WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-DR-1 **Control No.:** 2015-020

Waste Site Code(s)/Subsite Code(s): 100-D-85:2

Reclassification Category: Interim ☒ Final ☐

Reclassification Status: Closed Out ☒ No Action ☐ Rejected ☐
RCRA Postclosure ☐ Consolidated ☐ None ☐

Approvals Needed: DOE ☒ Ecology ☒ EPA ☐

Description of current waste site condition:

The 100-D-85:2, Additional 105-DR Reactor Effluent Pipelines subsite, part of the 100-DR-1 Operable Unit, was a candidate site for confirmatory sampling added to the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units* (Remaining Sites ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999), via the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 2009). Subsequently, the 100-D-85:2 pipelines subsite was identified for remediation due to possible contamination based upon past usage of the pipelines as radioactive effluent sewers for the 105-DR Reactor Building.

The 100-D-85:2 subsite consisted of 16 pipe segments associated with the discharge of effluent from the 105-DR Reactor to the 1608-DR Waste Water Pump House. The pipelines associated with these segments carried process water and steam condensate from sumps, floor drains, sinks, and steam traps on the eastern half of the 105-DR Reactor Building.

Remedial action at the 100-D-85:2 subsite began on March 26, 2014. Approximately, 13,048 bank cubic meters or 17,066 bank cubic yards of soil and debris were removed resulting in an excavation that is a maximum of 6.5 m (21.3 ft) below ground surface. A combination of direct loadout and a staging pile area (SPA) were used to manage the removed material, all of which was ultimately disposed to the Environmental Restoration and Disposal Facility (ERDF). Materials from the SPA area were completely disposed to ERDF by May 6, 2014. Direct loadout from the excavation to ERDF was complete August 13, 2014.

Verification sampling was conducted on January 20 and 21, 2015. The sampling was performed to determine if the waste site met the remedial action objectives (RAOs) and remedial action goals (RAGs) established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP), DOE/RL-97-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2009b), and the Remaining Sites ROD (EPA 1999). The selected remedy involved (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at ERDF, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the site for reclassification to Interim Closed Out.

Basis for reclassification:

Cleanup verification sampling results were evaluated in comparison to the RAGs. In accordance with this evaluation, the verification sampling results support a reclassification of this waste site to Interim Closed Out. The current site conditions achieve the RAOs and the corresponding RAGs established in the 100 Area RDR/RAWP (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999). The evaluation, which may include fate-and-transport modeling, of all verification sample data collected from the 100-D-85:2 subsite resulted in a determination that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-D-85:2, Additional 105-DR Reactor Effluent Pipelines Subsite* (attached). Contamination above direct exposure levels was not observed in shallow zone soils and is concluded to not exist in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-DR-1 **Control No.:** 2015-020

Waste Site Code(s)/Subsite Code(s): 100-D-85:2

Regulator comments:

Waste Site Controls:

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

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

J. P. Neath	J P Neath	6/4/15
DOE Federal Project Director (printed)	Signature	Date
N. Menard	Nina M. Menard	6/9/15
Ecology Project Manager (printed)	Signature	Date
N/A		
EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-85:2, ADDITIONAL 105-DR REACTOR EFFLUENT PIPELINES SUBSITE

Attachment to Waste Site Reclassification Form 2015-020

June 2015

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-85:2, ADDITIONAL 105-DR REACTOR EFFLUENT PIPELINES SUBSITE

EXECUTIVE SUMMARY

The 100-D-85:2, Additional 105-DR Reactor Effluent Pipelines subsite, part of the 100-DR-1 Operable Unit, was a candidate site for confirmatory sampling added to the *Interim Action Record of Decision for the 100-BC 1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units* (Remaining Sites ROD) (EPA 1999), via the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision* (EPA 2009). Subsequently, the 100-D-85:2 pipelines subsite was identified for remediation due to possible contamination based upon past usage of the pipelines as radioactive effluent sewers for the 105-DR Reactor Building (WCH 2010).

The 100-D-85:2 waste consisted of 16 pipe segments associated with the discharge of effluent from the 105-DR Reactor to the 1608-DR Waste Water Pump House (132-DR-1). The pipelines carried process water and steam condensate collected from sumps, floor drains, sinks, and steam traps on the eastern half of the 105-DR Building. The process water drained by gravity to the 1608-DR Waste Water Pump House where it was pumped to the main effluent pipeline (100-D-49:3). Many of the 100-D-85:2 pipelines were found to be leaking in 1958 (GE 1958a, 1958c). Repairs were made and the steam condensate drains were disconnected from the sewers (100-D-85:2) on the north end of the building (GE 1958b).

Remedial action at the 100-D-85:2 subsite began on March 26, 2014. Approximately 13,048 bank cubic meters or 17,066 bank cubic yards of soil and debris were removed resulting in an excavation which is a maximum of 6.5 m (21.3 ft) below ground surface. A combination of direct loadout and a staging pile area (SPA) were used to manage the removed material, all of which was ultimately disposed to the Environmental Restoration and Disposal Facility (ERDF). Materials from the SPA were completely disposed to ERDF by May 6, 2014. Direct loadout from the excavation to ERDF was complete on August 13, 2014. The concrete foundation of the 132-DR-1, 1608-DR Waste Water Pumping Station was uncovered on the northern edge of the excavation and extends down into the deep zone of the excavation. The demolished above ground portion as well as the remaining subsurface foundation of the 132-DR-1 Building were Interim Closed Out by waste site reclassification form 2005-035 (WCH 2005). There were no observed anomalies.

Verification sampling was conducted on January 20 and 21, 2015, per the *Work Instruction for Verification Sampling of the 100-D-85:2, Additional 105-DR Reactor Effluent Pipelines* (WCH 2015b). The sampling results indicate that the waste removal action achieved compliance with the remedial action objectives (RAOs) and remedial action goals (RAGs) of the Remaining Sites ROD (EPA 1999). A summary of the cleanup evaluation for the soil results against the applicable criteria is presented in Table ES-1.

Table ES-1. Summary of Remedial Action Goals for the 100-D-85:2 Waste Site.

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain a dose rate of <15 mrem/yr above background for 1,000 years.	The maximum predicted cumulative dose rate is 1.09 mrem/yr, which is less than 15 mrem/yr.	Yes
Direct Exposure – Nonradionuclides	Attain individual COPC direct exposure RAGs.	All individual COPC concentrations are below the direct exposure criteria.	Yes
Risk Requirements – Nonradionuclides	Attain a hazard quotient of <1 for all individual noncarcinogens.	The hazard quotients for individual nonradionuclide COPCs are <1.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogens.	The cumulative hazard quotient for all sampling areas (1.9×10^{-3}) is <1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	The excess cancer risks for individual carcinogens are $<1 \times 10^{-6}$.	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	The cumulative excess cancer risk, is 3.1×10^{-7}, which is $<1 \times 10^{-5}$.	
Groundwater/River Protection – Radionuclides	Attain single-COPC groundwater and river protection RAGs.	All individual radionuclide concentrations are below the groundwater and river cleanup requirements.	Yes
	Attain national primary drinking water standards [a]: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.		
	Meet drinking water standards for alpha emitters: the most stringent of 15 pCi/L MCL or 1/25th of the derived concentration guides from DOE Order 5400.5 [b].		
	Meet total uranium standard of 30 µg/L (21.2 pCi/L) [c].		

Table ES-1. Summary of Remedial Action Goals for the 100-D-85:2 Waste Site.

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	All individual COPC concentrations are below the groundwater and river cleanup requirements with the exception of aroclor-1254. However, RESRAD modeling predicts residual concentrations of aroclor-1254 to be protective of groundwater and the Columbia River.	Yes [d]

[a] "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).
[b] *Radiation Protection of the Public and the Environment* (DOE Order 5400.5).
[c] Based on the isotopic distribution of uranium in the 100 Area, the 30 µg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* (BHI 2001).
[d] Based on the RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), the residual concentration of aroclor-1254 is not expected to migrate more than 1 m (3.3 ft) vertically in 1,000 years (based on the distribution coefficient of 75.6 mL/g). The vadose zone underlying the soil below the 100-D-85:2 excavation is a minimum of 18 m (59 ft) thick; therefore, residual concentrations of aroclor-1254 are predicted to be protective of groundwater and the Columbia River.

COPC = contaminant of potential concern
MCL = maximum contaminant level
RAG = remedial action goal
RDR/RAWP= remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)

The results of the verification sampling are used to make reclassification decisions for the 100-D-85:2 subsite in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2011). In accordance with this evaluation, the verification sampling results support a reclassification of this waste site to Interim Closed Out. The current site conditions achieve the RAOs and the corresponding RAGs established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999). The results of verification sampling show that residual contaminant concentrations do not preclude any future uses, as bounded by the rural-residential scenario, and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Contamination above direct exposure levels was not observed in the shallow zone soils and is concluded to not exist in deep zone soils (i.e., below 4.6 m [15 ft]); therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the site contaminants of potential concern and other constituents. Ecological screening levels from the *Washington Administrative Code* 173-340, "Model Toxics Control Act – Cleanup," were exceeded for boron and vanadium.

The U.S. Environmental Protection Agency ecological soil screening levels were exceeded for antimony, manganese, vanadium, and zinc. Exceedance of screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of antimony, manganese, vanadium, and zinc are below background levels, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for ecological effects as a part of the final closeout decision for this site. A table showing contaminant concentrations from the 100-D-85:2 subsite that exceed ecological screening levels is provided in Appendix A.

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-85:2, ADDITIONAL 105-DR REACTOR EFFLUENT PIPELINES SUBSITE

STATEMENT OF PROTECTIVENESS

The 100-D-85:2, Additional 105-DR Reactor Effluent Pipelines subsite verification sampling data, site evaluations, and supporting documentation demonstrate that this site meets the objectives established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 2009b) and the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD) (EPA 1999).

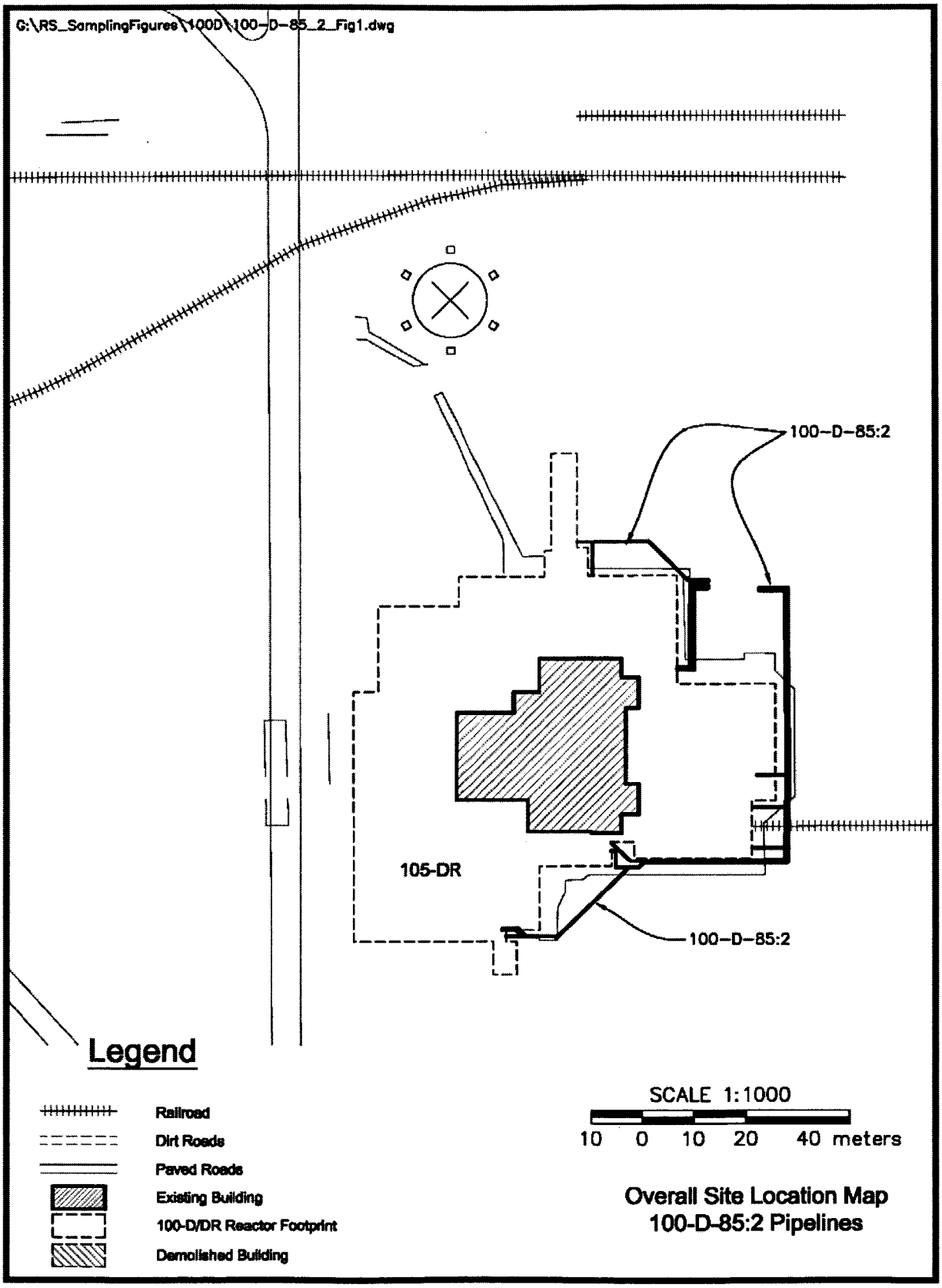
The results of verification sampling show that residual soil concentrations do not preclude any future land uses that can be represented (or bounded) by a rural-residential scenario and allow for unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that contaminant levels remaining in the soil are protective of groundwater and the Columbia River. Contamination above direct exposure levels was not observed in shallow zone soils and is concluded to not exist in the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the site contaminants of potential concern (COPCs) and other constituents. Ecological screening levels from the *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup," were exceeded for boron and vanadium. The U.S. Environmental Protection Agency (EPA) ecological soil screening levels were exceeded for antimony, manganese, vanadium, and zinc. Exceedance of screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of antimony, manganese, vanadium, and zinc are below background levels, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for ecological effects as a part of the final closeout decision for this site. A table showing contaminant concentrations from the 100-D-85:2 subsite that exceed ecological screening levels is provided in Appendix A.

GENERAL SITE INFORMATION AND BACKGROUND

The 100-D-85:2, Additional 105-DR Reactor Effluent Pipelines subsite consists of 16 pipeline segments located to the south and northeast of the 105-DR Reactor, with several pipelines located in each of these areas (Figure 1).

