Waste Site Reclassification Form

Date Submitted: 6/28/06 **Originator:** L. M. Dittmer **Phone:** 372-9664	**Operable Unit(s):** 100-FR-1 **Waste Site ID:** 100-F-43 **Type of Reclassification Action:** Rejected ☐ Closed Out ☐ Interim Closed Out ☒ No Action ☐	**Control Number:** 2006-046 **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 100-F-43 waste site is the portion of the former discharge spillway for the PNL Outfall formerly existing above the ordinary high water mark of the Columbia River. The spillway consisted of a concrete flume used to discharge waste effluents from the 100-F Experimental Animal Farm. Remedial actions at this site have been performed in accordance with remedial action objectives and goals established by the U.S. Environmental Protection Agency and the U.S. Department of Energy, Richland Operations Office, in concurrence with the Washington State Department of Ecology. The selected remedial action involved (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility in the 200 Area of the Hanford Site, and (3) backfilling the site with clean soil to adjacent grade elevations.

Basis for reclassification:

The 100-F-43 waste site has been remediated to meet the cleanup standards specified in the 1999 *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.* 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 116-F-16, PNL Outfall and the 100-F-43, PNL Outfall Spillway* (attached to Waste Site Reclassification Form Control Number 2006-039 for the 116-F-16 site).

D. C. Smith DOE-RL Project Manager	Signature	9/6/06 Date
NA Ecology Project Manager	Signature	Date
R. A. Lobos EPA Project Manager	Signature	9-14-06 Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 116-F-16, PNL OUTFALL AND THE 100-F-43, PNL OUTFALL SPILLWAY

Attachment to Waste Site Reclassification Form 2006-039 and 2006-046

PEK 12/2/08

June 2006

REMAINING SITES VERIFICATION PACKAGE FOR THE 116-F-16, PNL OUTFALL AND THE 100-F-43, PNL OUTFALL SPILLWAY

EXECUTIVE SUMMARY

This remaining sites verification package documents completion of remedial action for the 116-F-16 and 100-F-43 waste sites, the PNL Outfall Structure and its associated discharge spillway. The formatting of this document follows that used for cleanup verification packages for other radioactive liquid effluent waste sites rather than that used for remaining sites for consistency with the verification sampling approach.

These sites are located in the 100-FR-1 Operable Unit in the 100-F Area of the Hanford Site in southeastern Washington State. The sites were used to discharge effluent from the 100-F Area Experimental Animal Farm to the Columbia River.

Site excavation and waste disposal are complete, and the exposed surfaces have been sampled and analyzed to verify attainment of the remedial action goals. Results of the sampling, laboratory analyses, and data evaluations for the 116-F-16 and 100-F-43 sites indicate that all remedial action objectives for direct exposure, protection of groundwater, and protection of the Columbia River have been met (Table ES-1).

The sites meet cleanup standards and have been reclassified as interim closed out in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) and the Waste Site Reclassification Guideline TPA-MP-14 (RL-TPA-90-0001) (DOE-RL 1998).

Table ES-1. Summary of Cleanup Verification Results for the 116-F-16 and 100-F-43 Waste Sites. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?	Ref.
Direct Exposure – Radionuclides	1. Attain 15 mrem/yr dose rate above background over 1,000 years.	1. No radionuclide COCs were detected above background.	Yes	NA
Direct Exposure – Nonradionuclides	1. Attain individual COC RAGs.	1. The residual concentrations for hexavalent chromium and lead (the only nonradionuclide COCs) are below the direct exposure RAGs.	Yes	a
Nonradionuclide Risk Requirements	1. Attain hazard quotient of <1 for noncarcinogens.	1. Individual hazard quotients in each decision unit are less than 1.	Yes	a
	2. Attain cumulative hazard quotient of <1 for noncarcinogens.	2. Cumulative hazard quotients for each decision unit are less than 1.		
	3. Attain excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	3. Individual excess carcinogenic risk values for each decision unit are less than 1×10^{-6}.		
	4. Attain a total excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	4. Cumulative excess carcinogenic risk values for each decision unit are less than 1×10^{-5}.		

Table ES-1. Summary of Cleanup Verification Results for the 116-F-16 and 100-F-43 Waste Sites. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?	Ref.
Groundwater/River Protection – Radionuclides	1. Attain single-COC groundwater and river protection RAGs.	1. No radionuclide COCs were detected above background.	Yes	NA
	2. Attain National Primary Drinking Water Standards: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.	2. No radionuclide COCs were detected above background.		
	3. Meet drinking water standards for alpha emitters: the more stringent of the 15 pCi/L MCL or 1/25th of the derived concentration guide per DOE Order 5400.5.	3. No alpha-emitting radionuclide COCs were detected above background.	NA	
	4. Meet total uranium standard of 21.2 pCi/L.[b]	4. Uranium was not identified as a COC.	NA	NA
Groundwater/River Protection – Nonradionuclides	1. Attain individual nonradionuclide groundwater and river cleanup requirements.	1. Residual concentrations of hexavalent chromium and lead (the only nonradionuclide COCs) are below soil RAGs for protection of groundwater and the Columbia River.	Yes	a
Other supporting Information	1. Sample variance calculations (Appendix A)			c
	2. Sample location design (Appendix A)			d

[a] *116-F-16 Waste Site Cleanup Verification 95% UCL Calculations*, Calculation No. 0100F-CA-V0250, Rev. 0, Washington Closure Hanford, Richland, Washington (Appendix A).

[b] Uranium limits selected in 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* (EPA 1999) and *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b) were based on 1/25th of the derived concentration guidelines from DOE Order 5400.5. Since the time of Record of Decision signature, the U.S. Environmental Protection Agency has promulgated a more restrictive MCL of 30 µg/L for total uranium (65 *Federal Register* 76708). 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*, 0100X-CA-V0038 (BHI 2001a).

[c] *116-F-16 Outfall Structure Shallow Zone Variance Calculation*, Calculation No. 0100F-CA-V0255, Rev. 0, and *116-F-16 Outfall Structure Overburden Variance Calculation*, Calculation No. 0100F-CA-V0256, Rev. 0, Washington Closure Hanford, Richland, Washington.

[d] *116-F-16 Shallow Zone and Overburden Sampling Plan*, Calculation No. 0100F-CA-V0241, Rev. 0, Washington Closure Hanford, Richland, Washington.

COC = contaminant of concern
NA = not applicable
RAG = remedial action goal
MCL = maximum contaminant level (drinking water standard)
UCL = upper confidence limit

REMAINING SITES VERIFICATION PACKAGE FOR THE 116-F-16, PNL OUTFALL AND THE 100-F-43, PNL OUTFALL SPILLWAY

INTRODUCTION

This remaining sites verification package documents that the 116-F-16 and 100-F-43 waste sites were remediated in accordance with 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* (hereafter referred to as the Remaining Sites ROD) (EPA 1999). Remedial action objectives (RAOs) and remedial action goals (RAGs) for this site are documented in the Remaining Sites ROD (EPA 1999) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005b). The Remaining Sites ROD provides the U.S. Department of Energy, Richland Operations Office, the authority, guidance, and objectives to conduct this remedial action.

The remedy specified in the Remaining Sites ROD and conducted for the 116-F-16 waste site included (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility (ERDF) in the 200 Area of the Hanford Site, and (3) backfilling the site with clean soil to match adjacent grade elevation. The 100-F-43 waste site was administratively separated from the 116-F-16 waste site for future inclusion within the Remaining Sites ROD by agreement among the Tri-Parties (Hedel 2005). It was subsequently determined that sufficient evidence existed to warrant remedial action at the 100-F-43 waste site during remediation of the 116-F-16 waste site, and both waste sites were remediated and evaluated as a single unit.

Excavation was driven by RAOs for direct exposure, protection of groundwater, and protection of the Columbia River. For the respective points of compliance, RAGs summarized in Table 1 were established for the contaminants of concern (COCs) in the RDR/RAWP (DOE-RL 2005b). The waste site COCs presented in Table 1 were based on the list presented in the Remaining Sites ROD (EPA 1999), as expanded in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2005a) for the 116-F-16 waste site.

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 COCs; screening levels were not exceeded. 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 decisions for the 116-F-16 and 100-F-43 waste sites.

Table 1. 116-F-16 and 100-F-43 Remedial Action Goals.

COCs	Direct Exposure RAG	Groundwater Protection RAG (pCi/L)	Columbia River Protection RAG (pCi/L)
Cesium-137	15 mrem/yr (cumulative)[a]	4 mrem/yr (cumulative)[b]	4 mrem/yr (cumulative)[b]
Plutonium-239/240		1.2	1.2
Strontium-90		8[c,d]	8[c,d]
COC	**Direct Exposure RAG (mg/kg)**	**Soil RAG for Groundwater Protection (mg/kg)**	**Soil RAG for Columbia River Protection (mg/kg)**
Hexavalent chromium	2.1[e] 240[f]	4.8[g]	2[h]
Lead	353[i]	10.2[j]	10.2[j]

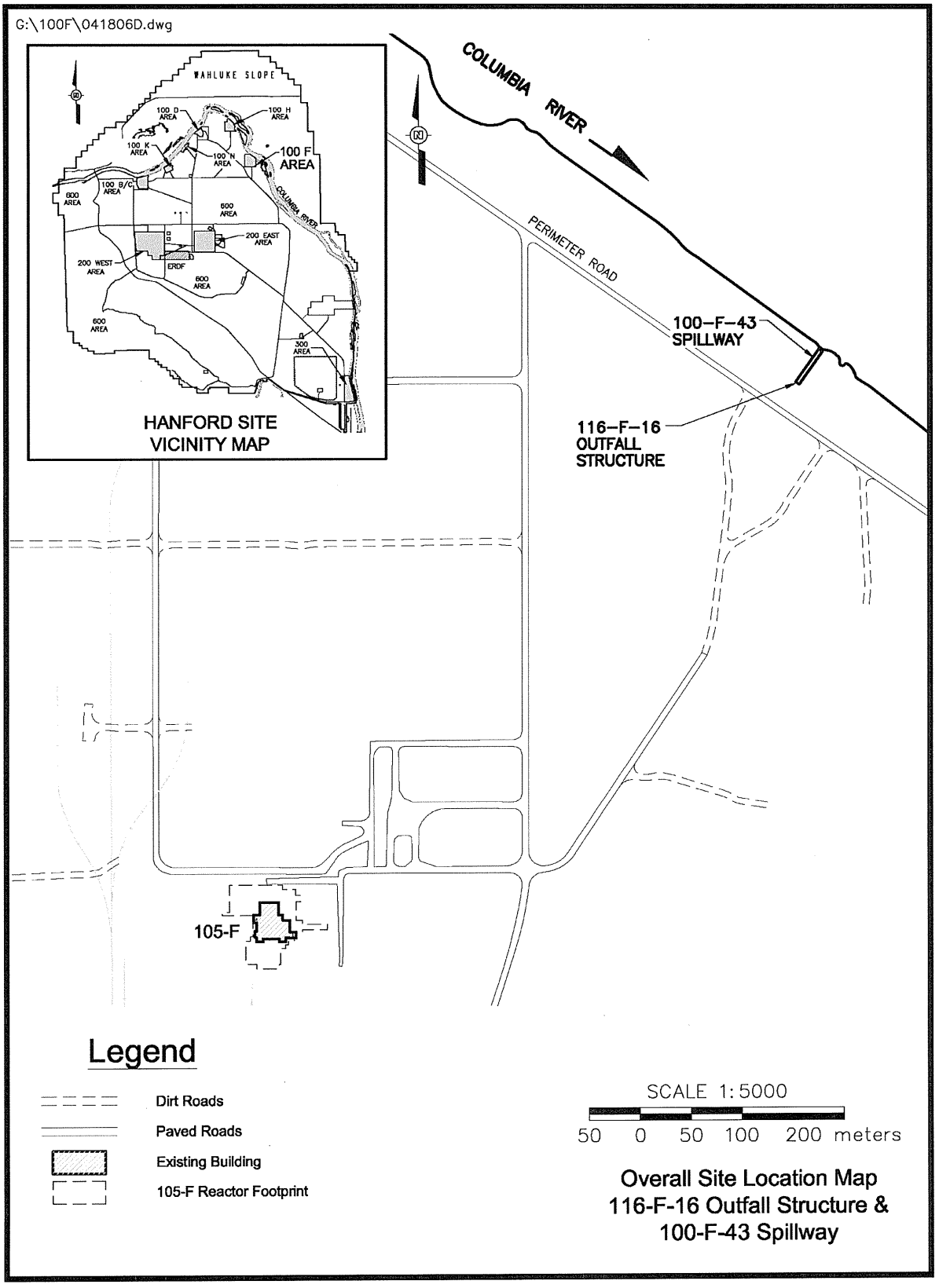
[a] Lookup values that correspond to the 15 mrem/yr dose rate based on a generic site model are presented in the RDR/RAWP (DOE-RL 2005b).
[b] Lookup values that correspond to the individual radionuclide 4 mrem/yr dose rate equivalent for beta- and gamma-emitter RAGs per National Drinking Water Standards are presented in the RDR/RAWP (DOE-RL 2005b). Non-uranium alpha emitters must meet drinking water standards for alpha emitters based on the more stringent of the 15 pCi/L MCL or 1/25th of the derived concentration guide per DOE Order 5400.5.
[c] Strontium-90 also contributes to the 4 mrem/yr (cumulative) dose rate for groundwater and river protection.
[d] Promulgated groundwater protection standard (40 CFR 141).
[e] WAC 173-340-750(3) Method B carcinogenic cleanup limit based on the inhalation exposure pathway, per *Calculation of Hexavalent Chromium Carcinogenic Risk* (BHI 2000).
[f] WAC 173-340-740(3) Method B noncarcinogenic cleanup limit.
[g] Calculated soil RAG per WAC 173-340-720(3), 1996 (Method B for groundwater) and WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 times rule") is lower than that presented in the RDR/RAWP (DOE-RL 2005b), based on the updated oral reference dose value (as provided in IRIS).
[h] Soil RAG based on 100 times dilution attenuation factor times the most restrictive surface water quality standard as presented in the RDR/RAWP (DOE-RL 2005b).
[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] Where cleanup levels are less than background, cleanup levels default to background (WAC 173-340-700[4][d]) (1996).

