--
Indeno(1,2,3-cd) pyrene	0.058	--	--	1.37	4.2E-08
Phenanthrene[e]	0.09	24,000	3.8E-06	--	--
Pyrene	0.14	2,400	5.8E-05	--	--
Totals					
Cumulative Hazard Quotient:			**3.2E-02**		
Cumulative Excess Cancer Risk:					**9.7E-07**

Notes:
[a] = From WCH 2006.
[b] = Value obtained from WAC 173-340-740(3), Method B, 1996, unless otherwise noted.
[c] = Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3]) (1996).
[d] = Value for the noncarcinogen RAG obtained from EPA (1994).
[e] = Toxicity data are not available for this constituent. RAGs for benzo(g,h,i)perylene and phenanthrene are based on the surrogate chemicals pyrene and anthracene, respectively.
-- = not applicable
RAG = remedial action goal
UCL = upper confidence limit
WAC = *Washington Administrative Code*

CONCLUSION:

This calculation demonstrates that the 141-C waste site meets the requirements for hazard quotient and excess carcinogenic risk as identified in the RDR/RAWP (DOE-RL 2005).