Figure 1. 100-D-85:2 Subsite Location Map.



The 100-D-85:2 subsite includes remaining underground pipelines that transported radioactive treated and untreated wastewater from the 105-DR Reactor Building and the 1608-DR Lift Station (132-DR-1 waste site). Two large main effluent pipelines drained cooling water from the 105-DR Reactor. The small effluent pipelines that drained process waste from the sides (east and south) of the 105-DR Reactor were joined into a single pipeline that ran to the 1608-DR Building. The 1608-DR Building was a rectangular-shaped, two-story reinforced concrete structure that was halfway below grade elevation.

The 100-D-85:2 pipeline segments were not previously assigned to an existing Waste Information Data System site and there was insufficient information to account for their removal during nearby remedial actions at the 118-DR-2:2 and 100-D-49:4 waste sites.

The 100-D-85:2 subsite was recommended for remedial action due to possible contamination based upon past usage of the pipelines as radioactive effluent sewers for the 105-DR Reactor Building (WCH 2010).

REMEDIAL ACTION SUMMARY

Remedial action at the 100-D-85:2 subsite began on March 26, 2014. Approximately 13,048 bank cubic meters (17,066 bank cubic yards) of soil and debris were removed resulting in an excavation that is a maximum of 6.5 m (21.3 ft) below ground surface (bgs). A combination of direct loadout and a staging pile area (SPA) were used to manage the removed material, all of which was ultimately disposed to the Environmental Restoration and Disposal Facility (ERDF). Materials from the SPA area were completely disposed to ERDF by May 6, 2014. Direct loadout from the excavation to ERDF was complete on August 13, 2014. There were no observed anomalies.

Materials removed from the 100-D-85:2 excavation included concrete, rebar, and steel pipe. Within the excavation the partially intact subsurface concrete foundations of several buildings were uncovered and remain.

The concrete foundation of the 132-DR-1, 1608-DR Waste Water Pumping Station was uncovered on the northern edge of the excavation and extends down into the deep zone of the excavation. The demolished above-ground portion as well as the remaining subsurface foundation of the 132-DR-1 Building were Interim Closed Out by waste site reclassification form 2005-035 (WCH 2005). Supporting documentation for the closure of the 132-DR-1 Building includes the data from an allowable residual contamination level calculation that was used to show that no additional decontamination of radiological constituents is needed and allowed for the remainder of the facility to be buried in place. During downposting of the 100-D-85:2 excavation, a radiological control technician identified low level removable radioactivity on a deep zone portion of the remaining 132-DR-1 concrete. This residual contamination is associated with the closed 132-DR-1 Building and is not considered part of the 100-D-85:2 pipeline subsite.

VERIFICATION SAMPLING ACTIVITIES

This section describes the basis for selection of a verification sampling design for the 100-D-85:2 subsite. Two decision units were identified for the 100-D-85:2 subsite consisting of the excavation and the SPA. These areas are in total approximately 5,163 m^2 (58,808 ft^2). A statistical sample design was utilized to evaluate each decision unit. No residual staining or anomalies were identified within the excavated waste site and SPA. Concrete protruding into the excavation was excluded from the sample design. The areas dominated by concrete appear as unmarked white areas on the excavation sample map (Figure 2).

Contaminants of Concern for Verification Sampling

The COPCs for the 100-D-85:2 subsite were identified based on historical information for the 105-DR Reactor Building effluent, the results of sampling at the 100-D-49:4 pipelines, and professional judgement. The radionuclide COPCs include americium-241, cesium-137, cobalt-60, europium-152, europium-154, europium-155, nickel-63, plutonium-238, plutonium-239/240, strontium-90, uranium-234, uranium-235, and uranium-238.

The nonradionuclide COPCs included hexavalent chromium, lead, mercury, sulfate, nitrate, and polychlorinated biphenyls (PCBs). While not considered COPCs, analysis for the remaining constituents of the expanded inductively coupled plasma (ICP) metals list were also included for the verification samples.

Verification Sampling Design

Verification sampling was conducted on January 20 and 21, 2015, per the *Work Instruction for Verification Sampling of the 100-D-85:2, Additional 105-DR Reactor Effluent Pipelines* (WCH 2015b). Twelve statistical verification soil samples plus a duplicate soil sample were collected from the excavation, and 12 statistical verification soil samples plus a duplicate were collected from the SPA decision units. Additionally, an equipment blank sample was collected. All sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management*, to fulfill the requirements of the *100 Area Remedial Action Sampling and Analysis Plan* (DOE-RL 2009a). Sampling was conducted to support a determination that residual contaminant concentrations in the soil meet cleanup criteria specified in the 100 Area RDR/RAWP (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999). The 100-D-85:2 subsite verification sample locations are shown in Figures 2 and 3.

A summary of the verification samples collected and laboratory analyses performed is provided in Table 1. Table 2 identifies the EPA-approved methods for the analyses performed for verification sampling. Additional information related to verification sampling can be found in the field sampling logbooks (WCH 2015a).

Figure 2. Sampling Locations for the 100-D-85:2 Excavation.

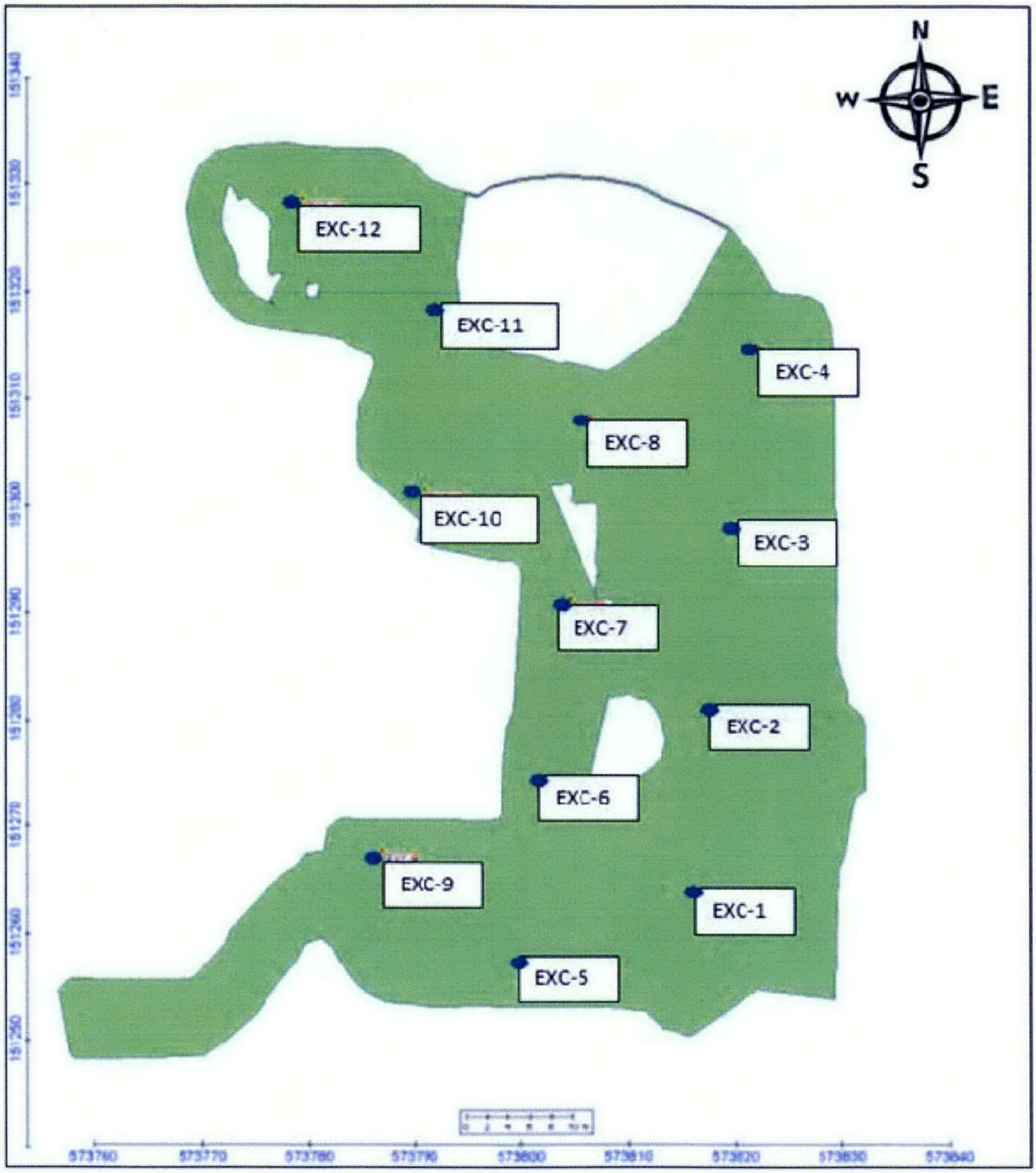


Figure 3. Sampling Locations for the 100-D-85:2 Staging Pile Area.

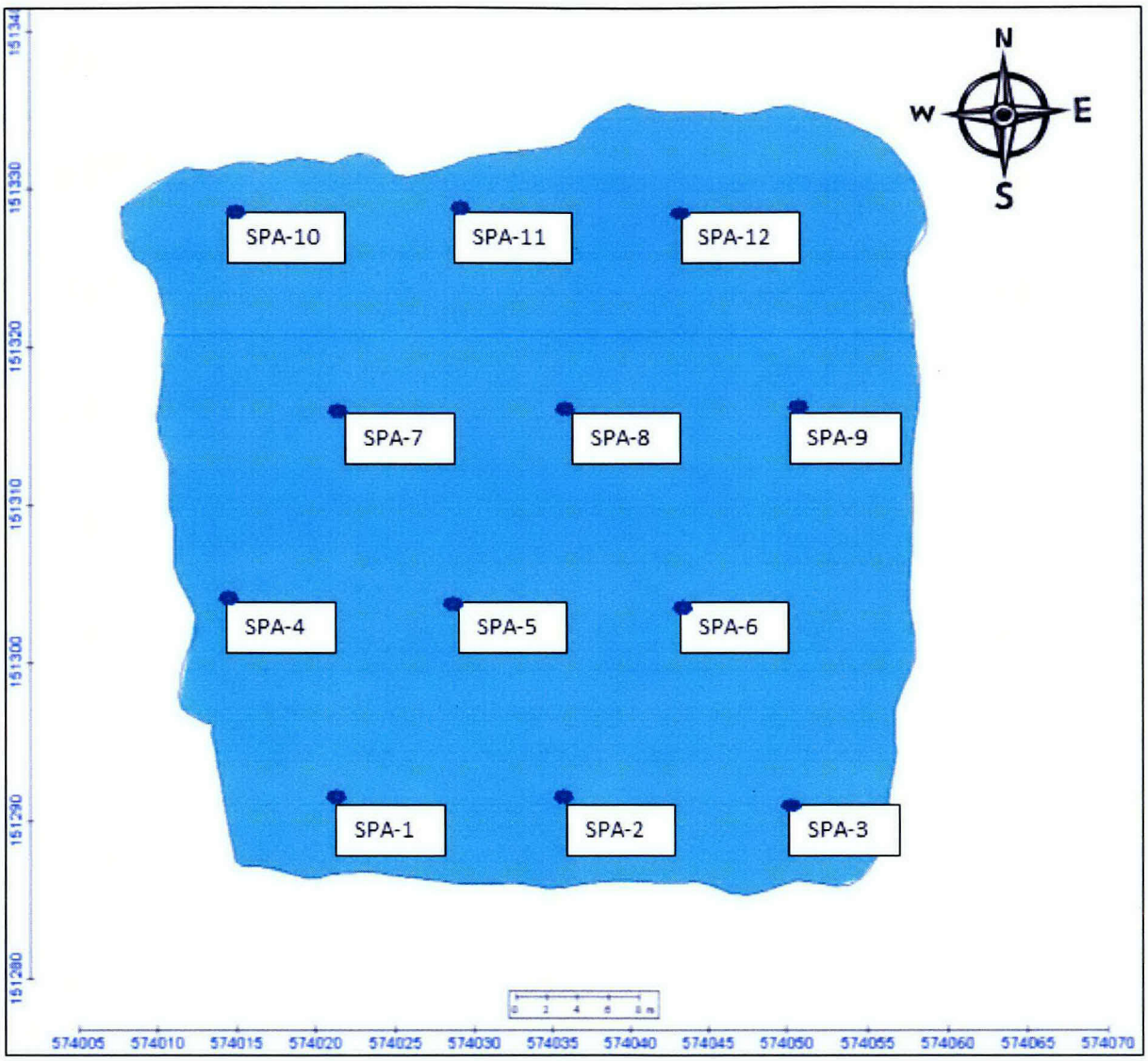


Table 1. 100-D-85:2 Verification Sample Summary.

Sample Location	HEIS Sample Number	Washington State Plane Coordinates (m)		Sample Analysis
		Northing	Easting	
Excavation Samples				
EXC-1	J1V321	151264.2	573816.1	Americium-241, GEA, nickel-63, isotopic plutonium, strontium-90, isotopic uranium, hexavalent chromium, IC anions, NO_2/NO_3, ICP metals [a], mercury, and PCBs
EXC-2	J1V322	151281.1	573818.1	
EXC-3	J1V323	151297.9	573820.2	
EXC-4	J1V324	151314.8	573822.3	
EXC-5	J1V325	151257.5	573800.4	
EXC-6	J1V326	151274.4	573802.5	
EXC-7	J1V327	151291.3	573804.6	
EXC-8	J1V328	151308.2	573806.6	
EXC-9	J1V329	151267.8	573786.8	
EXC-10	J1V330	151301.5	573791.0	
EXC-11	J1V331	151318.4	573793.0	
EXC-12	J1V332	151328.7	573779.5	
Duplicate of EXC-5	J1V333	151257.5	573800.4	
Staging Pile Area Samples				
SPA-1	J1V340	151289.3	574022.5	Americium-241, GEA, nickel-63, isotopic plutonium, strontium-90, isotopic uranium, hexavalent chromium, IC anions, NO_2/NO_3, ICP metals [a], mercury, and PCBs
SPA-2	J1V341	151289.3	574036.9	
SPA-3	J1V342	151289.3	574051.3	
SPA-4	J1V343	151301.8	574015.3	
SPA-5	J1V344	151301.8	574029.7	
SPA-6	J1V345	151301.8	574044.1	
SPA-7	J1V346	151314.2	574022.5	
SPA-8	J1V347	151314.2	574036.9	
SPA-9	J1V348	151314.2	574051.3	
SPA-10	J1V349	151326.7	574015.3	
SPA-11	J1V350	151326.7	574029.7	
SPA-12	J1V351	151326.7	574044.1	
Duplicate of SPA-10	J1V352	151326.7	574015.3	
Field Quality Assurance Sample				
Equipment blank	J1V353	NA	NA	ICP metals [a], mercury

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

GEA = gamma energy analysis
HEIS = Hanford Environmental Information System
IC = ion chromatography
ICP = inductively coupled plasma
NA = not applicable
PCB = polychlorinated biphenyl

Table 2. Laboratory Analytical Methods.