CFR = *Code of Federal Regulations*
COC = contaminant of concern
IRIS = Integrated Risk Information System
MCL = maximum contaminant level (drinking water standard)
RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
WAC = *Washington Administrative Code*

SITE DESCRIPTION AND SUPPORTING INFORMATION

The 116-F-16 waste site is part of the 100-FR-1 Operable Unit in the 100-F Area. The site consists of the former outfall for the Experimental Animal Farm process sewer (100-F-29 waste site). The outfall was a direct discharge to a 4.6-m (15-ft)-wide concrete spillway with 0.46-m (1.5-ft)-tall sidewalls extending into the Columbia River. No other effluent discharge mechanisms were associated with the 116-F-16 outfall. The 100-F-43 waste site encompasses the portion of the discharge spillway and associated contaminated soils above the Columbia River ordinary high water mark. The sites are located approximately 700 m (2,300 ft) northeast of the 105-F Reactor Building, adjacent to the Columbia River (Figure 1).

Figure 1. Hanford Site Map and Location of the 116-F-16 and 100-F-43 Waste Sites.



The outfall structure and spillway were designed to channel animal sewage and process waste discharges from the Experimental Animal Farm to the Columbia River. The influent line consisted of a 1.8-m (72-in.) reinforced concrete pipeline, removed in 2001 as part of previous remedial activities (BHI 2001b). Cooling water effluent from the 116-F-4 (107-F) Retention Basin, typically discharged to the 116-F-8 (1904-F) Outfall Structure could also theoretically be diverted to the 116-F-16 outfall via a junction box, though there is no known history of such usage (DeFord 1993). The upper portion of the spillway flume was demolished in-place and covered with clean soil, presumably in 1979, at the time of demolition of the adjacent 116-F-8 (1904-F) Outfall Structure (WHC 1991).

EXCAVATION AND DISPOSAL

Remedial action activities at the 116-F-16 and 100-F-43 waste sites were conducted from August 31, 2004, to September 8, 2005. Remediation involved excavation and staging of clean overburden material and removal of the outfall, the concrete spillway structure above the ordinary high water mark, and contaminated soil to the extent required to satisfy the RAOs and corresponding RAGs. Contaminated materials were disposed at the ERDF.

Pre- and post-remediation topographic maps are shown in Figures 2 and 3, respectively. Approximately 384 m^2 (4,130 ft^2) of plan area was excavated, with all remedial activities restricted to the shallow zone (less than 4.6 m [15 ft] below ground surface). Approximately 2,090 metric tons (2,300 U.S. tons) of material from the site was removed and disposed at the ERDF.

FIELD SCREENING AND VARIANCE SAMPLING

Radiological field screening was conducted during the site remedial actions as specified in the SAP (DOE-RL 2005a). Field screening was used to guide the excavation to quickly assess the presence and level of contamination. Field screening at the site included using a radiological data mapping system survey, hand-held sodium iodide (NaI) detectors, and gamma energy analyses of grab samples. The radiological mapping survey was performed overthe site excavation surface area (Figure 4); no significant areas of elevated radiological activity were observed. The hand-held NaI detectors were used to screen excavated waste material and to screen the excavation wall and floor for potential hot spots. Gamma energy analyses were used to support waste characterization and to corroborate the radiological mapping survey and hand-held NaI detector data.

Variance sampling was performed following an initial determination that remedial action objectives had been achieved. Variance sampling was performed at the overburden and shallow zone decision units on January 31 and February 2, 2006, respectively, with 24 variance samples collected from each decision unit to support variance analysis. The variance analysis quantifies the variability of residual contamination (see calculation briefs in Appendix A). This information was used to determine the site-specific number of final cleanup verification samples to be collected. The results of the variance analyses indicated that the number of verification samples to be taken for each shallow zone and overburden decision subunit were less than the

Figure 2. Pre-Remediation Topographic Plan for the 116-F-16 and 100-F-43 Waste Sites.

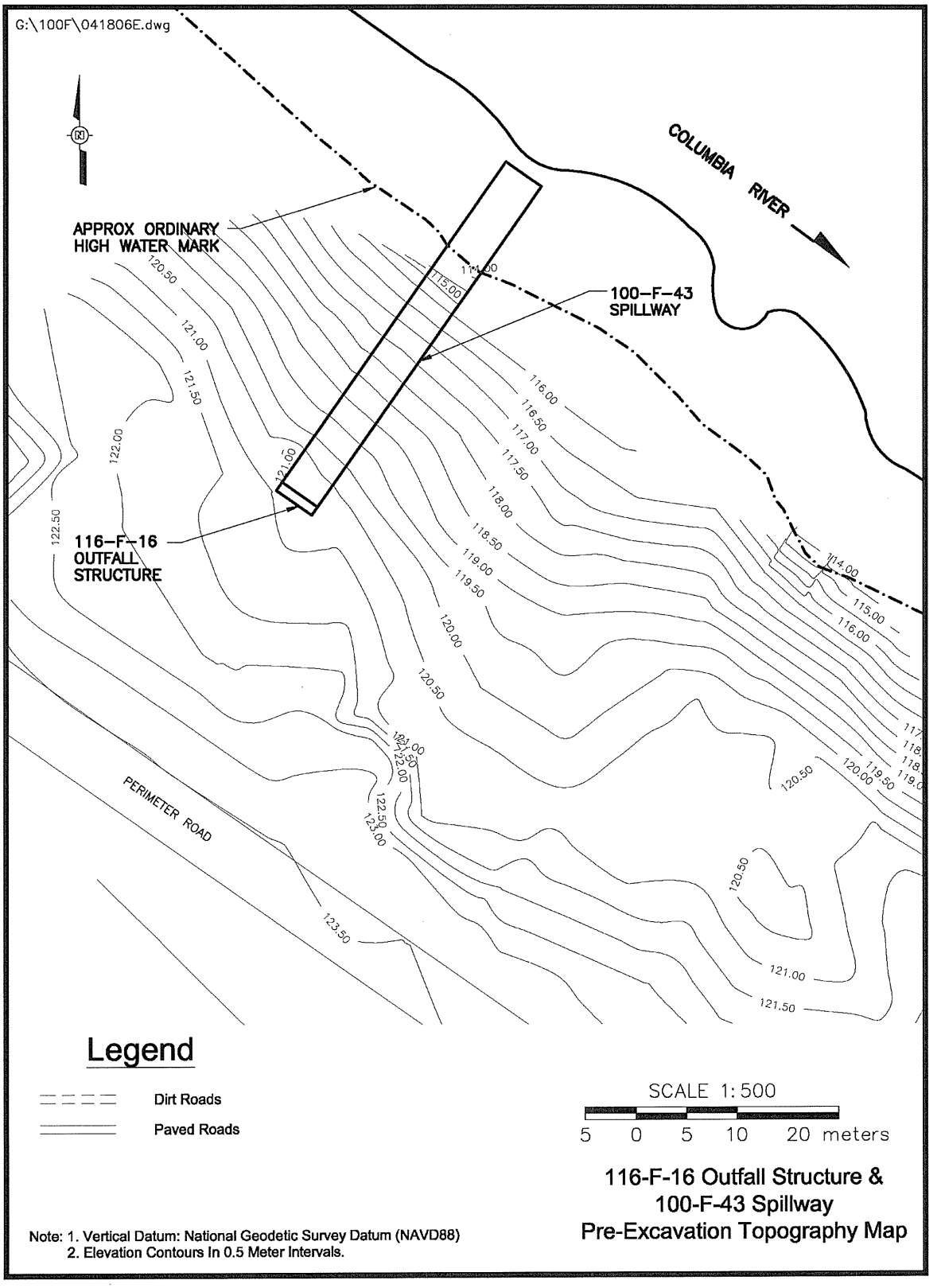


Figure 3. Post-Remediation Topographic Plan for the 116-F-16 and 100-F-43 Waste Sites.

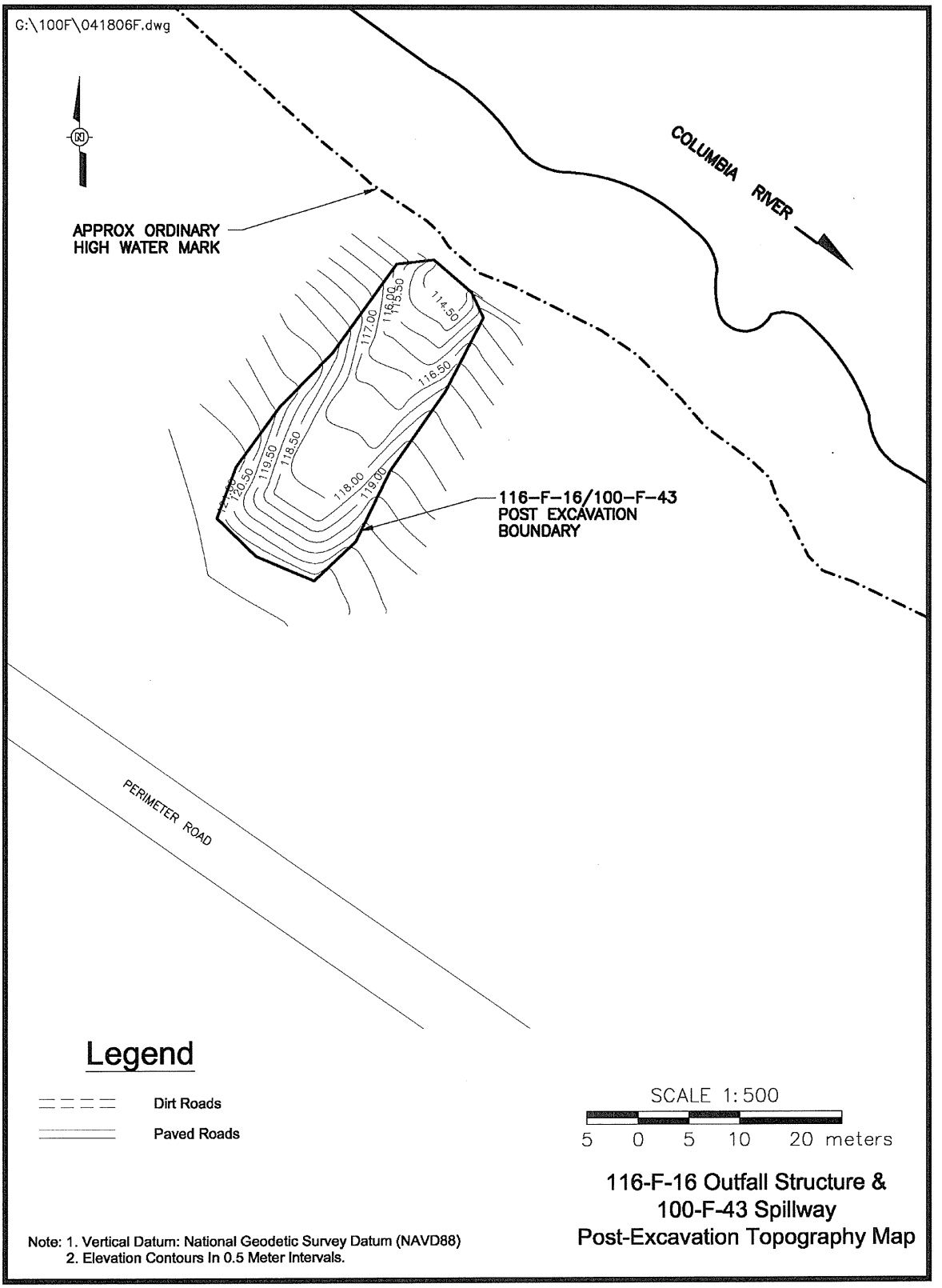
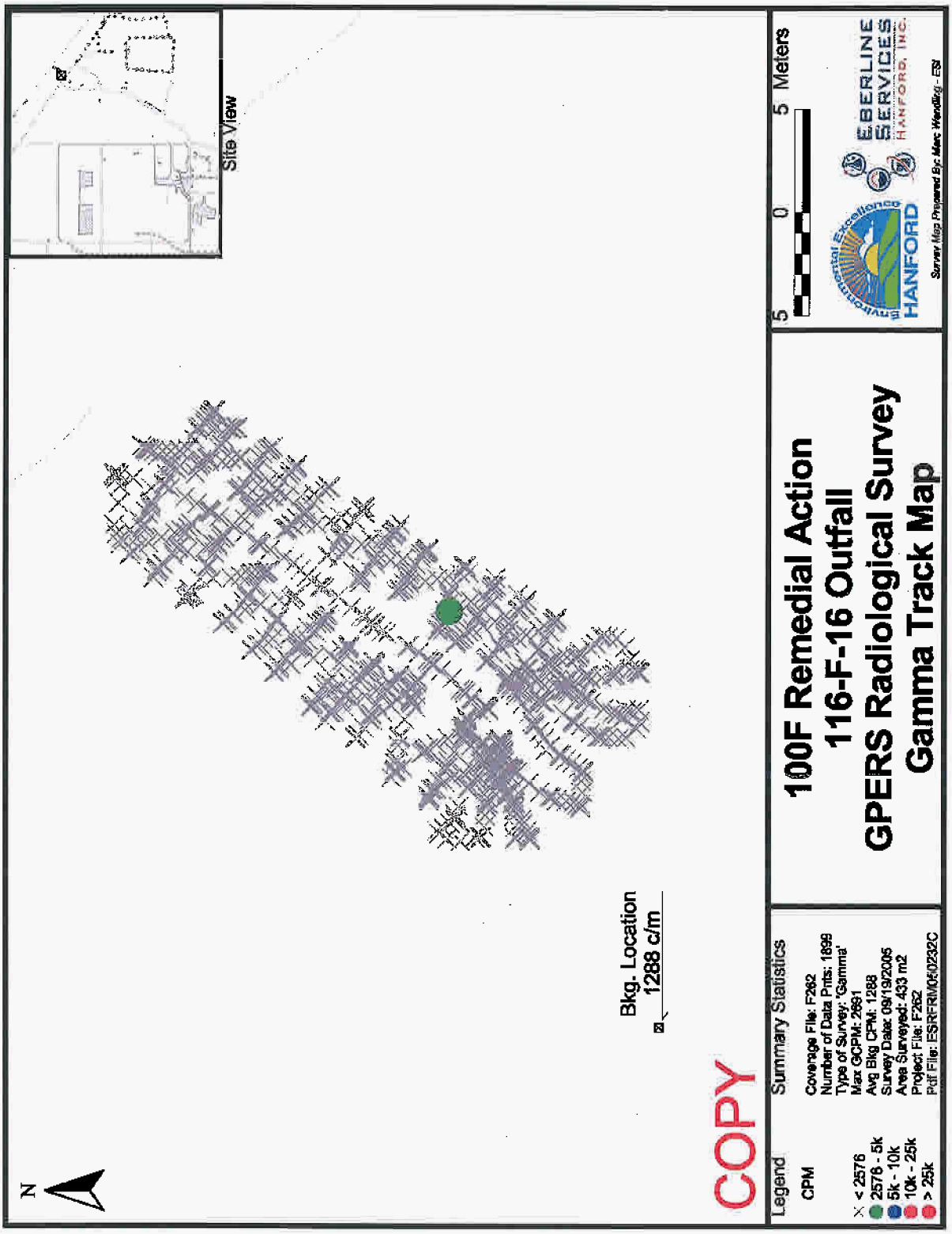


Figure 4. Radiological Mapping Survey Results for the 116-F-16 and 100-F-43 Sites.



default number of four specified in the SAP (DOE-RL 2005a); therefore, four final verification samples were collected from each of the decision subunits.

CLEANUP VERIFICATION SAMPLING AND ANALYSIS

Final cleanup verification sampling was conducted on February 13 and 15, 2006 (WCH 2006a, 2006b), following variance analyses. The final verification samples were submitted to offsite laboratories for analysis using approved U.S. Environmental Protection Agency analytical methods as required per the SAP (DOE-RL 2005a). Each verification sample was composed of a composite sample formed by combining soil collected at the required number of randomly selected locations within each sampling area (excluding the quality assurance/quality control samples).

Due to their immediate proximity and historic functional relationship, the 116-F-16 and 100-F-43 waste sites were combined into one unit for the purposes of decision unit stratification. The combined site included shallow zone and overburden decision units. The shallow zone decision unit contained one decision subunit, divided into four sampling areas. The overburden decision unit for the site contained one subunit, divided into four sampling areas. All sampling areas were further divided into 16 sampling nodes each as shown in the sample design methodology and sample location figures presented in the calculation briefs in Appendix A.

CLEANUP VERIFICATION DATA EVALUATION

This section presents the evaluation of the 116-F-16/100-F-43 cleanup verification data for comparison with the data quality criteria and RAGs.

Data Quality Assessment Process

A data quality assessment (DQA) is performed to compare the verification sampling approach and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications.

The DQA for the 116-F-16 and 100-F-43 waste sites determined that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. All analytical data were found to be acceptable for decision-making purposes. The evaluation also verified that the sample design was sufficient to support clean site verification. The cleanup verification sample analytical data are stored in the Environmental Restoration project-specific database prior to archiving in the Hanford Environmental Information System and are included within the 95% upper confidence limit (UCL) calculation brief in Appendix A. The detailed DQA is presented in Appendix B.

Contaminants of Concern 95% Upper Confidence Limit

The primary statistical calculation to support cleanup verification is the 95% UCL on the arithmetic mean of the data. The 95% UCL values for each COC are computed for each decision unit (i.e., shallow zone and overburden). Prior to calculating the 95% UCL, the individual sample results are reviewed and, as appropriate, adjusted per the SAP (DOE-RL 2005a). This process is summarized below.

For radionuclides, the laboratory-reported value is used in the calculation of the 95% UCL. In cases where the laboratory does not report a value for data qualified with a "U" (i.e., less than the detection limit), one-half of the minimum detectable activity is used in the calculation of the 95% UCL. For nonradionuclides, a value equal to one-half the practical quantitation limit is used for data flagged with a "U" (i.e., less than the detection limit) in the calculation of the 95% UCL, as required by *Washington Administrative Code* (WAC) 173-340-740[7][g].

Table 2. 116-F-16 and 100-F-43 Cleanup Verification Data Set.

COCs	95% UCL Statistical Values[a] (pCi/g)		Hanford Site Background[b] (pCi/g)	Cleanup Verification Data Set[c] (pCi/g)	
	Shallow Zone	Overburden		Shallow Zone	Overburden
Cesium-137	0.062 (ND)	0.031 (ND)	1.1	0.062 (ND)	0 (<BG) (ND)
Plutonium-239/240	0.043 (ND)	0.054 (ND)	0.025	0.043 (ND)	0.029 (ND)
Strontium-90	0.003 (ND)	0.068	0.18	0.003 (ND)	0 (<BG) (ND)
COCs	**95% UCL Statistical Values[a] (mg/kg)**		**Hanford Site Background (mg/kg)**	**Cleanup Verification Data Set[c] (mg/kg)**	
	Shallow Zone	**Overburden**		**Shallow Zone**	**Overburden**
Hexavalent chromium	0.39	0.23	NA	0.39	0.23
Lead	4.7	3.1	10.2	4.7 (<BG)	3.1 (<BG)

[a] Laboratory data, including the minimum detectable activities for the individual cleanup verification samples, are included in the 95% UCL calculation brief in Appendix A.
[b] Represents the 90th percentile of the lognormal distribution (DOE-RL 1996).
[c] For overburden, anthropogenic background (DOE-RL 1996) and naturally occurring background is subtracted from all radionuclides. For other decision units (i.e., shallow zone and deep zone), only naturally occurring background (uranium) is subtracted. Background is not subtracted for nonradionuclides, but considered in direct evaluation. Refer to the 95% UCL calculation brief in Appendix A for additional details on determination of statistical values.
BG = background
COC = contaminant of concern
NA = not applicable
ND = not detected (in all samples in the data set)
UCL = upper confidence limit

Statistical calculations for verification data sets are presented in the 95% UCL calculation briefs (Appendix A), with results shown in Table 2. The columns on the left side of Table 2 are the COCs and the 95% UCL values before subtraction of background. The fourth column of Table 2 presents the background, where values exist, and the last two columns present the statistical

values adjusted for background, if appropriate, which becomes the cleanup verification data set used for further evaluation and modeling.

Cleanup Verification Model

Because the statistical values summarized in Table 2 were significantly below generic dose-equivalence lookup values, a site-specific cleanup verification model was not developed for the 116-F-16/100-F-43 waste site combined unit. Evaluation of RAG attainment for radionuclides was performed using the generic dose-equivalence lookup values. The model used to develop these dose-equivalence lookup values is presented in the RDR/RAWP (DOE-RL 2005b).

EVALUATION OF REMEDIAL ACTION GOAL ATTAINMENT

Evaluations in the following sections demonstrate that remedial action at the 116-F-16 and 100-F-43 waste sites has achieved the applicable RAGs. They address attainment of direct exposure RAGs, and groundwater and Columbia River protection RAGs. The third section documents application of the WAC 173-340-740(7)(e) three-part test, which is required for nonradionuclide COCs only.

DIRECT EXPOSURE SOIL REMEDIAL ACTION GOALS ATTAINED

Radionuclides

No radionuclide COCs were detected above background in the cleanup verification data set. Table 3 compares the statistically quantified shallow zone (including overburden) radionuclide cleanup verification values presented in Table 2 to direct exposure single radionuclide 15 mrem/yr dose-equivalence values and shows the sum of fractions evaluations. The columns on the left side of Table 3 are the COCs and the 95% UCL values, corrected for background, as appropriate. The fourth column of Table 3 presents the single radionuclide 15 mrem/yr dose-equivalence activity, and the last two columns present the statistical values divided by the dose-equivalence activity. As demonstrated by the summation of these fractions, the cumulative dose contributed by residual radionuclide populations will be significantly less than the 15 mrem/yr direct exposure RAG.

Nonradionuclides

Direct Comparison to RAGs. Table 4 compares the shallow zone and overburden nonradionuclide cleanup verification statistical values presented in Table 2 to the direct exposure RAGs presented in Table 1. Residual concentrations of hexavalent chromium and lead are less than the direct exposure RAGs.

Table 3. Attainment of Radionuclide Direct Exposure RAG.

COCs	95% UCL Statistical Values (pCi/g)		Activity Equivalent to 15 mrem/yr Dose[a] (pCi/g)	Fraction	
	Shallow Zone	Overburden		Shallow Zone	Overburden
Cesium-137	0.062 (ND)	0 (<BG) (ND)	6.2	0.010	0
Plutonium-239/240	0.043 (ND)	0.029 (ND)	33.9	0.001	0.0009
Strontium-90	0.003 (ND)	0 (<BG) (ND)	4.5	0.001	0
			Sum of Fractions	0.012	0.0009
			Equivalent Dose (mrem/yr)	<0.18	<0.014

[a] Single radionuclide 15 mrem/yr dose-equivalence values and derivation methodology are presented in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b).
BG = background
COC = contaminant of concern
ND = not detected (in all samples in the data set)
UCL = upper confidence limit

Table 4. Attainment of Nonradionuclide Direct Exposure RAGs.

COC	Direct Exposure RAG (mg/kg)	Cleanup Verification Data Set (mg/kg)	Direct Exposure RAG Attained?[a]
Shallow Zone			
Hexavalent chromium	2.1[b] 240[c]	0.39	Yes
Lead	353[d]	4.7 (<BG)	Yes
Overburden			
Hexavalent chromium	2.1[b] 240[c]	0.23	Yes
Lead	353[d]	3.1 (<BG)	Yes

[a] Criterion is comparison to direct exposure RAG.
[b] WAC 173-340-750(3) Method B carcinogenic cleanup limit based on the inhalation exposure pathway, per *Calculation of Hexavalent Chromium Carcinogenic Risk* (BHI 2000).
[c] WAC 173-340-740(3) Method B noncarcinogenic cleanup limit.
[d] 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).
BG = background
COC = contaminant of concern
RAG = remedial action goal
WAC = *Washington Administrative Code*

Noncarcinogenic Hazard Quotient RAG Attained. For noncarcinogenic COCs, WAC 173-340-740(5)(a) and (b) specify the evaluation of the hazard quotient, which is given as daily intake divided by a reference dose (DOE-RL 2005b). This evaluation is shown in the 95% UCL calculation brief (Appendix A). Hazard quotients were not calculated for lead, as concentrations of this COC was not quantified above background levels. The calculated hazard quotients for statistical residual hexavalent chromium concentrations in the shallow zone and

overburden decision units are 1.6×10^{-3} and 9.6×10^{-4}, respectively. These values are below the individual and cumulative RAGs (a hazard quotient of <1.0 in both cases).

Carcinogenic Risk RAG Attained. For individual nonradionuclide carcinogenic COCs, the WAC 173-340-700(3) Method B cleanup limits are based on an individual excess cancer risk of 1×10^{-6}. The cumulative excess cancer risk for all nonradionuclide carcinogenic COCs must be less than 1×10^{-5}. The only carcinogenic nonradionuclide COC at the 116-F-16 site, hexavalent chromium, is a carcinogen in the inhalation exposure pathway (lead is not a carcinogen). The excess lifetime cancer risk estimate for residual concentrations of this COC in the shallow zone and overburden decision units are 1.8×10^{-7} and 1.1×10^{-7}, respectively (Appendix A). These values are below the risk limit for individual COCs (1×10^{-6}) and the cumulative excess carcinogenic risk RAG of 1×10^{-5}.

GROUNDWATER AND RIVER PROTECTION REMEDIAL ACTION GOALS ATTAINED

Radionuclides

No radionuclide COCs were detected above background in verification samples. Therefore, the groundwater and river protection RAGs have been attained.

Nonradionuclides

Table 5 compares the nonradionuclide cleanup verification statistical values presented in Table 2 to the soil RAGs for groundwater and river protection presented in Table 1. Residual concentrations of hexavalent chromium and lead are less than the respective soil RAGs for groundwater and river protection.

Table 5. Attainment of Nonradionuclide Groundwater and River Protection RAGs. (2 Pages)

COC	Cleanup Verification Data Set (mg/kg)	Soil RAG for Groundwater Protection (mg/kg)	Soil RAG for River Protection (mg/kg)	Cleanup Criteria Attained?[a]
Shallow Zone				
Hexavalent chromium	0.39	4.8[b]	2[c]	Yes
Lead	4.7 (<BG)	10.2[d]	10.2[d]	Yes

Table 5. Attainment of Nonradionuclide Groundwater and River Protection RAGs. (2 Pages)

COC	Cleanup Verification Data Set (mg/kg)	Soil RAG for Groundwater Protection (mg/kg)	Soil RAG for River Protection (mg/kg)	Cleanup Criteria Attained?[a]
Overburden				
Hexavalent chromium	0.23	4.8[b]	2[c]	Yes
Lead	3.1 (<BG)	10.2[d]	10.2[d]	Yes

[a] Criterion is comparison to soil RAG for groundwater protection.
[b] Calculated soil RAG per WAC 173-340-720(3), 1996 (Method B for groundwater) and WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 times rule") is lower than that presented in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b), based on the updated oral reference dose value (as provided in IRIS).
[c] Soil RAG based on 100 times dilution attenuation factor times the most restrictive surface water quality standard as presented in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b).
[d] Where cleanup levels are less than background, cleanup levels default to background (WAC 173-340-700[4][d]) (1996).
COC = contaminant of concern
IRIS = Integrated Risk Information System
RAG = remedial action goal

WAC 173-340 THREE-PART TEST FOR NONRADIONUCLIDES

The WAC 173-340-740(7)(e) three-part test is required for nonradionuclide statistical verification data sets. The three-part test consists of the following criteria: (1) the cleanup verification statistical value must be less than the most restrictive cleanup level, (2) no single detection within the data set can exceed two times the most restrictive cleanup criteria, and (3) the percentage of samples in the data set exceeding the most restrictive cleanup criteria must be less than 10%.