Analytical Method	Contaminants of Potential Concern
Isotopic americium	Americium-241
Gamma energy analysis	Cesium-137, cobalt-60, europium-152, europium-154, europium-155
Ni-63 scintillation	Nickel-63
Isotopic plutonium	Plutonium-238, plutonium-239/240
Total Sr-90 scintillation	Strontium-90
Isotopic uranium	Uranium-234, uranium-235, uranium-238
IC anions – Method 9056	Sulfate
Nitrate/nitrite – Method 353.2	Nitrate
ICP metals [a] – EPA Method 6010	Lead
Mercury – EPA Method 7471	Mercury
Hexavalent chromium – EPA Method 7196	Hexavalent chromium
PCB – EPA Method 8082	PCBs

[a] Analysis for the expanded ICP metals analytical list was performed to include antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.
EPA = U.S. Environmental Protection Agency
IC = ion chromatography
ICP = inductively coupled plasma
PCB = polychlorinated biphenyl

Verification Sampling Results

All verification samples were collected for full protocol laboratory analysis and analyzed using EPA-approved analytical methods. Evaluation of the statistical verification data from the 100-D-85:2 excavation and SPA was performed by direct comparison of the statistical result for each COPC against the cleanup criteria.

The primary statistical calculation to evaluate compliance with cleanup standards is the 95% upper confidence limit (UCL) on the arithmetic mean of the data. The 95% UCL values for each detected COPC are computed for the 100-D-85:2 subsite decision units as specified by the 100 Area RDR/RAWP (DOE-RL 2009b). The calculations are provided in Appendix B. When a nonradionuclide COPC was detected in fewer than 50% of the verification samples collected for the decision unit, the maximum detected value was used for comparison to the remedial action goals (RAGs). If no detections for a given COPC were reported in the data set, then no statistical calculation or evaluation was performed for that COPC.

Comparisons of the statistical sample results to the site RAGs for the 100-D-85:2 subsite are presented in Tables 3 and 4.

Table 3. Comparison of the Contaminant Concentrations to Remedial Action Goals for the 100-D-85:2 Subsite Excavation. (2 Pages)

COPC	Statistical or Maximum Result[b] (pCi/g)	Site Lookup Values[a]			Direct Exposure	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Radiological Remedial Action Goals (pCi/g)[a] 100-D-85:2 Subsite Excavation						
Cesium-137	0.0658 (<BG)	6.2	1,465	2,930	No	--
Europium-152	0.0400	3.3	-	-[c]	No	--
Europium-155	0.0468	125	-	-[c]	No	--
Total beta radiostrontium	0.194	4.5	27.6	55.2	No	--
Uranium-234	0.499 (<BG)	1.1[d]	1.1[d]	1.1[d]	No	--
Uranium-235	0.0241 (<BG)	0.61	0.5[e]	0.5[e]	No	--
Uranium-238	0.433 (<BG)	1.1[d]	1.1[d]	1.1[d]	No	--
COPC	**Statistical or Maximum Result[b] (mg/kg)**	**Remedial Action Goals[a]**			**Does the Result Exceed RAGs?**	**Does the Result Pass RESRAD Modeling?**
		Direct Exposure	**Soil Cleanup Level for Groundwater Protection**	**Soil Cleanup Level for River Protection**		
Nonradiological Remedial Action Goals (mg/kg)[a] 100-D-85:2 Subsite Excavation						
Antimony	1.2 (<BG)	32	5[d]	5[d]	No	--
Arsenic	2.6 (<BG)	20[d]	20[d]	20[d]	No	--
Barium	67.2 (<BG)	5,600	200	400	No	--
Beryllium	0.37 (<BG)	10.4[f]	1.51[d]	1.51[d]	No	--
Boron	0.90	7,200	320	--	No	--
Cadmium	0.13 (<BG)	13.9[f]	0.81[d]	0.81[d]	No	--
Chromium	8.6 (<BG)	80,000	18.5[d]	18.5[d]	No	--
Cobalt	9.7 (<BG)	24	15.7[d]	--	No	--
Copper	16.6 (<BG)	2,960	59.2	22.0[d]	No	--
Hexavalent chromium	0.180	2.1[f]	4.8	2	No	--
Lead	3.8 (<BG)	353	10.2[d]	10.2[d]	No	--
Manganese	336(<BG)	3,760	512[d]	512[d]	No	--
Mercury	0.012 (<BG)	24	0.33[d]	0.33[d]	No	--
Molybdenum	0.25	400	8	--	No	--
Nickel	10.6 (<BG)	1,600	19.1[d]	27.4	No	--
Vanadium	73.7 (<BG)	560	85.1[d]	--	No	--
Zinc	50.9 (<BG)	24,000	480	67.8[d]	No	--
Chloride	5.5 (<BG)	--	25,000	--	No	--
Fluoride	1.1 (<BG)	4,800	96	400	No	--
Nitrogen in nitrate	1.0 (<BG)	128,000	1,000	2,000	No	--
Nitrogen in nitrate and nitrite	0.47 (<BG)	128,000	1,000	2,000	No	--
Sulfate	52.5 (<BG)	--	25,000	--	No	--

Table 3. Comparison of the Contaminant Concentrations to Remedial Action Goals for the 100-D-85:2 Subsite Excavation. (2 Pages)

COPC	Statistical or Maximum Result[b] (mg/kg)	Remedial Action Goals[a]			Does the Result Exceed RAGs?	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Aroclor-1254	0.088	0.5	0.017[c]	0.017[c]	Yes	Yes[g]

[a] RAGs obtained from the 100 Area RDR/RAWP (DOE-RL 2009b).
[b] Maximum or 95% UCL values, depending on data censorship, as described in the *100-D-85:2 Waste Site Cleanup Verification 95% UCL Calculations* (Appendix B).
[c] No value; because the Kd value for this contaminant is greater than 80 mL/g, RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009) predicts that the contaminant will show no migration within the 100 Area vadose zone and no impact on groundwater or the Columbia River.
[d] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(6)(d) (Ecology 1996).
[e] Where cleanup levels are less than RDLs, cleanup levels default to RDLs per WAC 173-340 707(2) (Ecology 1996).
[f] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3]) using an airborne particulate mass-loading rate of 0.0001 g/m^3 (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).
[g] Based on the RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), the residual concentration of aroclor-1254 is not expected to migrate vertically more than 1m (3.3 ft) in 1,000 years (based on the K_d of 75.6 mL/g). The vadose zone underlying the soil below the 100-D-85:2 excavation is a minimum of 18 m (59 ft) thick; therefore, residual concentrations of aroclor-1254 are predicted to be protective of groundwater and the Columbia River.

-- = not applicable
BG = background
COPC = contaminant of potential concern
K_d = distribution coefficient
RAG = remedial action goal
RDL = required detection limit
RDR/RAWP= remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)
UCL = upper confidence limit
WAC = *Washington Administrative Code*

Table 4. Comparison of the Contaminant Concentrations to Action Levels for the 100-D-85:2 Subsite Staging Pile Area Verification Samples. (2 Pages)

COPC	Statistical or Maximum Result[b] (pCi/g)	Site Lookup Values[a]			Does the Result Exceed RAGs?	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Radiological Remedial Action Goals (pCi/g)[a] 100-D-85:2 Subsite Staging Pile Area						
Cesium-137	0.106 (<BG)	6.2	1,465	2,930	No	--
Uranium-234	0.194 (<BG)	1.1[c]	1.1[c]	1.1[c]	No	--
Uranium-238	0.224 (<BG)	1.1[c]	1.1[c]	1.1[c]	No	--

Table 4. Comparison of the Contaminant Concentrations to Action Levels for the 100-D-85:2 Subsite Staging Pile Area Verification Samples. (2 Pages)

COPC	Statistical or Maximum Result[b] (mg/kg)	Remedial Action Goals[a]			Does the Result Exceed RAGs?	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Nonradiological Remedial Action Goals (mg/kg)[a] 100-D-85:2 Subsite Staging Pile Area						
Antimony	1.3 (<BG)	32	5[c]	5[c]	No	--
Arsenic	2.7 (<BG)	20[c]	20[c]	20[c]	No	--
Barium	60.8 (<BG)	5,600	200	400	No	--
Beryllium	0.62 (<BG)	10.4[d]	1.51[c]	1.51[c]	No	--
Cadmium	0.13 (<BG)	13.9[d]	0.81[c]	0.81[c]	No	--
Chromium	7.4 (<BG)	80,000	18.5[c]	18.5[c]	No	--
Cobalt	11.5 (<BG)	24	15.7[c]	--	No	--
Copper	15.9 (<BG)	2,960	59.2	22.0[c]	No	--
Hexavalent chromium	0.282	2.1[e]	4.8	2	No	--
Lead	3.2 (<BG)	353	10.2[c]	10.2[c]	No	--
Manganese	320 (<BG)	3,760	512[c]	512[c]	No	--
Mercury	0.0070 (<BG)	24	0.33[c]	0.33[c]	No	--
Nickel	9.3 (<BG)	1,600	19.1[c]	27.4	No	--
Vanadium	74.7 (<BG)	560	85.1[c]	--	No	--
Zinc	44.9 (<BG)	24,000	480	67.8[c]	No	--
Fluoride	1.3 (<BG)	4,800	96	400	No	--
Nitrogen in nitrate	0.87 (<BG)	128,000	1,000	2,000	No	--
Sulfate	8.8 (<BG)	--	25,000	--	No	--

[a] RAGs obtained from the 100 Area RDR/RAWP (DOE-RL 2009b).
[b] Maximum or 95% UCL values, depending on data censorship, as described in the *100-D-85:2 Waste Site Cleanup Verification 95% UCL Calculations* (Appendix B).
[c] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(6)(d) (Ecology 1996).
[d] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3]) using an airborne particulate mass-loading rate of 0.0001 g/m^3 (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).

-- = not applicable
BG = background
COPC = contaminant of potential concern
RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)
UCL = upper confidence limit
WAC = *Washington Administrative Code*

Contaminants that were not detected by laboratory analysis are excluded from these tables. Calculated cleanup levels are not presented in the Cleanup Levels and Risk Calculations database (Ecology 2014) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations; therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COPCs and are also not included in these tables.

The complete laboratory results are stored in a Washington Closure Hanford (WCH) project-specific database prior to submitting to the Hanford Environmental Information System (HEIS) for archiving and are provided in Appendix B.

DATA EVALUATION

This section demonstrates that remedial actions at the 100-D-85:2 subsite have achieved the applicable RAGs developed to support unrestricted land use at the 100 Area as established in the Remaining Sites ROD (EPA 1999) and documented in the 100 Area RDR/RAWP (DOE-RL 2009b).

Attainment of Nonradionuclide RAGs

Tables 3 and 4 compare the cleanup verification sample results for the 100-D-85:2 subsite excavation area and SPAs to the applicable soil RAGs for direct exposure, protection of groundwater, and the Columbia River. All COPCs were quantified below direct exposure, groundwater, and river protection soil RAGs with the exception of aroclor-1254. Due to the high distribution coefficient (K_d) of aroclor-1254 (75.6 mL/g), RESidual RADioactivity (RESRAD) modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b) predicts aroclor-1254 will not migrate more than 1m (3.3 ft) vertically in 1,000 years. A contaminant with a K_d of 80 mL/g or greater is not predicted to migrate vertically through the soil. The vadose zone underlying the soil below the 100-D-85:2 excavation is a minimum of 18 m (59 ft) thick; therefore, residual concentrations of aroclor-1254 are predicted to be protective of groundwater and the Columbia River.

Attainment of Radionuclide Direct Exposure RAGs

Evaluation of RAG attainment for radionuclides was performed using the single-radionuclide dose-equivalence lookup values. The model used to develop these dose-equivalence lookup values is presented in the RDR/RAWP (DOE-RL 2009b). A comparison of the radionuclide verification sample results for the statistical data set to the cumulative direct exposure radiological dose limit of 15 mrem/yr was conducted using sum-of-fractions calculations (Appendix B). The sum of fractions were conservatively calculated for the 100-D-85:2 subsite excavation and staging pile decision units data sets using the greater of the statistical or maximum value for each COPC.

The sum of fractions shown in the *100-D-85:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations* in Appendix B determined that the maximum predicted total radiological dose is 1.09 mrem/yr for the excavation decision unit. Comparing this to the dose limit of <15 mrem/yr, the requirement is met.

Three-Part Test for Nonradionuclides

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

The application of the three-part test for the 100-D-85:2 subsite is included in the statistical calculations, where half or more of the data set was detected (Appendix B). The results of this evaluation indicate that residual COPC concentrations pass the three-part test in comparison against applicable RAGs, with the exception of the aroclor-1254 result for the excavation. However, as discussed above, RESRAD modeling predicts that the residual concentrations of aroclor-1254 are predicted to be protective of groundwater and the Columbia River.

Nonradionuclide Direct Contact Hazard Quotient and Carcinogenic Risk RAGs Attained

Nonradionuclide risk requirements include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than 1×10^{-6}, and a cumulative carcinogenic risk of less than 1×10^{-5}. For the 100-D-85:2 subsite, these risk values were not calculated for constituents that were either not detected or were detected at concentrations below Hanford Site or Washington State background. All individual hazard quotients for noncarcinogenic constituents were less than 1.0. The cumulative hazard quotient for those noncarcinogenic constituents above background or detected levels is 1.9×10^{-3}, which is less than 1.0. All individual contaminant carcinogenic risks were less than 1×10^{-6}. The total carcinogenic risk is 3.1×10^{-7}, which is below the cumulative cancer risk standard of 1×10^{-5}. Therefore, the 100-D-85:2 subsite meets the requirements for the direct contact hazard quotient and excess carcinogenic risk as identified in the 100 Area RDR/RAWP (DOE-RL 2009b).