Table 6 summarizes the results of the WAC 173-340-740[7][e] three-part test for the cleanup verification nonradionuclide data sets in comparison to the most restrictive applicable RAG. The table lists the most restrictive RAG (from Table 1), the statistical value, the maximum detected value, the total number of samples collected, and the percentage of samples exceeding the RAG. The final column of the table describes the result of applying the three criteria using the values listed in the preceding columns. As demonstrated in Table 6, residual concentrations of hexavalent chromium and lead in all decision units at the 116-F-16/100-F-43 waste site combined unit pass the three-part test in comparison to the most restrictive applicable RAG.

Table 6. Application of the WAC 173-340 Three-Part Test.

COC	Most Restrictive Applicable RAG[a]	Statistical Cleanup Verification Value (mg/kg)[b]	Maximum Detected Cleanup Verification Value (mg/kg)[c]	Total Number of Samples[d]	Percentage of Cleanup Verification Data Set Exceeding RAG[e]	Cleanup Criteria Attained?
Shallow Zone						
Hexavalent chromium	2[f]	0.39	0.42	5	0	Yes
Lead	10.2[g]	4.7	5.3	5	0	Yes
Overburden						
Hexavalent chromium	2[f]	0.23	0.23	5	0	Yes
Lead	10.2[g]	3.1	3.2	5	0	Yes

[a] From Table 1, the most restrictive RAG for hexavalent chromium is the soil RAG for protection of the Columbia River and the most restrictive RAG for lead is background.
[b] Criterion is statistical value cannot exceed most restrictive applicable RAG.
[c] Criterion is no single detection can exceed two times the most restrictive applicable RAG.
[d] Total number of samples in the decision unit includes field duplicate samples, which are included in the evaluation as separate samples.
[e] Criterion is percentage of data set exceeding the most restrictive applicable RAG cannot exceed 10%.
[f] Soil RAG based on 100 times dilution attenuation factor times the most restrictive surface water quality standard as presented in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b).
[g] 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).
COC = contaminant of concern
RAG = remedial action goal
WAC = *Washington Administrative Code*

STATEMENT OF PROTECTIVENESS

This remaining sites verification package demonstrates that remedial action at the 116-F-16 and 100-F-43 waste sites has achieved the RAOs and corresponding RAGs established in the Remaining Sites ROD (EPA 1999) and the RDR/RAWP (DOE-RL 2005b). The contaminated materials from this site have been excavated and disposed at the ERDF. The remaining soils at the site have been sampled, analyzed, and evaluated, and the results do not preclude any future uses (as bounded by the rural-residential scenario), allow unrestricted use of shallow zone soils, and pose no threat to groundwater or the Columbia River. The site has no deep zone; therefore, no deep zone institutional controls are required.

REFERENCES

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, as amended.

65 FR 76708, 2000, "National Primary Drinking Water Regulations; Radionuclides; Final Rule," *Federal Register*, Vol. 65, No. 236, p. 76708 (December 7).

BHI, 2000, *Calculation of Hexavalent Chromium Carcinogenic Risk*, 0100X-CA-V0031, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2001a, *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater*, 0100X-CA-V0038, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2001b, *Cleanup Verification Package for the 100-F-19:1 North Pipelines, 100-F-19:3 West Pipelines, 100-F-34 Biology Facility French Drain, and 116-F-12 French Drain*, CVP-2001-00002, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

DeFord, D. H., 1993, *100-F Reactor Site Technical Baseline Report Including Operable Units 100-FR-1 and 100-FR-2*, WHC-SD-EN-TI-169, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, Washington, D.C.

DOE-RL, 1996, *Hanford Site Background: Part 2, Soil Background for Radionuclides*, DOE/RL-96-12, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1998, *Tri-Party Agreement Handbook Management Procedures,* RL-TPA-90-0001, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)," U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2005a, *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order,* 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

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

EPA, 1999, *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*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

Hedel, C. W., 2005, *Path Forward for Final Disposition of 100 Area River Effluent Pipelines*, Meeting Minutes, CCN 112483, Bechtel Hanford, Inc., Richland, Washington.

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

WCH, 2006a, *100-F Area RAWD Sampling*, Logbook EFL-1174, Washington Closure Hanford, Richland, Washington.

WCH, 2006b, *100-F Area RAWD Sampling*, Logbook EFL-1174-1, Washington Closure Hanford, Richland, Washington.

WHC, 1991, *Summary of the Hanford Site Decontamination, Decommissioning, and Cleanup FY 1974 Through FY 1990*, WHC-EP-0478, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

CALCULATION BRIEFS

DISCLAIMER FOR CALCULATIONS

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

CALCULATION BRIEFS

The following calculation briefs have been prepared in accordance with ENG-1, *Engineering Services*, ENG-1-4.5, "Project Calculations," Washington Closure Hanford, Richland, Washington.

116-F-16 Shallow Zone and Overburden Sampling Plan, Calculation No. 0100F-CA-V0241, Rev. 0, Washington Closure Hanford, Richland, Washington.

116-F-16 Outfall Structure Shallow Zone Variance Calculation, Calculation No. 0100F-CA-V0255, Rev. 0, Washington Closure Hanford, Richland, Washington.

116-F-16 Outfall Structure Overburden Variance Calculation, Calculation No. 0100F-CA-V0256, Rev. 0, Washington Closure Hanford, Richland, Washington.

116-F-16 Waste Site Cleanup Verification 95% UCL Calculations, Calculation No. 0100F-CA-V0250, Rev. 0, Washington Closure Hanford, Richland, Washington.

NOTE: The calculation briefs referenced in this appendix are kept in the active Washington Closure Hanford project files and are available upon request. When the project is completed, the files will be stored in a U.S. Department of Energy, Richland Operations Office repository.

CALCULATION COVER SHEET

Project Title:	**116-F-16 Outfall Structure Sample Design**	**Job No.**	**14655**
Area	**100-F**		
Discipline	**Environmental Engineering**	**Calc. No.**	**0100F-CA-V0241**
Subject	**116-F-16 Shallow Zone and Overburden Sampling Plan**		
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 conjuction with other relevent documents in the administrative record.

Committed Calculation ☒ **Preliminary** ☐ **Superseded** ☐ **Voided** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sht Calc = 2 Shts Attach1 = 1 Sht Attach2 = 1 Sht Attach3 = 2 Shts Total = 7 Shts	G. Cruz 02/06/06	C.A. Bentz 2/6/06	R.T. Coffman 2/9/06	S.W. Callison 2-9-06	2-9-06

SUMMARY OF REVISIONS

*Obtain Calc. No. from DIS

DE01437.03 (12/09/2004)

Washington Closure Hanford

CALCULATION SHEET

Originator G. Cruz Date 2/1/2006 Calc. No. 0100F-CA-V0241 Rev. No. 0

Project 116-F-16 Outfall Structure Sample Design Job No. 14655 Checked GB Date 2/6/06

Subject 116-F-16 Shallow Zone and Overburden Sampling Plan Sheet No. 1 of 2

1	**Problem:**	Calculate and display required sampling nodes in concurrence with 100 Area		
2		SAP DOE/RL-96-22 Rev. 3 for verification and closure.		
3				
4	**Given:**	-SAP (DOE/RL-96-22 Rev. 3) and IG (0100X-IG-G0001 Rev. 5) requirements		
5		-Shallow Zone Sampling Area (Surface area of each zone determined from CAD program,		
6		Attachment 3, Sht 1 of 2, CAD file 1F:020106D, 116-F-16 Outfall Structure Shallow Zone Sampling Plan)		
7		-Overburden Sampling Area (Surface area of each zone determined from CAD program,		
8		Attachment 3, Sht 2 of 2, CAD file 1F:020106E, 116-F-16 Outfall Structure Overburden Sampling Plan)		
9				
10				
11				
12				
13				
14				
15	**SAP and IG Requirements:**			
16		-Develop a 16 node sampling grid for the sampling area		
17	Shallow Zone	-Use appendix A of the IG to determine which six of the sixteen will be sampled		
18		to collect variance and clean up verification samples		
19				
20		-Develop a 16 node sampling grid for the sampling area		
21	Overburden:	-Use appendix A of the IG to determine which six of the sixteen will be sampled		
22		to collect variance and clean up verification samples		
23				
24		-Develop a 16 node sampling grid for the sampling area		
25	Deep Zone:	-Use appendix A of the IG to determine which four of the sixteen will be sampled		
26		to collect variance/verification samples		
27				
28	**Determination of Shallow Zone Sampling Grid:**			
29				
30	Shallow Zone Sampling Grid Area determined from Table 5-1, IG			
31	Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)			
32				
33	Total Area:		384.29	m^2
34	Area of Decision Subunits (total area 1 subunit)		384.29	m^2
35				
36	Decision Subunit divided into 4 Sampling Areas:		96.07	m^2
37				
38	Sampling Areas divided into a 16 node grid (node numbers 1-16):		6.00	m^2
39				
40	Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)			
41		See Attachment 3, Sht 1 of 2, 116-F-16 Outfall Structure Shallow Zone Sampling Plan,		
42		for Sample Location Table		
43				
44				
45				
46				

Washington Closure Hanford

CALCULATION SHEET

Originator G. Cruz **Date** 2/1/2006 **Calc. No.** 0100F-CA-V0241 **Rev. No.** 0

Project 116-F-16 Outfall Structure Sample Design **Job No.** 14655 **Checked** GB **Date** 2/6/06

Subject 116-F-16 Shallow Zone and Overburden Sampling Plan **Sheet No.** 2 of 2

Determination of Overburden Sampling Grid:

Overburden Sampling Grid Area determined from Table 5-1, IG
Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)

Total Area:	252.02	m^2
Area of Decision Subunits (total area 1 subunit)	252.02	m^2
Decision Subunits divided into 4 Sampling Areas:	63.00	m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):	3.93	m^2

Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)

See Attachment 3, Sht 2 of 2, 116-F-16 Outfall Structure Overburden Sampling Plan, for Sample Location Table

Washington Closure Hanford

Originator G. Cruz Date 2/1/2006 Calc. No. 0100F-CA-V0241 Rev. No. 0

Project 116-F-16 Outfall Structure Sample Design Job No. 14655 Checked AB Date 2/6/06

Subject 116-F-16 Shallow Zone and Overburden Sampling Plan Sheet No 1 of 1

ATTACHMENT 1

Sample Grid Point Lookup Table.

Default Plan	Sampling Area 1	Sampling Area 2	Sampling Area 3	Sampling Area 4	Sampling Area 5	Sampling Area 6	Sampling Area 7	Sampling Area 8	Sampling Area 9	Sampling Area 10
Variance/Verification	3	6	1	4	5	1	3	3	4	16
Variance/Verification	4	7	11	3	15	15	5	13	10	10
Variance/Verification	16	3	2	7	7	10	11	4	3	14
Variance/Verification	10	15	4	12	1	13	4	8	16	4
Variance	2	14	5	9	13	12	8	2	14	8
Variance	13	10	9	13	2	16	1	12	5	3
Not Sampling	6	1	10	8	14	4	16	5	8	6
Not Sampling	1	9	13	1	10	5	12	1	1	15
Not Sampling	9	12	7	5	6	2	6	7	15	9
Not Sampling	15	16	15	14	16	6	2	15	11	1
Not Sampling	8	13	8	10	12	11	13	14	2	12
Not Sampling	5	2	3	11	4	3	9	10	7	11
Not Sampling	7	11	14	15	11	14	14	6	13	2
Not Sampling	11	4	6	2	9	7	7	11	9	7
Not Sampling	12	8	16	16	3	8	15	9	6	13
Not Sampling	14	5	12	6	8	9	10	16	12	5

** **Note:** Grid nodes for each sampling area in each waste site should be numbered consistently, e.g., begin numbering the nodes in the northwestern-most node, then number consecutively left to right.

Washington Closure Hanford

Originator G. Cruz Date 2/1/2006 Calc. No. 0100F-CA-V0241 Rev. No. 0

Project 116-F-16 Outfall Structure Sample Design Job No. 14655 Checked CAB Date 2/6/06

Subject 116-F-16 Shallow Zone and Overburden Sampling Plan Sheet No. 1 of 1

ATTACHMENT 2

Number of Decision Subunits Based on Area.

Area of Primary Decision Unit (m2)	Number of Subunits
<1,394	1
>1,394 to <2,326	2
>2,326 to <3,256	3
>3,256 to <4,186	4
>4,186 to <9,303	2
>9,303 to <13,024	3
>13,024 to <16,745	4
>16,745 to <20,466	5
>20,466	ROUNDa (Area/3,720)

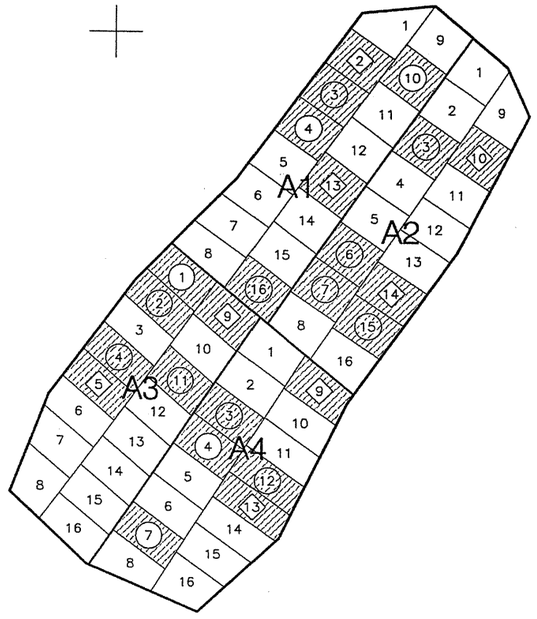
a ROUND is an integer rounding function.