Nonradionuclide Groundwater Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 100-D-85:2 subsite included calculations of the hazard quotient and carcinogenic (excess cancer) risk values for groundwater protection for nonradionuclides. The requirements include an individual and cumulative hazard quotient of less than 1.0, an individual excess carcinogenic risk of less than 1×10^{-6}, and a cumulative excess carcinogenic risk of less than 1×10^{-5}. These risk values were conservatively calculated for the entire waste site using the maximum value for each COPC. Risk values were calculated for constituents that were detected at concentrations above Hanford Site or Washington State background values or for which there is no background value. In addition, the K_d values for these contaminants are less than that necessary to show no migration to groundwater in 1,000 years based on RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b). Based on this model and a vadose zone of approximately 18 m (59 ft) in thickness at the excavation, a K_d of 4.1 or greater is required to show no predicted migration to groundwater within 1,000 years. All individual hazard quotients for noncarcinogenic constituents are less than 1.0. The cumulative hazard quotient for the 100-D-85:2 subsite is 6.2×10^{-2}, which is less than 1.0. Boron and hexavalent chromium were the only constituents

that met the criteria for these calculations. Neither of these constituents have carcinogenic RAGs associated with groundwater; therefore, the cumulative excess carcinogenic risk is zero and the criterion for excess cancer risk is met. Nonradionuclide risk requirements related to groundwater are met.

DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the verification sampling approach, the field logbook (WCH 2015a), and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications. The DQA for the 100-D-85:2 subsite established that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. The cleanup verification sample analytical data are stored in a WCH project-specific database for data evaluation prior to archival in the HEIS and are summarized in Appendix B. The detailed DQA is presented in Appendix C.

SUMMARY FOR INTERIM CLOSURE

The 100-D-85:2 subsite has been evaluated in accordance with the Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009b). Verification sampling was performed, and the analytical results indicate that the residual concentrations of COPCs at the 100-D-85:2 subsite meet the remedial action objectives for direct exposure, groundwater protection, and river protection. In accordance with this evaluation, the verification sampling results support a reclassification of the 100-D-85:2 subsite to Interim Closed Out. Contamination above direct exposure levels was not observed in the shallow zone soils and is concluded to not exist in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

REFERENCES

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APPENDIX A

ECOLOGICAL RISK COMPARISON TABLE

Table A-1. Contaminants Exceeding Ecological Screening Levels for the 100-D-85:2 Subsite [a].

Hazardous Substance		2007 WAC 173-340 Table 749-3			EPA Ecological Soil Screening Levels [b]				Waste Site Analyses
		Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian [c]	Mammalian [c]	
Metals (mg/kg)									
	Background								
Antimony	5	5	--	--	--	78	--	0.27	1.3 (<BG)
Boron	--[d]	0.5	--	--	--	--	--	--	0.9
Manganese	512	1,100 [e]	--	1,500	220	450	4,300	4,000	336 (<BG)
Vanadium	85.1	2	--	--	--	--	7.8	280	74.7 (<BG)
Zinc	67.8	86 [e]	200	360	160	120	46	79	50.9 (<BG)

NOTE: Shaded cells are exceeded by the maximum or the statistical result.
Blank cells = Values not available.

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

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

[c] Wildlife.

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

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

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

APPENDIX B

CALCULATIONS

APPENDIX B

CALCULATION BRIEFS

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

100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations, 0100D-CA-V0592, Rev. 0, Washington Closure Hanford, Richland, Washington.

100-D-85:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations, 0100D-CA-V0593, Rev. 0, Washington Closure Hanford, Richland, Washington.

100-D-85:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater Hazard, 0100D-CA-V0594, Rev. 0, Washington Closure Hanford, Richland, Washington.

DISCLAIMER FOR CALCULATIONS

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

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CALCULATION COVER SHEET

Project Title: 100-D Area Closure Operations **Job No. 14655**

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0592

Subject: 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculation

Computer Program: Excel Program No: Excel 2010

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 18 Attm. 1 = 10 Total = 29	J. D. Skoglie	I. B. Berezovskiy	R. J. Nielson	S. G. Wilkinson	6/11/15

SUMMARY OF REVISION

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

Washington Closure Hanford **CALCULATION SHEET**

Originator	J. D. Skoglie	**Date**	03/26/15	**Calc. No.** 0100D-CA-V0592	**Rev. No.** 0
Project	100-D Area Closure Operations	**Job No.**	14655	**Checked** I. B. Berezovskiy	**Date** 03/26/15
Subject	100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations				**Sheet No.** 1 of 18

Summary

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

Table of Contents:
Sheets 1 to 4 - Calculation Sheet Summary
Sheet 5 to 12- Calculation Sheet Verification Data - Excavation and Staging Pile Area
Sheet 13 to 16 - Ecology Software (MTCAStat) Results
Sheet 17 and 18 - Calculation Sheet Duplicate Analysis
Attachment 1 - 100-D-85:2 Verification Sampling Results (10 sheets)

Given/References:
1) Sample Results (Attachment 1).
2) Background values and remedial action goals (RAGs) are taken from DOE-RL (2005b), DOE-RL (2001), and Ecology (1996).
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, 2009a, *100 Area Remedial Action Sampling and Analysis Plan* (SAP), DOE/RL-96-22, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
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6) Ecology, 1992, *Statistical Guidance for Ecology Site Managers*, Publication #92-54, Washington Department of Ecology, Olympia, Washington.
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9) Ecology, 2014, Cleanup Levels and Risk Calculations (CLARC) Database, Washington State Department of Ecology, Olympia, Washington, <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.
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 2009b). Use data from attached worksheets to perform the 95% UCL calculation for each analyte, the WAC 173-340-740(7)(e) 3-part test for nonradionuclides, and the RPD calculations for each COC/COPC. The hazard quotient and carcinogenic risk calculations are located in a separate calculation brief as an appendix to the Remaining Sites Verification Package (RSVP).

Calculation Description:
The subject calculations were performed on statistical data from soil verification samples (Attachment 1) from the 100-D-85:2 subsite. The data were entered into an EXCEL 2010 spreadsheet and calculations performed by using the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2009b) is documented by this calculation. Duplicate RPD results are used in evaluation of data quality within the RSVP for this site.

Methodology:
The 100-D-85:2 subsite underwent statistical sampling at two decision units for verification sampling that included the excavation and staging pile area.

Analytical results for all sampling locations are summarized in the tables provided on sheets 3 and 4. Further information of the sample data quality is presented in the data quality assessment section of the associated RSVP.

Washington Closure Hanford **CALCULATION SHEET**

Originator J. D. Skoglie **Date** 03/26/15 **Calc. No.** 0100D-CA-V0592 **Rev. No.** 0
Project 100-D Area Closure Operations **Job No.** 14655 **Checked** I. B. Berezovskiy **Date** 03/26/15
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations **Sheet No.** 2 of 18

Summary (continued)

Methodology, continued:

For nonradioactive analytes with ≤50% of the data below detection limits, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For nonradioactive analytes with >50% of the data below detection limits, as determined by direct inspection of the sample results (Attachment 1), the maximum detected value for the data set (which includes primary and duplicate samples) is used instead of the 95% UCL, and no further calculations are performed for those data sets. For convenience, these maximum detected values are included in the summary tables that follow. The 95% UCL was not calculated for data sets with no reported detections. Calculated cleanup levels are not available in Ecology (2014) under WAC 173-340-740(3) for aluminum, calcium, iron, magnesium, potassium, silicon, and sodium; therefore, these constituents are not considered site COCs/COPCs and are also not included in these calculations. The 95% UCL values were not calculated for potassium-40, radium-226, radium-228, thorium-228, and thorium-232 based on natural occurence at the Hanford Site.

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

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

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

The RPD is calculated when both the primary value and either the duplicate or split value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method and is listed in Table 2-1 of the SAP (DOE-RL 2009a) for certain constituents. All other constituents will have their own pre-determined TDL's based on the laboratory and method used. Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

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

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

For quality assurance/quality control (QA/QC) duplicate RPD calculations, a value less than 30% indicates the data compare favorably. If the RPD is greater than 30%, further investigation regarding the usability of the data is performed. To assist in the identification of anomalous sample pairs, when an analyte is detected in the primary or duplicate/split sample, but was quantified at less than 5 times the TDL in one or both samples, an additional parameter is evaluated. In this case, if the difference between the primary and duplicate/split result exceeds a control limit of 2 times the TDL, further assessment regarding the usability of the data is performed. Additional discussion as necessary is provided in the data quality assessment section of the applicable RSVP.

Washington Closure Hanford **CALCULATION SHEET**

Originator J. D. Skoglie	**Date** 03/26/15	**Calc. No.** 0100D-CA-V0592	**Rev. No.** 0
Project 100-D Area Closure Operations	**Job No.** 14655	**Checked** I. B. Berezovskiy	**Date** 03/26/15
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations			**Sheet No.** 3 of 18

Summary (continued)

QUALIFIER LIST

B = estimated result. Result is less than the RL but greater than the MDL
C = detected in both the sample and the associated QC blank, and the sample concentration was ≤ 5X the blank concentration.
J = estimate
M = sample duplicate precision not met.
N = recovery is outside control limits
R = rejected
U = undetected
X = serial dilution in the analytical batch indicates that physical and chemical interferences are present

ACRONYM LIST

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

Washington Closure Hanford CALCULATION SHEET

Originator J. D. Skoglie Date 05/06/15 Calc. No. 0100D-CA-V0592 Rev. No. 0
Project 100-D Area Closure Operations Job No. 14655 Checked I. B. Berezovskiy Date 05/06/15
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations Sheet No. 4 of 18

Summary (continued)

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

Results Summary [a]

Analyte	Excavation		Staging Pile Area		Units
	95% UCL Result	Maximum Result	95% UCL Result	Maximum Result	
Cesium-137	0.0658	--	0.106	--	pCi/g
Europium-152	0.0400	--	--	--	pCi/g
Europium-155	0.0468	--	--	--	pCi/g
Total beta radiostrontium	0.194	--	--	--	pCi/g
Uranium-234	0.499	--	0.194	--	pCi/g
Uranium-235	0.0241	--	--	--	pCi/g
Uranium-238	0.433	--	0.224	--	pCi/g
Antimony	1.2	--	1.3	--	mg/kg
Arsenic	2.6	--	2.7	--	mg/kg
Barium	67.2	--	60.8	--	mg/kg
Beryllium	0.37	--	0.62	--	mg/kg
Boron	--	0.90	--	--	mg/kg
Cadmium	0.13	--	0.13	--	mg/kg
Chromium	8.6	--	7.4	--	mg/kg
Cobalt	9.7	--	11.5	--	mg/kg
Copper	16.6	--	15.9	--	mg/kg
Hexavalent chromium	0.180	--	--	0.282	mg/kg
Lead	3.8	--	3.2	--	mg/kg
Manganese	336	--	320	--	mg/kg
Mercury	0.012	--	0.0070	--	mg/kg
Molybdenum	--	0.25	--	--	mg/kg
Nickel	10.6	--	9.3	--	mg/kg
Vanadium	73.7	--	74.7	--	mg/kg
Zinc	50.9	--	44.9	--	mg/kg
Chloride	--	5.5	--	--	mg/kg
Fluoride	1.1	--	1.3	--	mg/kg
Nitrogen in nitrate	--	1.0	0.87	--	mg/kg
Nitrogen in nitrate and nitrite	--	0.47	--	--	mg/kg
Sulfate	52.5	--	8.8	--	mg/kg
Aroclor-1254	--	0.088	--	--	mg/kg
3 Part Test Evaluation:					
95% UCL or Maximum[a] > Cleanup Limit?	NO	YES	NA	NO	
> 10% above Cleanup Limit?	NO	NO	NA	NO	
Any sample > 2x Cleanup Limit?	NO	YES	NA	NO	

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

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

Analyte	Duplicate Analysis	
	Excavation	Staging Pile Area
Potassium-40	5.4%	2.2%
Aluminum	5.4%	1.0%
Barium	0.0%	5.3%
Calcium	4.7%	5.7%
Chromium	12.0%	0.9%
Copper	5.8%	3.4%
Iron	3.6%	0.0%
Magnesium	5.2%	2.3%
Manganese	2.2%	6.8%
Silicon	9.6%	10.4%
Vanadium	7.3%	1.5%
Zinc	8.3%	2.5%

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

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-D Area Closure Operations
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations

Date 03/26/15
Job No. 14655

Calc. No. 0100D-CA-V0592
Checked I. B. Berezovskiy

Rev. No. 0
Date 03/26/15
Sheet No. 5 of 18

1 **100-D-85:2 Subsite Statistical Calculations**
2 **Verification Data - Excavation**

3	Sample	Sample	Sample	Cesium-137			Europium-152			Europium-155			Total beta radiostrontium			Uranium-234			Uranium-235			Uranium-238		
4	Area	Number	Date	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
5	EXC-5	J1V325	1/20/15	-0.0139	U	0.0195	0.0147	U	0.0519	0.0449	U	0.0449	0.0515	U	0.373	0.154		0.0624	0	U	0.0465	0.120		0.0465
6	Duplicate of J1V325	J1V333	1/20/15	0.0104	U	0.0215	0.0488	U	0.0491	0.0427	U	0.0465	0.159	U	0.489	0.142		0.0549	-0.000810	U	0.0737	0.161		0.0737
7	EXC-1	J1V321	1/20/15	-0.0107	U	0.0289	-0.0199	U	0.0696	0.0613	U	0.0776	0.175	U	0.423	0.224		0.0819	0	U	0.0609	0.292		0.0609
8	EXC-2	J1V322	1/20/15	0.0147	U	0.0271	-0.371	U	0.0677	0.00925	U	0.0874	-0.0108	U	0.397	0.132		0.0357	0.0127	U	0.0480	0.117		0.0570
9	EXC-3	J1V323	1/20/15	-0.00497	U	0.0220	-0.0135	U	0.0515	0.0600	U	0.0639	0.238	U	0.574	0.119		0.0621	0.0171	U	0.0462	0.0853		0.0462
10	EXC-4	J1V324	1/20/15	-0.000544	U	0.0230	-0.0123	U	0.0609	0.0177	U	0.0548	0.188	U	0.387	0.147		0.0982	0.0421	U	0.0782	0.129		0.0583
11	EXC-6	J1V326	1/20/15	0.00367	U	0.0196	-0.00411	U	0.0427	0.0564		0.0398	0.142	U	0.393	0.126		0.0577	-0.00063	U	0.0577	0.143		0.0429
12	EXC-7	J1V327	1/20/15	0.277		0.0227	0.222		0.0490	0.0588	U	0.0484	0.417		0.411	1.64		0.0549	0.0607		0.0549	1.28		0.0549
13	EXC-8	J1V328	1/20/15	0.00219	U	0.0342	0.0156	U	0.0795	0.0635	U	0.0846	-0.00389	U	0.390	0.224		0.0649	0.0303	U	0.0697	0.210		0.0437
14	EXC-9	J1V329	1/20/15	0.0384	U	0.0323	-0.166	U	0.0822	-0.0110	U	0.0863	-0.00125	U	0.353	0.211		0.103	0	U	0.0645	0.167		0.0645
15	EXC-10	J1V330	1/20/15	0.00202	U	0.0252	-0.00661	U	0.0595	0.0286	U	0.0692	0.158	U	0.390	0.212		0.115	-0.00096	U	0.0876	0.239		0.0969
16	EXC-11	J1V331	1/20/15	0.0108	U	0.0257	0.00933	U	0.0575	0.0183	U	0.0526	0.161	U	0.441	0.0731		0.0536	-0.00236	U	0.0673	0.161		0.0536
17	EXC-12	J1V332	1/20/15	0.00651	U	0.0230	0.00953	U	0.0470	0.0261	U	0.0392	0.0751	U	0.416	0.301		0.0640	0.0153	U	0.0579	0.380		0.0640

18
19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Cesium-137	Europium-152	Europium-155	Total beta radiostrontium	Uranium-234	Uranium-235	Uranium-238
21	Area	Number	Date	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
22	EXC-5	J1V325/ J1V333	1/20/15	-0.00175	0.0318	0.0326	0.105	0.148	-0.000405	0.141
23	EXC-1	J1V321	1/20/15	-0.0107	-0.0199	0.0613	0.175	0.224	0	0.292
24	EXC-2	J1V322	1/20/15	0.0147	-0.371	0.00925	-0.0108	0.132	0.0127	0.117
25	EXC-3	J1V323	1/20/15	-0.00497	-0.0135	0.0600	0.238	0.119	0.0171	0.0853
26	EXC-4	J1V324	1/20/15	-0.000544	-0.0123	0.0177	0.188	0.147	0.0421	0.129
27	EXC-6	J1V326	1/20/15	0.00367	-0.00411	0.0564	0.142	0.126	-0.000634	0.143
28	EXC-7	J1V327	1/20/15	0.277	0.222	0.0588	0.417	1.64	0.0607	1.28
29	EXC-8	J1V328	1/20/15	0.00219	0.0156	0.0635	-0.00389	0.224	0.0303	0.210
30	EXC-9	J1V329	1/20/15	0.0384	-0.166	-0.0110	-0.00125	0.211	0	0.167
31	EXC-10	J1V330	1/20/15	0.00202	-0.00661	0.0286	0.158	0.212	-0.000963	0.239
32	EXC-11	J1V331	1/20/15	0.0108	0.00933	0.0183	0.161	0.0731	-0.00236	0.161
33	EXC-12	J1V332	1/20/15	0.00651	0.00953	0.0261	0.0751	0.301	0.0153	0.380

34 **Statistical Computations**

35		Cesium-137	Europium-152	Europium-155	Total beta radiostrontium	Uranium-234	Uranium-235	Uranium-238
36	95% UCL based on	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.
37	N	12	12	12	12	12	12	12
38	% < Detection limit	92%	92%	92%	92%	0%	92%	0%
39	Mean	0.0281	-0.0254	0.0351	0.137	0.296	0.0145	0.279
40	Standard deviation	0.0794	0.138	0.0246	0.120	0.428	0.0203	0.326
41	Z-statistic	1.64	1.64	1.64	1.64	1.64	1.64	1.64
42	95% UCL on mean	0.0658	0.0400	0.0468	0.194	0.499	0.0241	0.433
43	Maximum value	0.277	0.222	0.0564	0.417	1.64	0.0607	1.28

44

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-D Area Closure Operations
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations

Date 03/26/15
Job No. 14655

Calc. No. 0100D-CA-V0592
Checked I. B. Berezovskiy

Rev. No. 0
Date 03/26/15
Sheet No. 6 of 18

100-D-85:2 Subsite Statistical Calculations

Verification Data - Excavation

Sample Area	Sample Number	Sample Date	Antimony mg/kg	Q	PQL	Arsenic mg/kg	Q	PQL	Barium mg/kg	Q	PQL	Beryllium mg/kg	Q	PQL	Cadmium mg/kg	Q	PQL	Chromium mg/kg	Q	PQL	Cobalt mg/kg	Q	PQL	Copper mg/kg	Q	PQL	Hexavalent Chromium mg/kg	Q	PQL
EXC-5	J1V325	1/20/15	0.69		0.35	3.1		0.60	84.2		0.35	0.42		0.030	0.13	B	0.038	10.2		0.053	7.5		0.091	15.0		0.99	0.195		0.155
Duplicate of J1V325	J1V333	1/20/15	0.83		0.40	2.5		0.70	84.2		0.40	0.39		0.035	0.13	B	0.043	11.5		0.061	7.8		0.11	15.9		1.1	0.279		0.155
EXC-1	J1V321	1/20/15	1.2		0.37	1.4	N	0.64	54.8	M	0.37	0.37		0.032	0.14	BM	0.040	4.9		0.056	13.1		0.49	17.0		1.1	0.155	U	0.155
EXC-2	J1V322	1/20/15	1.1		0.39	1.9		0.67	56.3		0.39	0.37		0.034	0.11	B	0.042	5.2		0.059	8.4		0.10	15.2		1.1	0.155	U	0.155
EXC-3	J1V323	1/20/15	1.0		0.40	2.2		0.69	59.9		0.40	0.34		0.035	0.11	B	0.043	6.8		0.061	8.7		0.11	16.1		1.1	0.194		0.155
EXC-4	J1V324	1/20/15	1.8	B	1.8	1.2		0.62	57.0		0.35	0.41	B	0.15	0.11	B	0.038	3.9		0.054	13.2		0.47	15.6		1.0	0.167		0.155
EXC-6	J1V326	1/20/15	0.96		0.41	3.0		0.71	66.7		0.082	0.37		0.035	0.13	B	0.044	9.6		0.062	7.1		0.11	15.0		0.23	0.195		0.155
EXC-7	J1V327	1/20/15	1.2		0.37	2.6		0.64	67.2		0.37	0.38		0.032	0.15	B	0.040	11.3		0.056	7.6		0.097	17.5		1.1	0.263		0.155
EXC-8	J1V328	1/20/15	0.88		0.38	2.4		0.65	66.7		0.38	0.35		0.033	0.11	B	0.040	6.2		0.057	8.1		0.099	17.1		1.1	0.217		0.155
EXC-9	J1V329	1/20/15	0.86		0.35	1.1		0.61	65.1		0.35	0.31		0.030	0.11	B	0.038	4.2		0.053	7.3		0.092	16.7		1.0	0.155	U	0.155
EXC-10	J1V330	1/20/15	0.41	B	0.38	2.1		0.67	56.6		0.077	0.29		0.033	0.089	B	0.041	7.6		0.059	5.8		0.10	13.8		0.22	0.155	U	0.155
EXC-11	J1V331	1/20/15	0.93		0.39	1.0		0.67	57.6		0.39	0.33		0.034	0.086	B	0.042	5.7		0.059	9.2		0.10	17.3		1.1	0.155	U	0.155
EXC-12	J1V332	1/20/15	0.83		0.39	2.5		0.68	67.3		0.39	0.32		0.034	0.11	B	0.042	6.8		0.060	7.7		0.10	15.3		1.1	0.155	U	0.155

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Antimony mg/kg	Arsenic mg/kg	Barium mg/kg	Beryllium mg/kg	Cadmium mg/kg	Chromium mg/kg	Cobalt mg/kg	Copper mg/kg	Hexavalent Chromium mg/kg
EXC-5	J1V325/ J1V333	1/20/15	0.76	2.8	84.2	0.41	0.13	10.9	7.7	15.5	0.237
EXC-1	J1V321	1/20/15	1.2	1.4	54.8	0.37	0.14	4.9	13.1	17.0	0.0775
EXC-2	J1V322	1/20/15	1.1	1.9	56.3	0.37	0.11	5.2	8.4	15.2	0.0775
EXC-3	J1V323	1/20/15	1.0	2.2	59.9	0.34	0.11	6.8	8.7	16.1	0.194
EXC-4	J1V324	1/20/15	1.8	1.2	57.0	0.41	0.11	3.9	13.2	15.6	0.167
EXC-6	J1V326	1/20/15	0.96	3.0	66.7	0.37	0.13	9.6	7.1	15.0	0.195
EXC-7	J1V327	1/20/15	1.2	2.6	67.2	0.38	0.15	11.3	7.6	17.5	0.263
EXC-8	J1V328	1/20/15	0.88	2.4	66.7	0.35	0.11	6.2	8.1	17.1	0.217
EXC-9	J1V329	1/20/15	0.86	1.1	65.1	0.31	0.11	4.2	7.3	16.7	0.0775
EXC-10	J1V330	1/20/15	0.41	2.1	56.6	0.29	0.089	7.6	5.8	13.8	0.0775
EXC-11	J1V331	1/20/15	0.93	1.0	57.6	0.33	0.086	5.7	9.2	17.3	0.0775
EXC-12	J1V332	1/20/15	0.83	2.5	67.3	0.32	0.11	6.8	7.7	15.3	0.0775

Statistical Computations

	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Hexavalent Chromium
95% UCL based on	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.
N	12	12	12	12	12	12	12	12	12
% < Detection limit	0%	0%	0%	0%	0%	0%	0%	0%	50%
Mean	1.0	2.0	63.3	0.35	0.12	6.9	8.7	16.0	0.145
Standard deviation	0.33	0.69	8.2	0.037	0.019	2.5	2.3	1.1	0.0740
95% UCL on mean	1.2	2.6	67.2	0.37	0.13	8.6	9.7	16.6	0.180
Maximum value	1.8	3.1	84.2	0.42	0.15	11.5	13.2	17.5	0.279
Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)	5 GW & River Protection	20 DE, GW & River Protection	200 GW Protection	1.51 GW & River Protection	0.81 GW & River Protection	18.5 GW & River Protection	15.7 GW Protection	22.0 River Protection	2 River Protection
WAC 173-340 3-PART TEST									
95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA	NO
> 10% above Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA	NO
Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA	NO
WAC 173-340 Compliance?	Because all values are below background (5 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (6.5 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (132 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (1.51 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (0.81 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (18.5 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (15.7 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (22.0 mg/kg) the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent RAG.

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-D Area Closure Operations
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations

Date 03/26/15
Job No. 14655

Calc. No. 0100D-CA-V0592
Checked I. B. Berezovskiy

Rev. No. 0
Date 03/26/15
Sheet No. 7 of 18

1 **100-D-85:2 Subsite Statistical Calculations**
2 **Verification Data - Excavation**

3	Sample	Sample	Sample	Lead			Manganese			Mercury			Nickel			Vanadium			Zinc			Fluoride			Sulfate		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
5	EXC-5	J1V325	1/20/15	4.2		0.25	358		0.46	0.012	BC	0.0055	10.6		0.11	55.3		0.43	49.0		1.8	1.2	B	0.84	4.9	BC	1.7
6	Duplicate of J1V325	J1V333	1/20/15	4.1		0.29	366		0.53	0.013	BC	0.0062	12.3		0.13	59.5		0.50	45.1		2.1	1.2	BM	0.86	4.1	BC	1.8
7	EXC-1	J1V321	1/20/15	4.6	M	1.3	331		0.49	0.0095	BC	0.0057	9.5		0.12	80.9		0.46	52.1		1.9	1.4	B	0.85	9.5	C	1.8
8	EXC-2	J1V322	1/20/15	2.9		0.27	328		0.51	0.010	BC	0.0058	7.6		0.12	68.3		0.48	48.6		2.0	1.2	B	0.84	6.0	C	1.7
9	EXC-3	J1V323	1/20/15	2.8		0.28	338		0.53	0.0099	BC	0.0054	12.5		0.13	70.2		0.49	48.9		2.1	1.1	B	0.86	5.4	C	1.8
10	EXC-4	J1V324	1/20/15	2.0	B	1.3	342		0.47	0.0088	BC	0.0060	7.9		0.11	83.4		0.44	54.0		1.9	0.81	U	0.81	4.6	BC	1.7
11	EXC-6	J1V326	1/20/15	3.4		0.29	293		0.11	0.012	BC	0.0063	10.0		0.13	51.5		0.10	38.0		0.43	1.5	B	0.86	6.2	C	1.8
12	EXC-7	J1V327	1/20/15	5.6		0.26	329		0.48	0.015	BC	0.0056	9.8		0.12	64.2		0.46	56.9		1.9	0.88	B	0.84	12.7	C	1.7
13	EXC-8	J1V328	1/20/15	2.9		0.27	333		0.49	0.011	BC	0.0060	9.9		0.12	64.0		0.46	46.6		2.0	1.4	B	0.87	6.4	C	1.8
14	EXC-9	J1V329	1/20/15	1.9		0.25	280		0.46	0.010	BC	0.0065	6.9		0.11	64.2		0.43	45.5		1.8	0.81	U	0.81	5.1	C	1.7
15	EXC-10	J1V330	1/20/15	2.6		0.27	237		0.10	0.010	BC	0.0058	8.7		0.12	45.9		0.095	33.1		0.4	0.9	B	0.84	216		1.7
16	EXC-11	J1V331	1/20/15	1.9		0.27	349		0.51	0.0076	BC	0.0048	8.6		0.12	80.2		0.48	52.1		2.0	0.82	U	0.82	4.6	BC	1.7
17	EXC-12	J1V332	1/20/15	2.5		0.28	311		0.52	0.010	BC	0.0059	11.7		0.13	68.8		0.48	47.1		2.1	0.85	U	0.85	4.3	BC	1.8

18 **Statistical Computation Input Data**

19	Sample	Sample	Sample	Lead	Manganese	Mercury	Nickel	Vanadium	Zinc	Fluoride	Sulfate
20	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
21	EXC-5	J1V325/ J1V333	1/20/15	4.2	362	0.013	11.5	57.4	47.1	1.2	4.5
22	EXC-1	J1V321	1/20/15	4.6	331	0.0095	9.5	80.9	52.1	1.4	9.5
23	EXC-2	J1V322	1/20/15	2.9	328	0.010	7.6	68.3	48.6	1.2	6.0
24	EXC-3	J1V323	1/20/15	2.8	338	0.0099	12.5	70.2	48.9	1.1	5.4
25	EXC-4	J1V324	1/20/15	2.0	342	0.0088	7.9	83.4	54.0	0.41	4.6
26	EXC-6	J1V326	1/20/15	3.4	293	0.012	10.0	51.5	38.0	1.5	6.2
27	EXC-7	J1V327	1/20/15	5.6	329	0.015	9.8	64.2	56.9	0.88	12.7
28	EXC-8	J1V328	1/20/15	2.9	333	0.011	9.9	64.0	46.6	1.4	6.4
29	EXC-9	J1V329	1/20/15	1.9	280	0.010	6.9	64.2	45.5	0.41	5.1
30	EXC-10	J1V330	1/20/15	2.6	237	0.010	8.7	45.9	33.1	0.90	216
31	EXC-11	J1V331	1/20/15	1.9	349	0.0076	8.6	80.2	52.1	0.41	4.6
32	EXC-12	J1V332	1/20/15	2.5	311	0.010	11.7	68.8	47.1	0.43	4.3

33 **Statistical Computations**

34		Lead	Manganese	Mercury	Nickel	Vanadium	Zinc	Fluoride	Sulfate
35	95% UCL based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat normal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.
36	N	12	12	12	12	12	12	12	12
37	% < Detection limit	0%	0%	0%	0%	0%	0%	33%	0%
38	Mean	3.1	319	0.011	9.5	66.6	47.5	0.94	24
39	Standard deviation	1.2	34.6	0.0019	1.7	11.5	6.6	0.43	60.6
40	95% UCL on mean	3.8	336	0.012	10.6	73.7	50.9	1.1	52.5
41	Maximum value	5.6	366	0.015	12.5	83.4	56.9	1.5	216
42	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	10.2 GW & River Protection	512 GW & River Protection	0.33 GW & River Protection	19.1 GW Protection	85.1 GW Protection	67.8 River Protection	96 GW Protection	25,000 GW Protection
43	**WAC 173-340 3-PART TEST**								
44	95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
45	> 10% above Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
46	Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
47	**WAC 173-340 Compliance?**	Because all values are below background (10.2 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (512 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (0.33 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (19.1 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (85.1 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (67.8 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (2.81 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (237 mg/kg) the WAC 173-340 3-part test is not required.