1F:020106D

E 580950

N 148150

COLUMBIA RIVER



SCALE 1:250

2.5 0 2.5 5 10 meters

NOTES

1. SHALLOW ZONE NODE AREAS ARE APPROXIMATELY 6.00 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE SHALLOW ZONE CONSISTS OF SAMPLING AREAS A1, A2, A3, AND A4 WITHIN DECISION SUBUNIT 1.

LEGEND

(8) VARIANCE AND VERIFICATION SAMPLING NODE

(8) VERIFICATION SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	S-A1-2	148148.61	580962.38
		S-A1-3	148146.84	580961.10
		S-A1-4	148145.08	580959.84
		S-A1-10	148147.75	580965.01
		S-A1-13	148142.13	580961.08
		S-A1-16	148136.75	580957.39
	A2	S-A2-3	148144.18	580965.70
		S-A2-6	148138.58	580961.94
		S-A2-7	148136.77	580960.72
		S-A2-10	148143.64	580968.39
		S-A2-14	148136.58	580964.04
		S-A2-15	148134.88	580962.89
	A3	S-A3-1	148137.32	580953.46
		S-A3-2	148135.96	580952.31
		S-A3-4	148133.16	580950.27
		S-A3-5	148131.76	580949.24
		S-A3-9	148135.34	580955.82
		S-A3-11	148132.01	580953.43
	A4	S-A4-3	148130.23	580955.95
		S-A4-4	148128.62	580954.89
		S-A4-7	148123.98	580951.85
		S-A4-9	148131.54	580960.48
		S-A4-12	148126.88	580957.89
		S-A4-13	148125.52	580957.13

Attachment 3
Originator S. CRAIG
Chk'd By DSB
Calc. No. 0100F-CA-V0241

Sheet No. 1 of 2
Date 02/06/06
Date 2/6/06
Rev. No. 0

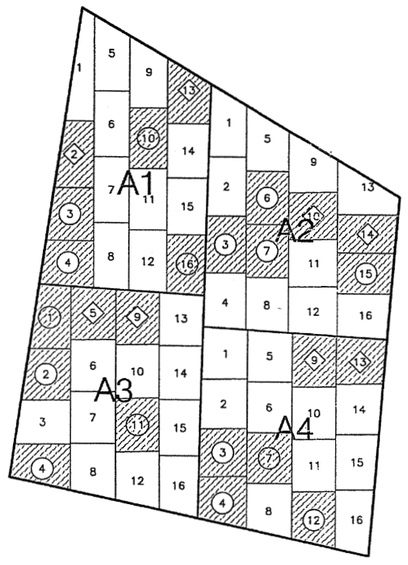
ATTACHMENT 3

U.S DEPARTMENT OF ENERGY
DOE RICHLAND OPERATIONS OFFICE
RIVIER CORRIDOR CLOSURE CONTRACT

100-F AREA
100 AREA REMEDIAL DESIGN
116-F-16 OUTFALL STRUCTURE
SHALLOW ZONE SAMPLING PLAN

1F:020106E

E 580950



N 148050

SCALE 1:200

2 0 2 4 8 meters

NOTES

1. OVERBURDEN NODE AREAS ARE APPROXIMATELY 3.93 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE OVERBURDEN CONSISTS OF SAMPLING AREAS A1, A2, A3, AND A4 WITHIN DECISION SUBUNIT 1.

LEGEND

VARIANCE AND VERIFICATION SAMPLING NODE

VERIFICATION SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	O-A1-2	148067.66	580960.62
		O-A1-3	148065.16	580960.45
		O-A1-4	148063.13	580960.38
		O-A1-10	148068.35	580963.62
		O-A1-13	148070.39	580965.27
		O-A1-16	148063.11	580965.23
	A2	O-A2-3	148063.93	580966.82
		O-A2-6	148065.91	580968.55
		O-A2-7	148063.68	580968.55
		O-A2-10	148065.16	580970.43
		O-A2-14	148064.42	580972.69
		O-A2-15	148062.77	580972.62
	A3	O-A3-1	148060.84	580959.63
		O-A3-2	148058.48	580959.50
		O-A3-4	148054.54	580959.35
		O-A3-5	148061.05	580961.41
		O-A3-9	148060.90	580963.20
		O-A3-11	148056.40	580963.21
	A4	O-A4-3	148055.27	580966.73
		O-A4-4	148053.16	580966.72
		O-A4-7	148055.05	580968.65
		O-A4-9	148059.16	580970.49
		O-A4-12	148052.48	580970.47
		O-A4-13	148059.11	580972.39

Attachment 3 Sheet No. 2 of 2
Originator G. CRUZ Date 02/06/06
Chkd By SB Date 2/6/06
Calc. No. 0100F-CA-V0241 Rev. No. 0

ATTACHMENT 3

U.S DEPARTMENT OF ENERGY
DOE RICHLAND OPERATIONS OFFICE
RIVIER CORRIDOR CLOSURE CONTRACT

100-F AREA
100 AREA REMEDIAL DESIGN
116-F-16 OUTFALL STRUCTURE
OVERBURDEN SAMPLING PLAN

CALCULATION COVER SHEET

Project Title 100 F Area Remedial Action **Job No.** 14655

Area 100 F

Discipline Environmental ***Calc. No.** 0100F-CA-V0255

Subject **116-F-16 Outfall Structure Shallow Zone Variance Calculation**

Computer Program MS Excel **Program No.** Excel 2003

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

Committed Calculation ☒ **Preliminary** ☐ **Superseded** ☐ **Voided** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	2	R.T. Coffman RT Coffman 10/6/06	S.W. Callison SW Callison 6-6-06	M.A. Buckmaster Mark Buckmaster per telecon 6/12/06	M.A. Buckmaster Mark Buckmaster per telecon	6/12/06

SUMMARY OF REVISION

WCH-DE-018 (04/14/2006) *Obtain Calc. No. from R&DC and Form from Intranet

CALCULATION SHEET

Washington Closure Hanford

Originator	R. T. Coffman	Date	5/9/2006	Calc. No.	0100F-CA-V0255	Rev. No.	0
Project	100-F Remedial Action	Job No.	14655	Checked	S. W. Callison SWC	Date	6/6/06
Subject	116-F-16 Outfall Structure Shallow Zone Variance Calculation					Sheet No.	1 of 2

Conclusion:
The required number of samples calculated (1sample) for each decision sub-unit is less than the default number (4 samples) specified in the DOE/RL-96-22, Rev 4. Therefore, the default number of samples will be collected from each shallow zone decision sub-unit.

Problem:
Calculate the number of close out samples required for 116-F-8 Outfall Shallow Unit verification sampling as required in "100 Area Remedial Action Sampling and Analysis Plan" (DOE/RL-96-22, Rev 4) and "Instruction Guide for the Remediation of 100 Areas Waste Sites" (0100X-IG-G0001, Rev 5).

Given:
1) Sample locations for the 116-F-16 Outfall Shallow Decision Unit are identified on the 116-F-16 Outfall Shallow Zone Sample Design, Calculation number 0100F-CA-V0241, Rev. 0.
2) Lookup values from DOE/RL-96-22, Rev 4.
3) Sample Design requirements from DOE/RL-96-22, Rev 4 and 0100X-IG-G0001, Rev 5.
4) Field sampling information from sampling logbook EL-1174.

Solution:
Calculation methodology is described in Appendix A of DOE/RL-96-22, Rev 4. Data from attached worksheets are used to calculate the required number of closeout samples. Variance calculation is based on the same three isotopes used to develop the statistical approach in DOE/RL-96-22, Rev 4. The statistical design is based on the premise that these isotopes are the predominant components of the contamination and are representative of the contamination distribution.

Sheet No.	Contents	Topic
1	Calc. Summary	Summary of Calc Brief
2	Shallow Zone	Required Number of Samples Calculation

CALCULATION SHEET

Washington Closure Hanford

Originator	R. T. Coffman	Date	5/9/2006	Calc. No.	0100F-CA-V0255	Rev. No.	0
Project	100-F Remedial Action	Job No.	14655	Checked	S. W. Callison SWC	Date	6/6/06
Subject	116-F-16 Outfall Structure Shallow Zone Variance Calculation					Sheet No.	2 of 2

Statistical Evaluation of Analytical Data

The required number of samples resulting from the calculation is highlighted at the bottom of the page.
Each value is reflective of the specific analyte evaluated.
The highest value of the three evaluations is used to determine the required number of samples as compared against the default of four.
Sample locations are from Calculation 0100F-CA-V0241.
Mean, Standard Deviation, *t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

Decision Unit: 116-F-16 Outfall Structure Shallow Zone
Samples values from GEA analysis
Sample Areas , A1 thru A4

			Constituent					
Sample #	**Sample Date**	**Location**	**Cobalt-60**	Q	**Cs-137**	Q	**Europium-152**	Q
			pCi/g		pCi/g		pCi/g	
Look-up Value (HT) ==========>			**1.4**		**6.2**		**3.3**	
J112H0	2/2/2006	S-A1-2	0.078	U	0.072	U	0.027	U
J112H1	2/2/2006	S-A1-3	0.093	U	0.077	U	0.18	U
J112H2	2/2/2006	S-A1-4	0.057	U	0.053	U	0.13	U
J112H3	2/2/2006	S-A1-10	0.094	U	0.17		0.26	U
J112H4	2/2/2006	S-A1-13	0.071	U	0.083	U	0.27	U
J112H5	2/2/2006	S-A1-16	0.08	U	0.069	U	0.16	U
J112H6	2/2/2006	S-A2-3	0.11	U	0.097	U	0.27	U
J112H7	2/2/2006	S-A2-6	0.067	U	0.058	U	0.16	U
J112H8	2/2/2006	S-A2-7	0.071	U	0.078	U	0.28	U
J112H9	2/2/2006	S-A2-10	0.094	U	0.09	U	0.18	U
J112J0	2/2/2006	S-A2-14	0.1	U	0.096	U	0.26	U
J112J1	2/2/2006	S-A2-15	0.055	U	0.094		0.241	
J112J2	2/2/2006	S-A3-1	0.057	U	0.06	U	0.21	U
J112J3	2/2/2006	S-A3-2	0.072	U	0.065	U	0.15	U
J112J4	2/2/2006	S-A3-4	0.084	U	0.083	U	0.2	U
J112J5	2/2/2006	S-A3-5	0.042	U	0.088		0.1	U
J112J6	2/2/2006	S-A3-9	0.1	U	0.099	U	0.24	U
J112J7	2/2/2006	S-A3-11	0.045	U	0.042	U	0.11	U
J112J8	2/2/2006	S-A4-3	0.076	U	0.08	U	0.19	U
J112J9	2/2/2006	S-A4-4	0.061	U	0.066	U	0.24	U
J112K0	2/2/2006	S-A4-7	0.077	U	0.084	U	0.22	U
J112K1	2/2/2006	S-A4-9	0.054	U	0.15		0.524	
J112K2	2/2/2006	S-A4-12	0.076	U	0.065	U	0.16	U
J112K3	2/2/2006	S-A4-13	0.074	U	0.072	U	0.24	U
Mean (LV) ==========>			0.07		0.08		0.21	
Standard Deviation (S) ==========>			0.02		0.03		0.09	
α (5%) ==========>			1.645		1.645		1.645	
β (20%) ==========>			0.842		0.842		0.842	
Number of Samples ==========>			**1**		**1**		**1**	

CALCULATION COVER SHEET

Project Title 100 F Area Remedial Action **Job No.** 14655

Area 100 F

Discipline Environmental ***Calc. No.** 0100F-CA-V256

Subject 116-F-16 Outfall Structure Overburden Variance Calculation

Computer Program MS Excel **Program No.** Excel 2003

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

Committed Calculation ☒ **Preliminary** ☐ **Superseded** ☐ **Voided** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	2	R.T. Coffman RT Coffman 6/7/06	S.W. Callison SW Callison 6-7-06	M.A. Buckmaster	M.A. Buckmaster	6/7/06

SUMMARY OF REVISION

WCH-DE-018 (04/14/2006) *Obtain Calc. No. from R&DC and Form from Intranet

CALCULATION SHEET

Washington Closure Hanford

Originator	R. T. Coffman	Date	5/9/2006	Calc. No.	0100F-CA-V0256	Rev. No.	0
Project	100-F Remedial Action	Job No.	14655	Checked	S. W. Callison SWC	Date	6/7/06
Subject	116-F-16 Outfall Structure Overburden Variance Calculation					Sheet No.	1 of 2

Conclusion:
The required number of samples calculated (1sample) for each decision sub-unit is less than the default number (4 samples) specified in the DOE/RL-96-22, Rev 4. Therefore, the default number of samples will be collected from each overburden decision sub-unit.

Problem:
Calculate the number of close out samples required for 116-F-16 Outfall Structure Overburden Unit verification sampling as required in "100 Area Remedial Action Sampling and Analysis Plan" (DOE/RL-96-22, Rev 4) and "Instruction Guide for the Remediation of 100 Areas Waste Sites" (0100X-IG-G0001, Rev 5).

Given:
1) Sample locations for the 116-F-16 Outfall Structure Overburden Decision Unit are identified on the 116-F-16 Outfall Structure Overburden Sample Design, Calculation number 0100F-CA-V0241, Rev. 0.
2) Lookup values from DOE/RL-96-22, Rev 4.
3) Sample Design requirements from DOE/RL-96-22, Rev 4 and 0100X-IG-G0001, Rev 5.
4) Field sampling information from sampling logbook EL-1174.