MAXIMUM VALUE 3-PART TEST CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-D Area Closure Operations
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations

Date 03/26/15
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Rev. No. 0
Date 03/26/15
Sheet No. 8 of 18

100-D-85:2 Subsite Maximum Calculations
Verification Data - Excavation

Sample Area	Sample Number	Sample Date	Boron			Molybdenum			Chloride			Nitrogen in Nitrate			Nitrogen in Nitrate and Nitrite			Aroclor-1254		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	ug/kg	Q	PQL
EXC-5	J1V325	1/20/15	0.90	B	0.90	0.24	U	0.24	2.1	U	2.1	0.32	UR	0.32	0.38	U	0.38	2.8	U	2.8
Duplicate of	J1V333	1/20/15	1.0	U	1.0	0.28	U	0.28	2.1	U	2.1	0.33	UR	0.33	0.38	U	0.38	2.7	U	2.7
EXC-1	J1V321	1/20/15	0.95	UN	0.95	0.25	B	0.25	2.3	B	2.1	0.70	B	0.33	0.37	U	0.37	2.6	U	2.6
EXC-2	J1V322	1/20/15	1.0	U	1.0	0.26	U	0.26	2.1	U	2.1	0.32	UR	0.32	0.38	U	0.38	2.7	U	2.7
EXC-3	J1V323	1/20/15	1.0	U	1.0	0.27	U	0.27	2.1	U	2.1	0.63	B	0.33	0.36	U	0.36	2.6	U	2.6
EXC-4	J1V324	1/20/15	0.91	U	0.91	0.24	U	0.24	2.0	U	2.0	0.31	UR	0.31	0.36	U	0.36	2.6	U	2.6
EXC-6	J1V326	1/20/15	1.1	U	1.1	0.28	U	0.28	5.5		2.1	0.87	B	0.33	0.38	U	0.38	2.7	U	2.7
EXC-7	J1V327	1/20/15	0.95	U	0.95	0.25	U	0.25	3.3	B	2.1	1.0	B	0.32	0.47	B	0.39	88		2.7
EXC-8	J1V328	1/20/15	0.97	U	0.97	0.26	U	0.26	2.1	U	2.1	0.33	UR	0.33	0.36	U	0.36	2.7	U	2.7
EXC-9	J1V329	1/20/15	0.90	U	0.90	0.24	U	0.24	2.0	U	2.0	0.31	UR	0.31	0.35	U	0.35	2.6	U	2.6
EXC-10	J1V330	1/20/15	0.99	U	0.99	0.26	U	0.26	2.0	U	2.0	0.76	B	0.32	0.36	U	0.36	2.7	U	2.7
EXC-11	J1V331	1/20/15	1.0	U	1.0	0.26	U	0.26	2.0	B	2.0	0.71	B	0.31	0.37	U	0.37	2.5	U	2.5
EXC-12	J1V332	1/20/15	1.0	U	1.0	0.27	U	0.27	2.1	U	2.1	0.33	UR	0.33	0.37	U	0.37	2.7	U	2.7

3-Part Test Evaluations

	Boron	Molybdenum	Chloride	Nitrogen in Nitrate	Nitrogen in Nitrate and Nitrite	Aroclor-1254
% < Detection limit	92%	92%	67%	0%	92%	92%
Maximum value	0.90	0.25	5.5	1.0	0.47	88
Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg) unless stated otherwise	320 GW Protection	8 GW Protection	25,000 GW Protection	1,000 GW Protection	1,000 GW Protection	17 ug/kg GW & River Protection
3-PART TEST						
Maximum > Cleanup Limit?	NO	NO	NA	NA	NA	YES
> 10% above Cleanup Limit?	NO	NO	NA	NA	NA	NO
Any sample > 2X Cleanup Limit?	NO	NO	NA	NA	NA	YES
3-Part Test Compliance?	The data set meets the 3-part test criteria when compared to the most stringent RAG.	The data set meets the 3-part test criteria when compared to the most stringent RAG.	Because all values are below background (100 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (11.8 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (11.8 mg/kg) the WAC 173-340 3-part test is not required.	A detailed assessment will be performed. The data set meets the 3-part test criteria when compared to the direct exposure RAG.

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-D Area Closure Operations
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations

Date 03/26/15
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Rev. No. 0
Date 03/26/15
Sheet No. 9 of 18

100-D-85:2 Subsite Statistical Calculations
Verification Data - Staging Pile Area

Sample Area	Sample Number	Sample Date	Cesium-137 pCi/g	Q	MDA	Uranium-234 pCi/g	Q	MDA	Uranium-238 pCi/g	Q	MDA
SPA-10	J1V349	1/21/15	0.000513	U	0.0321	0.124		0.0481	0.194		0.0646
Duplicate of J1V349	J1V352	1/21/15	0.00885	U	0.0306	0.0285	U	0.0530	0.203		0.0530
SPA-1	J1V340	1/21/15	0.00727	U	0.036	0.198		0.0617	0.137		0.0617
SPA-2	J1V341	1/21/15	0.0268	U	0.0322	0.230		0.0665	0.232		0.0529
SPA-3	J1V342	1/21/15	0.00241	U	0.0254	0.229		0.0388	0.157		0.0388
SPA-4	J1V343	1/21/15	0.436		0.0208	0.132		0.0596	0.192		0.0539
SPA-5	J1V344	1/21/15	0.00683	U	0.0199	0.119		0.0604	0.0894		0.0546
SPA-6	J1V345	1/21/15	-0.0109	U	0.0306	0.235		0.0559	0.277		0.0506
SPA-7	J1V346	1/21/15	0.0383	U	0.0342	0.161		0.0437	0.193		0.0437
SPA-8	J1V347	1/21/15	0.00363	U	0.0245	0.122		0.0765	0.193		0.0712
SPA-9	J1V348	1/21/15	0.0579		0.0338	0.144		0.0638	0.211		0.0575
SPA-11	J1V350	1/21/15	-0.0118	U	0.0231	0.227		0.0410	0.271		0.0550
SPA-12	J1V351	1/21/15	0.00295	U	0.0393	0.150		0.0551	0.233		0.0371

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Cesium-137 pCi/g			Uranium-234 pCi/g			Uranium-238 pCi/g		
SPA-10	J1V349/ J1V352	1/21/15	0.00468			0.0753			0.199		
SPA-1	J1V340	1/21/15	0.00727			0.198			0.137		
SPA-2	J1V341	1/21/15	0.0268			0.230			0.232		
SPA-3	J1V342	1/21/15	0.00241			0.229			0.157		
SPA-4	J1V343	1/21/15	0.436			0.132			0.192		
SPA-5	J1V344	1/21/15	0.00683			0.119			0.0894		
SPA-6	J1V345	1/21/15	-0.0109			0.235			0.277		
SPA-7	J1V346	1/21/15	0.0383			0.161			0.193		
SPA-8	J1V347	1/21/15	0.00363			0.122			0.193		
SPA-9	J1V348	1/21/15	0.0579			0.144			0.211		
SPA-11	J1V350	1/21/15	-0.0118			0.227			0.271		
SPA-12	J1V351	1/21/15	0.00295			0.150			0.233		

Statistical Computations

	Cesium-137			Uranium-234			Uranium-238		
95% UCL based on	Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.		
N	12			12			12		
% < Detection limit	83%			0%			0%		
Mean	0.0470			0.169			0.199		
Standard deviation	0.124			0.0538			0.0534		
Z-statistic	1.64			1.64			1.64		
95% UCL on mean	0.106			0.194			0.224		
Maximum value	0.436			0.235			0.277		

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-D Area Closure Operations
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations

Date 03/26/15
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Checked I. B. Berezovskiy

Rev. No. 0
Date 03/26/15
Sheet No. 10 of 18

100-D-85:2 Subsite Statistical Calculations

Verification Data - Staging Pile Area

Sample Area	Sample Number	Sample Date	Antimony mg/kg	Q	PQL	Arsenic mg/kg	Q	PQL	Barium mg/kg	Q	PQL	Beryllium mg/kg	Q	PQL	Cadmium mg/kg	Q	PQL	Chromium mg/kg	Q	PQL	Cobalt mg/kg	Q	PQL	Copper mg/kg	Q	PQL	Lead mg/kg	Q	PQL
SPA-10	J1V349	1/21/15	0.48	JB	0.35	3.2		0.61	76.0	X	0.071	0.39		0.031	0.16	B	0.038	11.3	X	0.054	7.8		0.093	14.3		0.20	4.0		0.25
Duplicate of J1V349	J1V352	1/21/15	0.57	J	0.36	2.9		0.62	72.1	X	0.072	0.42		0.031	0.13	B	0.039	11.4	X	0.055	7.6		0.094	14.8		0.20	4.0		0.25
SPA-1	J1V340	1/21/15	1.9	UJ	1.9	2.2		0.64	42.7	X	0.074	0.66	B	0.16	0.10	B	0.040	4.4	X	0.057	11.9		0.49	16.0		1.1	2.2	B	1.3
SPA-2	J1V341	1/21/15	1.2	J	0.36	2.1		0.63	56.7	X	0.073	0.42		0.032	0.13	B	0.039	5.1	X	0.056	10.2		0.096	14.2		0.21	2.7		0.26
SPA-3	J1V342	1/21/15	1.1	J	0.33	2.3		0.58	51.4	X	0.067	0.55		0.029	0.10	B	0.036	5.2	X	0.051	10.2		0.088	13.4		0.19	2.4		0.24
SPA-4	J1V343	1/21/15	2.0	UJ	2.0	2.8		0.69	64.7	X	0.079	0.82	B	0.17	0.15	B	0.043	5.0	X	0.061	13.2		0.52	17.2		1.1	2.9		1.4
SPA-5	J1V344	1/21/15	1.2	J	0.39	2.1		0.68	48.2	X	0.079	0.47		0.034	0.12	B	0.043	4.5	X	0.060	11.0		0.10	15.1		0.23	3.1		0.28
SPA-6	J1V345	1/21/15	2.1	JB	1.8	2.3		0.64	48.9	X	0.074	0.70	B	0.16	0.10	B	0.040	4.7	X	0.056	12.4		0.49	16.6		1.1	1.9	B	1.3
SPA-7	J1V346	1/21/15	1.1	J	0.40	2.6		0.70	51.8	X	0.080	0.43		0.035	0.12	B	0.043	6.1	X	0.061	9.5		0.11	13.4		0.23	3.0		0.28
SPA-8	J1V347	1/21/15	1.8	UJ	1.8	2.7		0.62	56.6	X	0.071	0.77	B	0.15	0.13	B	0.038	6.5	X	0.054	12.5		0.47	17.4		1.0	2.3		1.3
SPA-9	J1V348	1/21/15	1.1	J	0.40	2.7		0.69	55.3	X	0.079	0.44		0.034	0.11	B	0.043	6.8	X	0.061	9.4		0.10	15.5		0.23	3.4		0.28
SPA-11	J1V350	1/21/15	1.2	J	0.33	2.4		0.58	55.6	X	0.067	0.44		0.029	0.11	B	0.036	6.7	X	0.051	9.3		0.088	14.6		0.19	2.7		0.24
SPA-12	J1V351	1/21/15	0.55	JB	0.40	2.8		0.69	65.6	X	0.079	0.39		0.035	0.13	B	0.043	10.2	X	0.061	7.8		0.10	13.0		0.23	3.2		0.28

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Antimony mg/kg	Arsenic mg/kg	Barium mg/kg	Beryllium mg/kg	Cadmium mg/kg	Chromium mg/kg	Cobalt mg/kg	Copper mg/kg	Lead mg/kg
SPA-10	J1V349/ J1V352	1/21/15	0.53	3.1	74.1	0.41	0.15	11.4	7.7	14.6	4.0
SPA-1	J1V340	1/21/15	0.95	2.2	42.7	0.66	0.10	4.4	11.9	16.0	2.2
SPA-2	J1V341	1/21/15	1.2	2.1	56.7	0.42	0.13	5.1	10.2	14.2	2.7
SPA-3	J1V342	1/21/15	1.1	2.3	51.4	0.55	0.10	5.2	10.2	13.4	2.4
SPA-4	J1V343	1/21/15	1.0	2.8	64.7	0.82	0.15	5.0	13.2	17.2	2.9
SPA-5	J1V344	1/21/15	1.2	2.1	48.2	0.47	0.12	4.5	11.0	15.1	3.1
SPA-6	J1V345	1/21/15	2.1	2.3	48.9	0.70	0.10	4.7	12.4	16.6	1.9
SPA-7	J1V346	1/21/15	1.1	2.6	51.8	0.43	0.12	6.1	9.5	13.4	3.0
SPA-8	J1V347	1/21/15	0.90	2.7	56.6	0.77	0.13	6.5	12.5	17.4	2.3
SPA-9	J1V348	1/21/15	1.1	2.7	55.3	0.44	0.11	6.8	9.4	15.5	3.4
SPA-11	J1V350	1/21/15	1.2	2.4	55.6	0.44	0.11	6.7	9.3	14.6	2.7
SPA-12	J1V351	1/21/15	0.55	2.8	65.6	0.39	0.13	10.2	7.8	13.0	3.2

Statistical Computations

	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead
95% UCL based on	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.
N	12	12	12	12	12	12	12	12	12
% < Detection limit	25%	0%	0%	0%	0%	0%	0%	0%	0%
Mean	1.1	2.5	56.0	0.54	0.12	6.4	10.4	15.1	2.8
Standard deviation	0.40	0.31	8.6	0.15	0.017	2.2	1.8	1.5	0.58
95% UCL on mean	1.3	2.7	60.8	0.62	0.13	7.4	11.5	15.9	3.2
Maximum value	2.1	3.2	76.0	0.82	0.16	11.4	13.2	17.4	4.0
Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)	5 GW & River Protection	20 DE, GW & River Protection	200 GW Protection	1.51 GW & River Protection	0.81 GW & River Protection	18.5 GW & River Protection	15.7 GW Protection	22.0 River Protection	10.2 GW & River Protection
WAC 173-340 3-PART TEST									
95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA	NA
> 10% above Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA	NA
Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA	NA
WAC 173-340 Compliance?	Because all values are below background (5 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (6.5 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (132 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (1.51 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (0.81 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (18.5 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (15.7 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (22.0 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (10.2 mg/kg) the WAC 173-340 3-part test is not required.

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-D Area Closure Operations
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations

Date 03/26/15
Job No. 14655

Calc. No. 0100D-CA-V0592
Checked I. B. Berezovskiy

Rev. No. 0
Date 03/26/15
Sheet No. 11 of 18

1 **100-D-85:2 Subsite Statistical Calculations**

2 **Verification Data - Staging Pile Area**

3	Sample	Sample	Sample	Manganese			Mercury			Nickel			Vanadium			Zinc			Fluoride			Nitrogen in Nitrate			Sulfate		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
5	SPA-10	J1V349	1/21/15	320	X	0.093	0.0077	B	0.0057	11.5	X	0.11	47.9	JX	0.087	37.0	X	0.37	1.2	B	0.87	0.70	JB	0.33	1.8	U	1.8
6	Duplicate of J1V349	J1V352	1/21/15	299	X	0.094	0.019		0.0059	11.5	X	0.12	48.6	JX	0.089	36.1	X	0.38	1.2	B	0.87	0.71	JB	0.33	6.9		1.8
7	SPA-1	J1V340	1/21/15	287	X	0.097	0.0053	U	0.0053	7.6	X	0.12	73.6	JX	0.46	43.0	X	0.39	1.1	B	0.83	0.83	JB	0.32	7.3		1.7
8	SPA-2	J1V341	1/21/15	321	X	0.096	0.0053	U	0.0053	7.7	X	0.12	66.6	JX	0.090	42.9	X	0.38	1.1	B	0.84	1.0	JB	0.32	8.8		1.7
9	SPA-3	J1V342	1/21/15	308	X	0.088	0.0057	U	0.0057	8.1	X	0.11	64.9	JX	0.083	42.5	X	0.35	1.0	B	0.84	1.1	JB	0.32	7.7		1.7
10	SPA-4	J1V343	1/21/15	371	X	0.10	0.0061	B	0.0053	7.7	X	0.13	83.1	JX	0.49	48.2	X	0.42	1.2	B	0.84	0.68	JB	0.32	8.1		1.7
11	SPA-5	J1V344	1/21/15	313	X	0.10	0.0050	U	0.0050	8.7	X	0.13	77.7	JX	0.097	48.5	X	0.41	1.1	B	0.83	0.67	JB	0.32	1.7	U	1.7
12	SPA-6	J1V345	1/21/15	301	X	0.097	0.0057	U	0.0057	7.5	X	0.12	78.6	JX	0.46	44.4	X	0.39	1.2	B	0.81	0.78	JB	0.31	15.5		1.7
13	SPA-7	J1V346	1/21/15	304	X	0.11	0.0067	B	0.0058	8.3	X	0.13	64.2	JX	0.099	41.4	X	0.42	1.2	B	0.83	0.68	JB	0.32	8.7		1.7
14	SPA-8	J1V347	1/21/15	319	X	0.094	0.0089	B	0.0052	8.3	X	0.12	80.5	JX	0.44	46.4	X	0.37	1.5	B	0.84	0.32	UR	0.32	7.4		1.7
15	SPA-9	J1V348	1/21/15	300	X	0.10	0.0079	B	0.0057	8.8	X	0.13	61.5	JX	0.098	42.1	X	0.42	1.4	B	0.84	0.76	JB	0.32	7.4		1.7
16	SPA-11	J1V350	1/21/15	293	X	0.088	0.0060	B	0.0054	8.6	X	0.11	63.2	JX	0.083	41.2	X	0.35	1.3	B	0.82	0.31	UR	0.31	1.7	U	1.7
17	SPA-12	J1V351	1/21/15	294	X	0.10	0.0071	B	0.0051	11.0	X	0.13	49.6	JX	0.098	37.2	X	0.42	1.3	B	0.85	0.71	JB	0.33	7.2		1.8

18 **Statistical Computation Input Data**

19	Sample	Sample	Sample	Manganese	Mercury	Nickel	Vanadium	Zinc	Fluoride	Nitrogen in Nitrate	Sulfate
20	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
21	SPA-10	J1V349/ J1V352	1/21/15	310	0.013	11.5	48.3	36.6	1.2	0.71	3.9
22	SPA-1	J1V340	1/21/15	287	0.0027	7.6	73.6	43.0	1.1	0.83	7.3
23	SPA-2	J1V341	1/21/15	321	0.0027	7.7	66.6	42.9	1.1	1.0	8.8
24	SPA-3	J1V342	1/21/15	308	0.0029	8.1	64.9	42.5	1.0	1.1	7.7
25	SPA-4	J1V343	1/21/15	371	0.0061	7.7	83.1	48.2	1.2	0.68	8.1
26	SPA-5	J1V344	1/21/15	313	0.0025	8.7	77.7	48.5	1.1	0.67	0.85
27	SPA-6	J1V345	1/21/15	301	0.0029	7.5	78.6	44.4	1.2	0.78	15.5
28	SPA-7	J1V346	1/21/15	304	0.0067	8.3	64.2	41.4	1.2	0.68	8.7
29	SPA-8	J1V347	1/21/15	319	0.0089	8.3	80.5	46.4	1.5		7.4
30	SPA-9	J1V348	1/21/15	300	0.0079	8.8	61.5	42.1	1.4	0.76	7.4
31	SPA-11	J1V350	1/21/15	293	0.0060	8.6	63.2	41.2	1.3		0.85
32	SPA-12	J1V351	1/21/15	294	0.0071	11.0	49.6	37.2	1.3	0.71	7.2

33 **Statistical Computations**

34		Manganese	Mercury	Nickel	Vanadium	Zinc	Fluoride	Nitrogen in Nitrate	Sulfate
35	95% UCL based on	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.
36	N	12	12	12	12	12	12	10	12
37	% < Detection limit	0%	42%	0%	0%	0%	0%	0%	17%
38	Mean	310	0.0058	8.7	67.6	42.9	1.2	0.43	7.0
39	Standard deviation	22	0.0033	1.3	11.4	3.7	0.14	0.088	3.9
40	95% UCL on mean	320	0.0070	9.3	74.7	44.9	1.3	0.87	8.8
41	Maximum value	371	0.019	11.5	83.1	48.5	1.5	1.1	15.5
42	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	512 GW & River Protection	0.33 GW & River Protection	19.1 GW Protection	85.1 GW Protection	67.8 River Protection	96 GW Protection	1,000 River Protection	25,000 GW Protection
43	**WAC 173-340 3-PART TEST**								
44	95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
45	> 10% above Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
46	Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
47	**WAC 173-340 Compliance?**	Because all values are below background (512 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (0.33 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (19.1 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (85.1 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (67.8 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (2.81 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (11.8 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (237 mg/kg) the WAC 173-340 3-part test is not required.

MAXIMUM VALUE 3-PART TEST CALCULATION SHEET

Washington Closure Hanford
Originator J. D. Skoglie
Project 100-D Area Closure Operations
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations

Date 03/26/15 **Calc. No.** 0100D-CA-V0592 **Rev. No.** 0
Job No. 14655 **Checked** I. B. Berezovskiy **Date** 03/26/15
Sheet No. 12 of 18

1 **100-D-85:2 Subsite Maximum Calculations**
2 **Verification Data - Staging Pile Area**

3	Sample	Sample	Sample	Hexavalent Chromium		
4	Area	Number	Date	mg/kg	Q	PQL
5	SPA-10	J1V349	1/21/15	0.155	U	0.155
6	Duplicate of J1V349	J1V352	1/21/15	0.155	U	0.155
7	SPA-1	J1V340	1/21/15	0.282		0.155
8	SPA-2	J1V341	1/21/15	0.155	U	0.155
9	SPA-3	J1V342	1/21/15	0.155	U	0.155
10	SPA-4	J1V343	1/21/15	0.155	U	0.155
11	SPA-5	J1V344	1/21/15	0.155	U	0.155
12	SPA-6	J1V345	1/21/15	0.155	U	0.155
13	SPA-7	J1V346	1/21/15	0.155	U	0.155
14	SPA-8	J1V347	1/21/15	0.175		0.155
15	SPA-9	J1V348	1/21/15	0.179		0.155
16	SPA-11	J1V350	1/21/15	0.155	U	0.155
17	SPA-12	J1V351	1/21/15	0.173		0.155

18 **3-Part Test Evaluations**

19		Hexavalent Chromium		
20	% < Detection limit	67%		
21	Maximum value	0.282		
22	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	2	River Protection	
23	**3-PART TEST**			
24	Maximum > Cleanup Limit?	NO		
25	> 10% above Cleanup Limit?	NO		
26	Any sample > 2X Cleanup Limit?	NO		
27	**3-Part Test Compliance?**	The data set meets the 3-part test criteria when compared to the most stringent RAG.		

28

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-D Area Closure Operations
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations

Date 03/26/15
Job No. 14655

Calc. No. 0100D-CA-V0592
Checked I. B. Berezovskiy

Rev. No. 0
Date 03/26/15
Sheet No. 13 of 18

Ecology Software (MTCAStat) Results, 100-D-85:2 Subsite Excavation

Antimony 95% UCL Calculation

DATA	ID
0.76	J1V325/ J1V333
1.2	J1V321
1.1	J1V322
1.0	J1V323
1.8	J1V324
0.96	J1V326
1.2	J1V327
0.88	J1V328
0.86	J1V329
0.41	J1V330
0.93	J1V331
0.83	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	0.99
Censored		Lognormal mean	1.0
Detection limit or PQL		Std. devn.	0.33
Method detection limit		Median	0.95
TOTAL	12	Min.	0.41
		Max.	1.8

Lognormal distribution? r-squared is: 0.877
Normal distribution? r-squared is: 0.874
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 1.2

Arsenic 95% UCL Calculation

DATA	ID
2.8	J1V325/ J1V333
1.4	J1V321
1.9	J1V322
2.2	J1V323
1.2	J1V324
3.0	J1V326
2.6	J1V327
2.4	J1V328
1.1	J1V329
2.1	J1V330
1.0	J1V331
2.5	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	2.0
Censored		Lognormal mean	2.0
Detection limit or PQL		Std. devn.	0.69
Method detection limit		Median	2.2
TOTAL	12	Min.	1.0
		Max.	3.0

Lognormal distribution? r-squared is: 0.913
Normal distribution? r-squared is: 0.948
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 2.6

Barium 95% UCL Calculation

DATA	ID
84.2	J1V325/ J1V333
54.8	J1V321
56.3	J1V322
59.9	J1V323
57.0	J1V324
66.7	J1V326
67.2	J1V327
66.7	J1V328
65.1	J1V329
56.6	J1V330
57.6	J1V331
67.3	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	63.3
Censored		Lognormal mean	63.3
Detection limit or PQL		Std. devn.	8.2
Method detection limit		Median	62.5
TOTAL	12	Min.	54.8
		Max.	84.2

Lognormal distribution? r-squared is: 0.852
Normal distribution? r-squared is: 0.813
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 67.2

Beryllium 95% UCL Calculation

DATA	ID
0.41	J1V325/ J1V333
0.37	J1V321
0.37	J1V322
0.34	J1V323
0.41	J1V324
0.37	J1V326
0.38	J1V327
0.35	J1V328
0.31	J1V329
0.29	J1V330
0.33	J1V331
0.32	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	0.35
Censored		Lognormal mean	0.35
Detection limit or PQL		Std. devn.	0.037
Method detection limit		Median	0.36
TOTAL	12	Min.	0.29
		Max.	0.41

Lognormal distribution? r-squared is: 0.973
Normal distribution? r-squared is: 0.977
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.37

Cadmium 95% UCL Calculation

DATA	ID
0.13	J1V325/ J1V333
0.14	J1V321
0.11	J1V322
0.11	J1V323
0.11	J1V324
0.13	J1V326
0.15	J1V327
0.11	J1V328
0.11	J1V329
0.089	J1V330
0.086	J1V331
0.11	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	0.12
Censored		Lognormal mean	0.12
Detection limit or PQL		Std. devn.	0.019
Method detection limit		Median	0.11
TOTAL	12	Min.	0.086
		Max.	0.15

Lognormal distribution? r-squared is: 0.902
Normal distribution? r-squared is: 0.903
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.13

Chromium 95% UCL Calculation

DATA	ID
10.9	J1V325/ J1V333
4.9	J1V321
5.2	J1V322
6.8	J1V323
3.9	J1V324
9.6	J1V326
11.3	J1V327
6.2	J1V328
4.2	J1V329
7.6	J1V330
5.7	J1V331
6.8	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	6.9
Censored		Lognormal mean	7.0
Detection limit or PQL		Std. devn.	2.5
Method detection limit		Median	6.5
TOTAL	12	Min.	3.9
		Max.	11.3

Lognormal distribution? r-squared is: 0.971
Normal distribution? r-squared is: 0.927
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 8.6

Cobalt 95% UCL Calculation

DATA	ID
7.7	J1V325/ J1V333
13.1	J1V321
8.4	J1V322
8.7	J1V323
13.2	J1V324
7.1	J1V326
7.6	J1V327
8.1	J1V328
7.3	J1V329
5.8	J1V330
9.2	J1V331
7.7	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	8.7
Censored		Lognormal mean	8.7
Detection limit or PQL		Std. devn.	2.3
Method detection limit		Median	7.9
TOTAL	12	Min.	5.8
		Max.	13.2