Solution:
Calculation methodology is described in Appendix A of DOE/RL-96-22, Rev 4. Data from attached worksheets are used to calculate the required number of closeout samples. Variance calculation is based on the same three isotopes used to develop the statistical approach in DOE/RL-96-22, Rev 4. The statistical design is based on the premise that these isotopes are the predominant components of the contamination and are representative of the contamination distribution.

Sheet No.	Contents	Topic
1	Calc. Summary	Summary of Calc Brief
2	Overburden	Required Number of Samples Calculation

CALCULATION SHEET

Washington Closure Hanford

Originator	R. T. Coffman	Date	5/9/2006	Calc. No.	0100F-CA-V0256	Rev. No.	0
Project	100-F Remedial Action	Job No.	14655	Checked	S. W. Callison SWC	Date	6/7/06
Subject	116-F-16 Outfall Structure Overburden Variance Calculation					Sheet No.	2 of 2

Statistical Evaluation of Analytical Data

The required number of samples resulting from the calculation is highlighted at the bottom of the page.
Each value is reflective of the specific analyte evaluated.
The highest value of the three evaluations is used to determine the required number of samples as compared against the default of four.
Sample locations are from Calculation 0100F-CA-V0241.
Mean, Standard Deviation, *t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

Decision Unit: 116-F-16 Outfall Structure Overburden
Samples values from GEA analysis
Sample Areas : A1 thru A4

			Constituent					
Sample #	**Sample Date**	**Location**	**Cobalt-60**	**Q**	**Cs-137**	**Q**	**Europium-152**	**Q**
			pCi/g		pCi/g		pCi/g	
Look-up Value (HT) ==========>			**1.4**		**6.2**		**3.3**	
J112K4	1/31/2006	O-A1-2	0.075	U	0.11		0.17	U
J112K5	1/31/2006	O-A1-3	0.079	U	0.081	U	0.26	U
J112K6	1/31/2006	O-A1-4	0.096	U	0.101		0.22	U
J112K7	1/31/2006	O-A1-10	0.045	U	0.047	U	0.11	U
J112K8	1/31/2006	O-A1-13	0.093	U	0.081	U	0.2	U
J112K9	1/31/2006	O-A1-16	0.065	U	0.075	U	0.16	U
J112L0	1/31/2006	O-A2-3	0.07	U	0.071	U	0.26	U
J112L1	1/31/2006	O-A2-6	0.1	U	0.098	U	0.24	U
J112L2	1/31/2006	O-A2-7	0.056	U	0.07		0.15	U
J112L3	1/31/2006	O-A2-10	0.095	U	0.077	U	0.22	U
J112L4	1/31/2006	O-A2-14	0.068	U	0.078	U	0.16	U
J112L5	1/31/2006	O-A2-15	0.072	U	0.077	U	0.25	U
J112L6	1/31/2006	O-A3-1	0.088	U	0.09	U	0.2	U
J112L7	1/31/2006	O-A3-2	0.057	U	0.054	U	0.12	U
J112L8	1/31/2006	O-A3-4	0.11	U	0.08	U	0.18	U
J112L9	1/31/2006	O-A3-5	0.059	U	0.065	U	0.15	U
J112M0	1/31/2006	O-A3-9	0.066	U	0.071	U	0.24	U
J112M1	1/31/2006	O-A3-11	0.1	U	0.114		0.23	U
J112M2	1/31/2006	O-A4-3	0.12	U	0.07		0.14	U
J112M3	1/31/2006	O-A4-4	0.11	U	0.11	U	0.24	U
J112M4	1/31/2006	O-A4-7	0.08	U	0.085	U	0.19	U
J112M5	1/31/2006	O-A4-9	0.08	U	0.082	U	0.31	U
J112M6	1/31/2006	O-A4-12	0.021	U	0.057		0.05	U
J112M7	1/31/2006	O-A4-13	0.012	U	0.036		0.038	U
Mean (LV) ==========>			0.08		0.08		0.19	
Standard Deviation (S) ==========>			0.03		0.02		0.07	
α (5%) ==========>			1.645		1.645		1.645	
β (20%) ==========>			0.842		0.842		0.842	
Number of Samples ==========>			**1**		**1**		**1**	

116-F-16 Outfall Overburden

CALCULATION COVER SHEET

Project Title	100-F Area Field Remediation	**Job No.**	14655
Area	100-F		
Discipline	Environmental	***Calc. No.**	0100F-CA-V0250
Subject	116-F-16 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 calculations should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ **Preliminary** ☐ **Superseded** ☐ **Voided** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 7 Attm. 1 = 2 Total = 10	5/8/06 J. M. Capron	5/9/06 T. M. Blakley	5/11/06 L. M. Dittmer	S. W. Callison	5-18-06

SUMMARY OF REVISIONS

WCH-DE-018 (4/14/06) * Obtain Calc No. from R&DC and Form from Intranet

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC Date 05/08/06 Calc. No. 0100F-CA-V0250 Rev. No. 0
Project 100-F Area Field Remediation Job No. 14655 Checked T. M. Blakley TMB Date 5/9/06
Subject 116-F-16 Waste Site Cleanup Verification 95% UCL Calculations Sheet No. 1 of 7

Summary

Purpose:
Calculate the 95% upper confidence limit (UCL) values to evaluate compliance with cleanup standards for the subject site. Also, calculate the carcinogenic risk for applicable nonradionuclide analytes, 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 and primary-split sample pairs for each contaminant of potential concern (COPC), as necessary.

Table of Contents:

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 calculate the 95% UCL, hazard quotients, and excess carcinogenic risk, and RPD values and perform the WAC 173-340 3-part test for nonradionuclides.

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. Split and duplicate RPD results are used in evaluation of data quality within the remaining sites verification package (RSVP) for this site.

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC Date 05/08/06 Calc. No. 0100F-CA-V0250 Rev. No. 0
Project 100-F Area Field Remediation Job No. 14655 Checked T. M. Blakley TMB Date 5/9/06
Subject 116-F-16 Waste Site Cleanup Verification 95% UCL Calculations Sheet No. 2 of 7

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 values were calculated only for the site COPCs (as identified in the SAP [DOE-RL 2005a]). 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.

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 minimum detectable activity (MDA), half of the MDA is used in the calculation. For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above.

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For nonradionuclide small data sets ($n < 10$) and all radionuclide data sets, as for the subject site, the calculations are performed assuming nonparametric distribution, so no tests for distribution are performed. For nonradionuclide data sets of ten or greater, distributional testing and calculation of the 95% UCL is done using Ecology's MTCAStat software (Ecology 1993).

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 regulatory 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.

Washington Closure Hanford **CALCULATION SHEET**

Originator J. M. Capron JMC **Date** 05/08/06 **Calc. No.** 0100F-CA-V0250 **Rev. No.** 0
Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley TMB **Date** 5/9/06
Subject 116-F-16 Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 3 of 7

Summary (continued)

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

Results Summary

Analyte	Shallow Zone		Overburden		Units
	Result	Qualifier	Result	Qualifier	
Cesium-137	0.062	U	0 (< BG)	U	pCi/g
Plutonium-239/240	0.043	U	0.029	U	pCi/g
Strontium-90	0.003	U	0 (< BG)	U	pCi/g
Hexavalent chromium	0.39		0.23		mg/kg
Lead	4.7		3.1		mg/kg

BG = background
U = undetected (in all samples submitted to the primary laboratory)

WAC 173-340 Evaluation (Shallow Zone)

3-Part Test:
95% UCL > Cleanup Limit? NO
> 10% above Cleanup Limit? NO
Any sample > 2x Cleanup Limit? NO

All nonradionuclide COPC concentrations satisfy the 3-part test criteria.

Risk Estimate:
Nonrad noncarcinogenic index sum: 1.6E-03
Nonrad carcinogenic risk: 1.8E-07

WAC 173-340 Evaluation (Overburden)

3-Part Test:
95% UCL > Cleanup Limit? NO
> 10% above Cleanup Limit? NO
Any sample > 2x Cleanup Limit? NO

All nonradionuclide COPC concentrations satisfy the 3-part test criteria.

Risk Estimate:
Nonrad noncarcinogenic index sum: 9.6E-04
Nonrad carcinogenic risk: 1.1E-07

Relative Percent Difference Results

Relative percent difference analysis was not required for any primary-duplicate or primary-split sample pairs.

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC **Date** 05/08/06 **Calc. No.** 0100F-CA-V0250 **Rev. No.** 0
Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley TMB **Date** 5/9/06
Subject 116-F-16 Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 4 of 7

116-F-16 Shallow Zone Sample Data

Sampling Area	HEIS Number	Sample Date	Cesium-137			Plutonium-239/240			Strontium-90		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J117N8	2/15/2006	0.090	U	0.090	0	U	0.35	-0.032	U	0.30
Duplicate of J117N8	J117P2	2/15/2006	0.091	U	0.091	0	U	0.16	0.058	U	0.36
A2	J117N9	2/15/2006	0.11	U	0.11	0.065	U	0.50	-0.012	U	0.29
A3	J117P0	2/15/2006	0.11	U	0.11	0	U	0.50	-0.028	U	0.29
A4	J117P1	2/15/2006	0.13	U	0.13	0	U	0.48	-0.016	U	0.32

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Cesium-137 pCi/g			Plutonium-239/240 pCi/g			Strontium-90 pCi/g		
A1	J117N8/ J117P2	2/15/2006	0.045			0			0.013		
A2	J117N9	2/15/2006	0.055			0.065			-0.012		
A3	J117P0	2/15/2006	0.055			0			-0.028		
A4	J117P1	2/15/2006	0.065			0			-0.016		

Statistical Computations

	Cesium-137			Plutonium-239/240			Strontium-90		
95% UCL value based on	Radionuclide data set. Use nonparametric z-stat.			Radionuclide data set. Use nonparametric z-stat.			Radionuclide data set. Use nonparametric z-stat.		
N	4			4			4		
% < Detection limit	100%			100%			100%		
Mean	0.055			0.016			-0.011		
Standard deviation	0.008			0.03			0.017		
Z-statistic	1.645			1.645			1.645		
95% UCL on mean	0.062	U		0.043	U		0.003	U	
Maximum value	0.13	U		0.065	U		0.058	U	
Statistical value	0.062	U		0.043	U		0.003	U	
Background	NA			NA			NA		
Statistical value above background	0.062	U		0.043	U		0.003	U	

Split-Duplicate Analysis

Sampling Area	HEIS Number	Sample Date	Cesium-137			Plutonium-239/240			Strontium-90		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J117N8	2/15/2006	0.090	U	0.090	0	U	0.35	-0.032	U	0.30
Duplicate of J117N8	J117P2	2/15/2006	0.091	U	0.091	0	U	0.16	0.058	U	0.36
Split of J117N8	J117X3	2/15/06	-0.00144	U	0.0160	0.0351	U	0.0552	0.00237	U	0.145
TDL			0.1			1			1		
Duplicate Analysis	Both > MDA?		No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)		
	Both > 5xTDL?										
	RPD										
Split Analysis	Both > MDA?		No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)		
	Both > 5xTDL?										
	RPD										

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.

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
NA = not applicable
Q = qualifier
RPD = relative percent difference
TDL = target detection limit
U = undetected
UCL = upper confidence limit

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC Date 05/08/06 Calc. No. 0100F-CA-V0250 Rev. No. 0
Project 100-F Area Field Remediation Job No. 14655 Checked T. M. Blakley TMB Date 5/9/06
Subject 116-F-16 Waste Site Cleanup Verification 95% UCL Calculations Sheet No. 5 of 7

116-F-16 Shallow Zone Sample Data (continued)

Sampling Area	HEIS Number	Sample Date	Hexavalent Chromium mg/kg	Q	PQL	Lead mg/kg	Q	PQL
A1	J117N8	2/15/2006	0.29		0.21	3.4		0.93
Duplicate of J117N8	J117P2	2/15/2006	0.20	U	0.20	3.4		0.89
A2	J117N9	2/15/2006	0.42		0.21	5.3		0.92
A3	J117P0	2/15/2006	0.28		0.22	3.5		0.96
A4	J117P1	2/15/2006	0.34		0.21	3.9		0.93

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Hexavalent Chromium mg/kg			Lead mg/kg		
A1	J117N8/ J117P2	2/15/2006	0.20			3.4		
A2	J117N9	2/15/2006	0.42			5.3		
A3	J117P0	2/15/2006	0.28			3.5		
A4	J117P1	2/15/2006	0.34			3.9		

Statistical Computations

	Hexavalent Chromium			Lead		
95% UCL value based on	Small data set. Use nonparametric z-stat.			Small data set. Use nonparametric z-stat.		
N	4			4		
% < Detection limit	0%			0%		
Mean	0.31			4.0		
Standard deviation	0.10			0.9		
Z-statistic	1.645			1.645		
95% UCL on mean	0.39			4.7		
Maximum value	0.42			5.3		
Statistical value	0.39			4.7		
Most Stringent Cleanup Limit for nonradionuclide and RAG type	2	River Protection		10.2	BG/GW & River Protection	
WAC 173-340 3-PART Test						
95% UCL > Cleanup Limit?	NO			NA		
> 10% above Cleanup Limit?	NO			NA		
Any sample > 2X Cleanup Limit?	NO			NA		
RISK EVALUATION						
WAC 173-340 Non-Carcinogenic Cleanup:	240			353		
Hazard quotient for each nonradionuclide:	1.6E-03			0		
WAC 173-340 Carcinogenic Cleanup:	2.1			NA		
Risk for each carcinogenic nonradionuclide:	1.8E-07			0		
WAC 173-340 Compliance? YES	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.			Because all values are below background (10.2 mg/kg), the WAC 173-340 3-part test is not required.		
Hazard quotient sum: 1.6E-03						
Carcinogenic risk sum: 1.8E-07						

Split-Duplicate Analysis

Sampling Area	HEIS Number	Sample Date	Hexavalent Chromium mg/kg	Q	PQL	Lead mg/kg	Q	PQL
A1	J117N8	2/15/2006	0.29		0.21	3.4		0.93
Duplicate of J117N8	J117P2	2/15/2006	0.20	U	0.20	3.4		0.89
Split of J117N8	J117X3	2/15/06	0.350	U	0.350	3.5		1.0
TDL			0.5			5		
Duplicate Analysis	Both > PQL?		No-Stop (acceptable)			**Yes (continue)**		
	Both > 5xTDL?					No-Stop (acceptable)		
	RPD							
Split Analysis	Both > PQL?		No-Stop (acceptable)			**Yes (continue)**		
	Both > 5xTDL?					No-Stop (acceptable)		
	RPD							

BG = background
GW = groundwater
HEIS = Hanford Environmental Information System
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
RAG = remedial action goal
RPD = relative percent difference
TDL = target detection limit
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron **Date** 05/08/06 **Calc. No.** 0100F-CA-V0250 **Rev. No.** 0
Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley **Date** 5/9/06
Subject 116-F-16 Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 6 of 7

116-F-16 Overburden Sample Data

Sampling Area	HEIS Number	Sample Date	Cesium-137			Plutonium-239/240			Strontium-90		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J117P3	2/13/2006	0.069	U	0.069	0	U	0.52	0.033	U	0.29
Duplicate of J117P3	J117P7	2/13/2006	0.051	U	0.051	0.038	U	0.29	0.096	U	0.28
A2	J117P4	2/13/2006	0.050	U	0.050	0	U	0.33	0.073	U	0.32
A3	J117P5	2/13/2006	0.037	U	0.037	0.035	U	0.27	0.006	U	0.29
A4	J117P6	2/13/2006	0.062	U	0.062	0.068	U	0.26	-0.022	U	0.26

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Cesium-137 pCi/g			Plutonium-239/240 pCi/g			Strontium-90 pCi/g		
A1	J117P3/ J117P7	2/13/2006	0.030			0.019			0.065		
A2	J117P4	2/13/2006	0.025			0			0.073		
A3	J117P5	2/13/2006	0.019			0.035			0.006		
A4	J117P6	2/13/2006	0.031			0.068			-0.022		

Statistical Computations

	Cesium-137			Plutonium-239/240			Strontium-90		
95% UCL value based on	Radionuclide data set. Use nonparametric z-stat.			Radionuclide data set. Use nonparametric z-stat.			Radionuclide data set. Use nonparametric z-stat.		
N	4			4			4		
% < Detection limit	100%			100%			100%		
Mean	0.026			0.031			0.030		
Standard deviation	0.006			0.029			0.046		
Z-statistic	1.645			1.645			1.645		
95% UCL on mean	0.031	U		0.054	U		0.068	U	
Maximum value	0.069	U		0.068	U		0.096	U	
Statistical value	0.031	U		0.054	U		0.068	U	
Background	1.1			0.025			0.18		
Statistical value above background	0 (< BG)	U		0.029	U		0 (< BG)	U	

Split-Duplicate Analysis

Sampling Area	HEIS Number	Sample Date	Cesium-137			Plutonium-239/240			Strontium-90		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J117P3	2/13/2006	0.069	U	0.069	0	U	0.52	0.033	U	0.29
Duplicate of J117P3	J117P7	2/13/2006	0.051	U	0.051	0.038	U	0.29	0.096	U	0.28
Split of J117P3	J117X4	2/13/06	0.0250		0.0194	0.0872	U	0.187	0.0718	U	0.142
TDL			0.1			1			1		
Duplicate Analysis	Both > MDA?		No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)		
	Both > 5xTDL?										
	RPD										
Split Analysis	Both > MDA?		No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)		
	Both > 5xTDL?										
	RPD										

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.

BG = background
HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
NA = not applicable
Q = qualifier
RPD = relative percent difference
TDL = target detection limit
U = undetected
UCL = upper confidence limit

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron JMC **Date** 05/08/06 **Calc. No.** 0100F-CA-V0250 **Rev. No.** 0
Project 100-F Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley TMB **Date** 5/9/06
Subject 116-F-16 Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 7 of 7

1 **116-F-16 Overburden Sample Data (continued)**

Sampling Area	HEIS Number	Sample Date	Hexavalent Chromium mg/kg	Q	PQL	Lead mg/kg	Q	PQL
A1	J117P3	2/13/2006	0.22	U	0.22	3.2		0.33
Duplicate of J117P3	J117P7	2/13/2006	0.22	U	0.22	3.1		0.33
A2	J117P4	2/13/2006	0.22	U	0.22	2.9		0.32
A3	J117P5	2/13/2006	0.23		0.21	3.0		0.31
A4	J117P6	2/13/2006	0.22	U	0.22	3.1		0.32

9 **Statistical Computation Input Data**

Sampling Area	HEIS Number	Sample Date	Hexavalent Chromium mg/kg			Lead mg/kg		
A1	J117P3/ J117P7	2/13/2006	0.11			3.2		
A2	J117P4	2/13/2006	0.11			2.9		
A3	J117P5	2/13/2006	0.23			3.0		
A4	J117P6	2/13/2006	0.11			3.1		

16 **Statistical Computations**

	Hexavalent Chromium			Lead		
95% UCL value based on	Small data set. Use nonparametric z-stat.			Small data set. Use nonparametric z-stat.		
N	4			4		
% < Detection limit	75%			0%		
Mean	0.14			3.0		
Standard deviation	0.06			0.1		
Z-statistic	1.645			1.645		
95% UCL on mean	0.19			3.1		
Maximum value	0.23			3.2		
Statistical value	0.23			3.1		
Most Stringent Cleanup Limit for nonradionuclide and RAG type	2	River Protection		10.2	BG/GW & River Protection	
WAC 173-340 3-PART Test						
95% UCL > Cleanup Limit?	NO			NA		
> 10% above Cleanup Limit?	NO			NA		
Any sample > 2X Cleanup Limit?	NO			NA		
RISK EVALUATION						
WAC 173-340 Non-Carcinogenic Cleanup:	240			353		
Hazard quotient for each nonradionuclide:	9.6E-04			0		
WAC 173-340 Carcinogenic Cleanup:	2.1			NA		
Risk for each carcinogenic nonradionuclide:	1.1E-07			0		
WAC 173-340 Compliance? YES	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.			Because all values are below background (10.2 mg/kg), the WAC 173-340 3-part test is not required.		
Hazard quotient sum: 9.6E-04						
Carcinogenic risk sum: 1.1E-07						

40 **Split-Duplicate Analysis**

Sampling Area	HEIS Number	Sample Date	Hexavalent Chromium mg/kg	Q	PQL	Lead mg/kg	Q	PQL
A1	J117P3	2/13/2006	0.22	U	0.22	3.2		0.33
Duplicate of J117P3	J117P7	2/13/2006	0.22	U	0.22	3.1		0.33
Split of J117P3	J117X4	2/13/06	0.350	U	0.350	3.8		1.1
TDL			0.5			5		
Duplicate Analysis	Both > PQL?		No-Stop (acceptable)			**Yes (continue)**		
	Both > 5xTDL?					No-Stop (acceptable)		
	RPD							
Split Analysis	Both > PQL?		No-Stop (acceptable)			**Yes (continue)**		
	Both > 5xTDL?					No-Stop (acceptable)		
	RPD							

53 BG = background
54 GW = groundwater
55 HEIS = Hanford Environmental Information System
56 NA = not applicable
PQL = practical quantitation limit
Q = qualifier
RAG = remedial action goal
RPD = relative percent difference
TDL = target detection limit
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

Attachment 1. 116-F-16 Verification Sampling Results.

Sample Location	HEIS Number	Sample Date	Americium-241			Cesium-137			Cobalt-60			Europium-152			Europium-154			Europium-155			Nickel-63		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
SZ A1	J117N8	2/15/06	0.27	U	0.27	0.090	U	0.090	0.10	U	0.10	0.19	U	0.19	0.28	U	0.28	0.18	U	0.18			
Duplicate of J117N8	J117P2	2/15/06	0.32	U	0.32	0.091	U	0.091	0.099	U	0.099	0.23	U	0.23	0.30	U	0.30	0.26	U	0.26			
Split of J117N8	J117X3	2/15/06				-0.00144	U	0.0160	0.00967	U	0.0173	-0.0254	U	0.0412	-0.0285	U	0.0513	0.0140	U	0.0435			
SZ A2	J117N9	2/15/06	0.23	U	0.23	0.11	U	0.11	0.11	U	0.11	0.32	U	0.32	0.39	U	0.39	0.26	U	0.26			
SZ A3	J117P0	2/15/06	0.23	U	0.23	0.11	U	0.11	0.13	U	0.13	0.32	U	0.32	0.40	U	0.40	0.25	U	0.25			
SZ A4	J117P1	2/15/06	0.27	U	0.27	0.13	U	0.13	0.14	U	0.14	0.39	U	0.39	0.44	U	0.44	0.28	U	0.28			
OB A1	J117P3	2/13/06	0.16	U	0.16	0.069	U	0.069	0.033	U	0.033	0.072	U	0.072	0.10	U	0.10	0.15	U	0.15	0.235	U	3.4
Duplicate of J117P3	J117P7	2/13/06	0.14	U	0.14	0.051	U	0.051	0.026	U	0.026	0.062	U	0.062	0.083	U	0.083	0.080	U	0.080	0.363	U	3.5
Split of J117P3	J117X4	2/13/06				0.0250		0.0194	-0.00250	U	0.0209	0.0332	U	0.0470	-0.0039	U	0.0689	0.0427	U	0.0437	2.68	U	6.08
OB A2	J117P4	2/13/06	0.17	U	0.17	0.050	U	0.050	0.054	U	0.054	0.11	U	0.11	0.17	U	0.17	0.12	U	0.12	-0.480	U	3.4
OB A3	J117P5	2/13/06	0.20	U	0.20	0.037	U	0.037	0.036	U	0.036	0.13	U	0.13	0.12	U	0.12	0.14	U	0.14	0.762	U	3.4
OB A4	J117P6	2/13/06	0.14	U	0.14	0.062	U	0.062	0.044	U	0.044	0.095	U	0.095	0.17	U	0.17	0.10	U	0.10	-0.317	U	3.4
Equipment blank	J118J1	2/15/06	0.19	U	0.19	0.075	U	0.075	0.084	U	0.084	0.18	U	0.18	0.24	U	0.24	0.18	U	0.18			

Note: The following abbreviations apply to all Attachment 1 tables.
HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
OB = overburden
PQL = practical quantitation limit
Q = qualifier
SZ = shallow zone
U = undetected

Attachment	1	Sheet No.	1 of 2
Originator	J. M. Capron *JMC*	Date	05/08/06
Checked	T. M. Blakley *TMB*	Date	5/9/06
Calc. No.	0100F-CA-V0250	Rev. No.	0

Attachment 1. 116-F-16 Verification Sampling Results.

Sample Location	HEIS Number	Sample Date	Potassium-40			Plutonium-238			Plutonium-239/240			Radium-226			Radium-228			Silver-108m			Thorium-228		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
SZ A1	J117N8	2/15/06	11.2		0.72	0	U	0.35	0	U	0.35	0.21	U	0.21	0.75	U	0.75	0.057	U	0.057	0.387		0.097
Duplicate of J117N8	J117P2	2/15/06	17.4		0.84	0	U	0.16	0	U	0.16	0.48	U	0.48	1.0	U	1.0	0.063	U	0.063	0.448		0.15
Split of J117N8	J117X3	2/15/06				0.00586	U	0.0552	0.0351	U	0.0552							-0.0043	U	0.0124			
SZ A2	J117N9	2/15/06	9.86		0.97	-0.065	U	0.50	0.065	U	0.50	0.22	U	0.22	0.46	U	0.46	0.079	U	0.079	0.629		0.16
SZ A3	J117P0	2/15/06	8.41		1.3	-0.065	U	0.50	0	U	0.50	0.343		0.18	0.52	U	0.52	0.083	U	0.083	0.472		0.15
SZ A4	J117P1	2/15/06	8.86		1.3	0	U	0.48	0	U	0.48	0.50	U	0.50	0.64	U	0.64	0.092	U	0.092	0.552		0.17
OB A1	J117P3	2/13/06	15.3		0.33	-0.068	U	0.65	0	U	0.52	0.470		0.051	0.734		0.13	0.022	U	0.022	0.633		0.035
Duplicate of J117P3	J117P7	2/13/06	15.5		0.26	0.038	U	0.29	0.038	U	0.29	0.464		0.045	0.763		0.11	0.018	U	0.018	0.600		0.029
Split of J117P3	J117X4	2/13/06				0.0164	U	0.154	0.0872	U	0.187							-0.0064	U	0.0141			
OB A2	J117P4	2/13/06	15.3		0.46	0.043	U	0.33	0	U	0.33	0.484		0.099	0.688		0.23	0.031	U	0.031	0.598		0.050
OB A3	J117P5	2/13/06	7.34		0.34	0	U	0.27	0.035	U	0.27	0.349		0.077	0.324		0.16	0.028	U	0.028	0.672		0.066
OB A4	J117P6	2/13/06	15.3		0.44	0	U	0.26	0.068	U	0.26	0.477		0.087	0.715		0.18	0.027	U	0.027	0.685		0.048
Equipment blank	J118J1	2/15/06	3.65		0.60	-0.027	U	0.21	0.027	U	0.21	0.37	U	0.37	0.40	U	0.40	0.053	U	0.053	0.35	U	0.35

Sample Location	HEIS Number	Sample Date	Thorium-232			Total Beta Radiostrontium			Uranium-235			Uranium-238			Hexavalent Chromium			Lead		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL
SZ A1	J117N8	2/15/06	0.75	U	0.75	-0.032	U	0.30	0.28	U	0.28	11	U	11	0.29		0.21	3.4		0.93
Duplicate of J117N8	J117P2	2/15/06	1.0	U	1.0	0.058	U	0.36	0.33	U	0.33	11	U	11	0.20	U	0.20	3.4		0.89
Split of J117N8	J117X3	2/15/06				0.00237	U	0.145							0.350	U	0.350	3.5		1.0
SZ A2	J117N9	2/15/06	0.46	U	0.46	-0.012	U	0.29	0.39	U	0.39	14	U	14	0.42		0.21	5.3		0.92
SZ A3	J117P0	2/15/06	0.52	U	0.52	-0.028	U	0.29	0.39	U	0.39	13	U	13	0.28		0.22	3.5		0.96
SZ A4	J117P1	2/15/06	0.64	U	0.64	-0.016	U	0.32	0.43	U	0.43	17	U	17	0.34		0.21	3.9		0.93
OB A1	J117P3	2/13/06	0.734		0.13	0.033	U	0.29	0.11	U	0.11	3.7	U	3.7	0.22	U	0.22	3.2		0.33
Duplicate of J117P3	J117P7	2/13/06	0.763		0.11	0.096	U	0.28	0.091	U	0.091	3.0	U	3.0	0.22	U	0.22	3.1		0.33
Split of J117P3	J117X4	2/13/06				0.0718	U	0.142							0.350	U	0.350	3.8		1.1
OB A2	J117P4	2/13/06	0.688		0.23	0.073	U	0.32	0.17	U	0.17	5.9	U	5.9	0.22	U	0.22	2.9		0.32
OB A3	J117P5	2/13/06	0.324		0.16	0.006	U	0.29	0.18	U	0.18	4.1	U	4.1	0.23		0.21	3.0		0.31
OB A4	J117P6	2/13/06	0.715		0.18	-0.022	U	0.26	0.15	U	0.15	5.2	U	5.2	0.22	U	0.22	3.1		0.32
Equipment blank	J118J1	2/15/06	0.40	U	0.40	-0.014	U	0.32	0.29	U	0.29	12	U	12	0.20	U	0.20	0.30	U	0.30

Attachment	1	Sheet No.	2 of 2
Originator	J. M. Capron	Date	05/08/06
Checked	T. M. Blakley	Date	
Calc. No.	0100F-CA-V0250	Rev. No.	0

APPENDIX B

DATA QUALITY ASSESSMENT

DATA QUALITY ASSESSMENT FOR THE 116-F-16 AND 100-F-43 WASTE SITES

OVERVIEW

The data quality assessment (DQA) completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process. The DQA includes a review of the field logbook information (WCH 2006a, 2006b) to verify sample location, date, and time. It also involves a scientific and statistical evaluation of the data to determine if they are of the right type, quality, and quantity to support their intended use for closeout decisions.

This DQA was performed in accordance with ENV-1, *Environmental Monitoring and Management*. Specific data quality objectives for the site are found in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2005a). The DQA is based on the guidelines presented in *Guidance for Data Quality Assessment* (EPA 2000). Statistical tests used in this DQA were performed as specified in the SAP and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005b).

Prior to performing statistical tests, the field logbooks (WCH 2006a, 2006b), sample design (Appendix A), and sample analytical data are evaluated. A portion of the cleanup verification sample analytical data are validated for compliance requirements (DOE-RL 2005a). Data evaluation is performed to determine if the laboratory carried out all steps required by the SAP and the laboratory contract governing the conduct of analysis and reporting of the data. This evaluation also examines the available laboratory data to determine if an analyte is present or absent in a sample and the degree of overall uncertainty associated with that determination. Data validation is done in accordance with validation procedures (BHI 2000a, 2000b) as part of data evaluation. After data evaluation and validation, the appropriate statistical analyses are performed on the adjusted raw analytical data (Appendix A) to determine statistical values for each contaminant. The cleanup verification sample analytical data are stored in the Environmental Restoration project-specific database prior to archiving in the Hanford Environmental Information System and are included within the 95% upper confidence limit (UCL) calculation brief in Appendix A.

LABORATORY QUALITY MEASURES

All verification samples are subject to laboratory-specific quality assurance (QA) requirements, including instrument procurement, maintenance, calibration, and operation. Additional laboratory quality control (QC) checks are performed, as appropriate, for the analytical method at a rate of one per sample delivery group (SDG), or one in 20, whichever is more frequent. Laboratory internal QC checks include the following:

- Laboratory Contamination. Each analytical batch contains a laboratory (method) blank (material of similar composition as the samples with known/minimal contamination of the analytes of interest) carried through the complete analytical process. The method blank is

used to evaluate false-positive results in samples due to contamination during handling at the laboratory.

- Analytical Accuracy. For most analyses, a known quantity of representative analytes of interest (matrix spike/matrix spike duplicate [MS/MSD]) is added to a separate aliquot of a sample from the analytical batch. The recovery percentage of the added MS is used to evaluate analytical accuracy. For analyses not amenable to MS techniques (e.g., gamma energy analysis) or where analytical recovery is corrected via internal standards (e.g., alpha spectral analyses), accuracy is evaluated from recovery of the QC reference sample (e.g., laboratory control spike or blank spike sample).

- Analytical Precision. Separate aliquots removed from the same sample container (replicate samples) are analyzed for each analytical batch. The replicate sample results (evaluated as relative percent differences [RPDs]) are used to assess analytical precision.

- QC Reference Samples. A QC reference sample is prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples provide an independent check on analytical technique and methodology.

Laboratories are also subject to periodic and random assessments of the laboratory performance, systems, and overall program. These assessments are performed by the Washington Closure Hanford QA group to ensure that the laboratories are performing within laboratory contract requirements.

DATA VALIDATION

After sampling was completed, all of the fixed-base laboratory data from SDG K0228 were submitted for third-party validation to Level C per ENV-1-2.12, "Data Package Validation." Level C validation procedures are specified in *Data Validation Procedure for Radiochemical Analysis* (BHI 2000b) and *Data Validation Procedure for Chemical Analysis* (BHI 2000a).

Use of Level C validation procedures was included in the review of the following items, as appropriate, for each analytical method:

- Sample holding times
- Method blanks
- MS/MSD recovery
- Surrogate recovery
- Sample replicates
- Associated batch laboratory control sample results
- Data package completeness
- Achievement of required (or contractual) detection limits (RDLs).

Data flagged by the validator as estimated (i.e., "J") indicate that the associated concentration is an estimate, but that the data may be used for decision-making purposes. Data flagged as below

detection limits (i.e., "U") indicate the contaminant was analyzed for but not detected, and the concentration is below the minimum detectable activity (MDA) for radionuclides or the practical quantitation limit (PQL) (i.e., reporting limit) for nonradionuclides. For nonradionuclides, nondetects are reported at the PQL. For radionuclides, nondetects report the actual value obtained from analysis (positive or negative but less than the MDA) except for limited analyses where no value can be calculated. In these cases, the MDA is reported. This situation is applicable for sample results that are below detection limits. All other validated results are considered to be accurate within the standard errors associated with the methods.

The adequacy of laboratory QA/QC was evaluated for precision, accuracy, completeness, and RDLs pursuant to the SAP (DOE-RL 2005a). The organization performing the data validation reported that, of the data given formal validation, the laboratory met the standards for performance for precision (±30%), accuracy (±30%), and completeness (>90%). Comparison of the RDL with the respective MDA or PQL is discussed in the following section.

SDG K0228, a validated SDG, contains six samples (J117N8, J117N9, J117P0, J117P1, J117P2, J118J1). Sample J118J1 is the equipment blank and sample J117P2 is a duplicate of sample J117N8. A summary of deficiencies noted during validation follows.

- **Radionuclides.** Third-party validation noted no major deficiencies. A minor deficiency was noted in that potassium-40 was found in the equipment blank and had an RPD value of 43% between the primary and lab duplicate. Third-party validation did not apply any qualification to the potassium-40 data in SDG K0228. The field sample data are useable for decision-making purposes.

- **Nonradionuclides.** Third-party validation noted no major or minor deficiencies.

LABORATORY DATA EVALUATION

The following paragraphs include a data evaluation of the remaining verification sample SDGs for the 116-F-16/100-F-43 waste site combined unit. Those SDGs are J00060, J00062, and K0223. SDG J00060 consists of one sample (J117X4), a split of sample J117P3. SDG J00062 consists of one sample (J117X3), a split of sample J117N8. SDG K0223 consists of five field samples (J117P3 to 7), of which sample J117P7 is a duplicate of sample J117P3.

The context for assessing the data includes evaluating the sample data using the statistical methodology of the SAP (DOE-RL 2005a) (included in the calculation brief in Appendix A) and a comparison of analytical results to the parameters as specified in the SAP. This section summarizes the results of the comparison and presents an evaluation of the affected data.

Major Deficiencies

Any data anomaly that causes final data to be qualified as rejected (R flagged) is considered a major deficiency. No major deficiencies were identified in the data.

Minor Deficiencies

Sample Holding Times. All of the method-specific holding times were met for all samples in the 116-F-16/100-F-43 data set.

Method Blanks. The method blank is used to evaluate false-positive results in samples due to contamination during handling at the laboratory.

Radionuclides. All of the method blank results in the radionuclide data were within the acceptance criteria.

Nonradionuclides. All of the method blank results in the radionuclide data were within the acceptance criteria.

MS/MSDs Recoveries. Recovery of spiked analytes in the MS/MSD pair is used to evaluate method efficiency and the effect of the matrix on an environmental sample.

Radionuclides. All MS/MSD recoveries for radionuclide analytes were within acceptance criteria.

Nonradionuclides. A lead chromate spike is often used when evaluating insoluble substrates, such as dried paint, for hexavalent chromium. In several of the SDGs, the lead chromate spike recovery was low. This parameter is not usually reported with soil samples and is only commented on here because the laboratory made a similar comment. The insoluble forms of hexavalent chromium are not of primary concern on the Hanford site. The typical matrix spike (soluble) and matrix spike duplicate were within acceptance criteria. The data are useable for the intended purpose.

RDL Comparison. Reported analytical detection levels for nondetected analytes were compared to the RDLs specified in the SAP (DOE-RL 2005a). When detected results were obtained, evaluation of detection limits was not performed. The data validation and supplemental data evaluation noted any analyses in which the detection limit (MDA or PQL) was above the SAP RDLs for nondetected analytes.

Radionuclides. All of the reported MDAs are sufficiently low for decision-making purposes. All values meet the site cleanup criteria as demonstrated in the calculation briefs (Appendix A) and discussed in this remaining sites verification package.

Nonradionuclides. All of the reported MDLs are sufficiently low for decision-making purposes. All values meet the site cleanup criteria as demonstrated in the calculation briefs (Appendix A) and discussed in this remaining sites verification package.

Precision and Accuracy Evaluation. Analytical accuracy and precision were evaluated by examination of the RPD of the main, duplicate, and split samples (Appendix A). Only the contaminants of concern (COCs) detected at five times the detection limit (or greater) are used for data analysis with respect to accuracy and precision.

Radionuclides. RPDs for the radionuclide analytes were not calculated because an evaluation of the data shows none of the analytes were detected in both the main and duplicate (or split) sample at more than five times the target detection limit.

Nonradionuclides. RPDs for the nonradionuclide analytes were not calculated because an evaluation of the data shows none of the analytes were detected in both the main and duplicate (or split) sample at more than five times the target detection limit. RPDs of analytes detected at low concentrations (less than five times the detection limit) are not considered to be indicative of the analytical system performance. The data are useable for decision-making purposes.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

Field QA/QC measures were used to assess potential sources of error and cross contamination of soil samples that could bias results. Field QA/QC samples listed in the field logbooks (WCH 2006a, 2006b) are summarized in Table B-1. All main and QA/QC sample results are presented in Appendix A.

Table B-1. Summary of Field Quality Control Samples.

Equipment Blank	Main Sample	Duplicate	Split
	J117P3	J117P7	J117X4
J118J1	J117N8	J117P2	J117X3

Field duplicate samples were collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the duplicate samples for each COC. Only analytes with values above five times the detection limits for both the main and duplicate samples are compared. The 95% upper confidence limit (UCL) calculation briefs in Appendix A provide details on duplicate pair evaluation and RPD calculation. The data are suitable for the intended purpose of cleanup verification.

Split samples were collected to provide a relative measure of the degree of variability in the sampling, sample handling, and analytical techniques used by commercial laboratories. The field main and split samples are evaluated by computing the RPD of the split samples for each COC to determine the usability of the verification data. The U.S. Environmental Protection Agency Contract Laboratory Program duplicate sample comparison methodology, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 1994), is used as an initial test of the data from the splits. Only analytes that had values above five times the contractual RDL for both the main and split sample were compared. The 95% UCL calculation brief in Appendix A provides details on split pair RPD calculation. RPDs for the split samples were not calculated because an evaluation of the data shows none of the analytes were detected in both the main and split sample at more than five times the target detection limit.

SUITABILITY OF DATA

The DQA for the 116-F-16 and 100-F-43 waste sites determined that the data are of the right type, quality, and quantity to support site cleanup verification decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. All analytical data were found to be acceptable for decision-making purposes.

REFERENCES

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

BHI, 2000b, *Data Validation Procedure for Radiochemical Analysis*, BHI-01433, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

DOE-RL, 2005a, *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

ENV-1, *Environmental Monitoring and Management*, Washington Closure Hanford, Richland, Washington.

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.

EPA, 2000, *Guidance for Data Quality Assessment*, EPA QA/G-9, QA00 Update, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

WCH, 2006a, *100-F Area RAWD Sampling*, Logbook EFL-1174, Washington Closure Hanford, Richland, Washington.

WCH, 2006b, *100-F Area RAWD Sampling*, Logbook EFL-1174-1, Washington Closure Hanford, Richland, Washington.