Lognormal distribution? r-squared is: 0.871
Normal distribution? r-squared is: 0.802
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 9.7

Copper 95% UCL Calculation

DATA	ID
15.5	J1V325/ J1V333
17.0	J1V321
15.2	J1V322
16.1	J1V323
15.6	J1V324
15.0	J1V326
17.5	J1V327
17.1	J1V328
16.7	J1V329
13.8	J1V330
17.3	J1V331
15.3	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	16.0
Censored		Lognormal mean	16.0
Detection limit or PQL		Std. devn.	1.1
Method detection limit		Median	15.9
TOTAL	12	Min.	13.8
		Max.	17.5

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

UCL (Land's method) is 16.6

Hexavalent chromium 95% UCL Calculation

DATA	ID
0.237	J1V325/ J1V333
0.0775	J1V321
0.0775	J1V322
0.194	J1V323
0.167	J1V324
0.195	J1V326
0.263	J1V327
0.217	J1V328
0.0775	J1V329
0.0775	J1V330
0.0775	J1V331
0.0775	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	0.145
Censored		Lognormal mean	0.147
Detection limit or PQL		Std. devn.	0.0740
Method detection limit		Median	0.122
TOTAL	12	Min.	0.0775
		Max.	0.263

Lognormal distribution? r-squared is: 0.788
Normal distribution? r-squared is: 0.823
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 0.180

Washington Closure Hanford

CALCULATION SHEET

Originator J. D. Skoglie	**Date** 03/26/15	**Calc. No.** 0100D-CA-V0592	**Rev. No.** 0
Project 100-D Area Closure Operations	**Job No.** 14655	**Checked** I. B. Berezovskiy	**Date** 03/26/15
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations			**Sheet No.** 14 of 18

Ecology Software (MTCAStat) Results, 100-D-85:2 Subsite Excavation

Lead 95% UCL Calculation

DATA	ID
4.2	J1V325/ J1V333
4.6	J1V321
2.9	J1V322
2.8	J1V323
2.0	J1V324
3.4	J1V326
5.6	J1V327
2.9	J1V328
1.9	J1V329
2.6	J1V330
1.9	J1V331
2.5	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	3.1
Censored		Lognormal mean	3.1
Detection limit or PQL		Std. devn.	1.2
Method detection limit		Median	2.9
TOTAL	12	Min.	1.9
		Max.	5.6

Lognormal distribution? r-squared is: 0.951
Normal distribution? r-squared is: 0.895
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 3.8

Manganese 95% UCL Calculation

DATA	ID
362	J1V325/ J1V333
331	J1V321
328	J1V322
338	J1V323
342	J1V324
293	J1V326
329	J1V327
333	J1V328
280	J1V329
237	J1V330
349	J1V331
311	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	319
Censored		Lognormal mean	320
Detection limit or PQL		Std. devn.	35
Method detection limit		Median	330
TOTAL	12	Min.	237
		Max.	362

Lognormal distribution? r-squared is: 0.832
Normal distribution? r-squared is: 0.872
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 336

Mercury 95% UCL Calculation

DATA	ID
0.013	J1V325/ J1V333
0.0095	J1V321
0.010	J1V322
0.0099	J1V323
0.0088	J1V324
0.012	J1V326
0.015	J1V327
0.011	J1V328
0.010	J1V329
0.010	J1V330
0.0076	J1V331
0.010	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	0.011
Censored		Lognormal mean	0.011
Detection limit or PQL		Std. devn.	0.0019
Method detection limit		Median	0.010
TOTAL	12	Min.	0.0076
		Max.	0.015

Lognormal distribution? r-squared is: 0.921
Normal distribution? r-squared is: 0.885
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.012

Nickel 95% UCL Calculation

DATA	ID
11.5	J1V325/ J1V333
9.5	J1V321
7.6	J1V322
12.5	J1V323
7.9	J1V324
10.0	J1V326
9.8	J1V327
9.9	J1V328
6.9	J1V329
8.7	J1V330
8.6	J1V331
11.7	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	9.5
Censored		Lognormal mean	9.6
Detection limit or PQL		Std. devn.	1.7
Method detection limit		Median	9.7
TOTAL	12	Min.	6.9
		Max.	12.5

Lognormal distribution? r-squared is: 0.981
Normal distribution? r-squared is: 0.975
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 10.6

Vanadium 95% UCL Calculation

DATA	ID
57.4	J1V325/ J1V333
80.9	J1V321
68.3	J1V322
70.2	J1V323
83.4	J1V324
51.5	J1V326
64.2	J1V327
64.0	J1V328
64.2	J1V329
45.9	J1V330
80.2	J1V331
68.8	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	66.6
Censored		Lognormal mean	66.7
Detection limit or PQL		Std. devn.	11.5
Method detection limit		Median	66.3
TOTAL	12	Min.	45.9
		Max.	83.4

Lognormal distribution? r-squared is: 0.945
Normal distribution? r-squared is: 0.960
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 73.7

Zinc 95% UCL Calculation

DATA	ID
47.1	J1V325/ J1V333
52.1	J1V321
48.6	J1V322
48.9	J1V323
54.0	J1V324
38.0	J1V326
56.9	J1V327
46.6	J1V328
45.5	J1V329
33.1	J1V330
52.1	J1V331
47.1	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	47.5
Censored		Lognormal mean	47.6
Detection limit or PQL		Std. devn.	6.6
Method detection limit		Median	47.9
TOTAL	12	Min.	33.1
		Max.	56.9

Lognormal distribution? r-squared is: 0.867
Normal distribution? r-squared is: 0.911
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 50.9

Fluoride 95% UCL Calculation

DATA	ID
1.2	J1V325/ J1V333
1.4	J1V321
1.2	J1V322
1.1	J1V323
0.41	J1V324
1.5	J1V326
0.88	J1V327
1.4	J1V328
0.41	J1V329
0.90	J1V330
0.41	J1V331
0.43	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	0.94
Censored		Lognormal mean	0.96
Detection limit or PQL		Std. devn.	0.43
Method detection limit		Median	1.0
TOTAL	12	Min.	0.41
		Max.	1.5

Lognormal distribution? r-squared is: 0.837
Normal distribution? r-squared is: 0.892
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 1.1

Nitrogen in nitrate 95% UCL Calculation

DATA	ID
	J1V325/ J1V333
0.70	J1V321
	J1V322
0.63	J1V323
	J1V324
0.87	J1V326
1.0	J1V327
	J1V328
	J1V329
0.76	J1V330
0.71	J1V331
	J1V332

Number of samples		Uncensored values	
Uncensored	6	Mean	0.78
Censored		Lognormal mean	0.74
Detection limit or PQL		Std. devn.	0.13
Method detection limit		Median	0.74
TOTAL	6	Min.	0.63
		Max.	1.0

Lognormal distribution? r-squared is: NA
Normal distribution? r-squared is: 0.816
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 0.64

Sulfate 95% UCL Calculation

DATA	ID
4.5	J1V325/ J1V333
9.5	J1V321
6.0	J1V322
5.4	J1V323
4.6	J1V324
6.2	J1V326
12.7	J1V327
6.4	J1V328
5.1	J1V329
216	J1V330
4.6	J1V331
4.3	J1V332

Number of samples		Uncensored values	
Uncensored	12	Mean	23.8
Censored		Lognormal mean	14.5
Detection limit or PQL		Std. devn.	60.6
Method detection limit		Median	5.7
TOTAL	12	Min.	4.3
		Max.	216

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

UCL (based on Z-statistic) is 52.5

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie	**Date** 03/26/15	**Calc. No.** 0100D-CA-V0592	**Rev. No.** 0
Project 100-D Area Closure Operations	**Job No.** 14655	**Checked** I. B. Berezovskiy	**Date** 03/26/15
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations			**Sheet No.** 15 of 18

Ecology Software (MTCAStat) Results, 100-D-85:2 Subsite Staging Pile Area

Antimony 95% UCL Calculation

DATA	ID
0.53	J1V349/ J1V352
0.95	J1V340
1.2	J1V341
1.1	J1V342
1.0	J1V343
1.2	J1V344
2.1	J1V345
1.1	J1V346
0.90	J1V347
1.1	J1V348
1.2	J1V350
0.55	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	1.1
Censored		Lognormal mean	1.1
Detection limit or PQL		Std. devn.	0.40
Method detection limit		Median	1.1
TOTAL	12	Min.	0.53
		Max.	2.1

Lognormal distribution? r-squared is: 0.858
Normal distribution? r-squared is: 0.803
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 1.3

Arsenic 95% UCL Calculation

DATA	ID
3.1	J1V349/ J1V352
2.2	J1V340
2.1	J1V341
2.3	J1V342
2.8	J1V343
2.1	J1V344
2.3	J1V345
2.6	J1V346
2.7	J1V347
2.7	J1V348
2.4	J1V350
2.8	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	2.5
Censored		Lognormal mean	2.5
Detection limit or PQL		Std. devn.	0.31
Method detection limit		Median	2.5
TOTAL	12	Min.	2.1
		Max.	3.1

Lognormal distribution? r-squared is: 0.949
Normal distribution? r-squared is: 0.948
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 2.7

Barium 95% UCL Calculation

DATA	ID
74.1	J1V349/ J1V352
42.7	J1V340
56.7	J1V341
51.4	J1V342
64.7	J1V343
48.2	J1V344
48.9	J1V345
51.8	J1V346
56.6	J1V347
55.3	J1V348
55.6	J1V350
65.6	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	56.0
Censored		Lognormal mean	56.0
Detection limit or PQL		Std. devn.	8.6
Method detection limit		Median	55.5
TOTAL	12	Min.	42.7
		Max.	74.1

Lognormal distribution? r-squared is: 0.966
Normal distribution? r-squared is: 0.944
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 60.8

Beryllium 95% UCL Calculation

DATA	ID
0.41	J1V349/ J1V352
0.66	J1V340
0.42	J1V341
0.55	J1V342
0.82	J1V343
0.47	J1V344
0.70	J1V345
0.43	J1V346
0.77	J1V347
0.44	J1V348
0.44	J1V350
0.39	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	0.54
Censored		Lognormal mean	0.54
Detection limit or PQL		Std. devn.	0.15
Method detection limit		Median	0.46
TOTAL	12	Min.	0.39
		Max.	0.82

Lognormal distribution? r-squared is: 0.880
Normal distribution? r-squared is: 0.856
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 0.62

Cadmium 95% UCL Calculation

DATA	ID
0.15	J1V349/ J1V352
0.10	J1V340
0.13	J1V341
0.10	J1V342
0.15	J1V343
0.12	J1V344
0.10	J1V345
0.12	J1V346
0.13	J1V347
0.11	J1V348
0.11	J1V350
0.13	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	0.12
Censored		Lognormal mean	0.12
Detection limit or PQL		Std. devn.	0.017
Method detection limit		Median	0.12
TOTAL	12	Min.	0.10
		Max.	0.15

Lognormal distribution? r-squared is: 0.940
Normal distribution? r-squared is: 0.936
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.13

Chromium 95% UCL Calculation

DATA	ID
11.4	J1V349/ J1V352
4.4	J1V340
5.1	J1V341
5.2	J1V342
5.0	J1V343
4.5	J1V344
4.7	J1V345
6.1	J1V346
6.5	J1V347
6.8	J1V348
6.7	J1V350
10.2	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	6.4
Censored		Lognormal mean	6.4
Detection limit or PQL		Std. devn.	2.2
Method detection limit		Median	5.7
TOTAL	12	Min.	4.4
		Max.	11.4

Lognormal distribution? r-squared is: 0.879
Normal distribution? r-squared is: 800.000
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 7.4

Cobalt 95% UCL Calculation

DATA	ID
7.7	J1V349/ J1V352
11.9	J1V340
10.2	J1V341
10.2	J1V342
13.2	J1V343
11.0	J1V344
12.4	J1V345
9.5	J1V346
12.5	J1V347
9.4	J1V348
9.3	J1V350
7.8	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	10.4
Censored		Lognormal mean	10.4
Detection limit or PQL		Std. devn.	1.8
Method detection limit		Median	10.2
TOTAL	12	Min.	7.7
		Max.	13.2

Lognormal distribution? r-squared is: 0.955
Normal distribution? r-squared is: 0.962
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 11.5

Copper 95% UCL Calculation

DATA	ID
14.6	J1V349/ J1V352
16.0	J1V340
14.2	J1V341
13.4	J1V342
17.2	J1V343
15.1	J1V344
16.6	J1V345
13.4	J1V346
17.4	J1V347
15.5	J1V348
14.6	J1V350
13.0	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	15.1
Censored		Lognormal mean	15.1
Detection limit or PQL		Std. devn.	1.5
Method detection limit		Median	14.9
TOTAL	12	Min.	13.0
		Max.	17.4

Lognormal distribution? r-squared is: 0.969
Normal distribution? r-squared is: 0.966
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 15.9

Lead 95% UCL Calculation

DATA	ID
4.0	J1V349/ J1V352
2.2	J1V340
2.7	J1V341
2.4	J1V342
2.9	J1V343
3.1	J1V344
1.9	J1V345
3.0	J1V346
2.3	J1V347
3.4	J1V348
2.7	J1V350
3.2	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	2.8
Censored		Lognormal mean	2.8
Detection limit or PQL		Std. devn.	0.58
Method detection limit		Median	2.8
TOTAL	12	Min.	1.9
		Max.	4.0

Lognormal distribution? r-squared is: 0.987
Normal distribution? r-squared is: 0.977
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 3.2

CALCULATION SHEET

Washington Closure Hanford

Originator	J. D. Skoglie	**Date** 06/02/15	**Calc. No.** 0100D-CA-V0592
Project	100-D Area Closure Operations	**Job No.** 14655	**Checked** I. B. Berezovskiy
Subject	100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations		

Rev. No. 0
Date 06/02/15
Sheet No. 16 of 18

Ecology Software (MTCAStat) Results, 100-D-85:2 Subsite Staging Pile Area

Manganese 95% UCL Calculation

DATA	ID
310	J1V349/ J1V352
287	J1V340
321	J1V341
308	J1V342
371	J1V343
313	J1V344
301	J1V345
304	J1V346
319	J1V347
300	J1V348
293	J1V350
294	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	310
Censored		Lognormal mean	310
Detection limit or PQL		Std. devn.	22
Method detection limit		Median	306
TOTAL	12	Min.	287
		Max.	371

Lognormal distribution? r-squared is: 0.797
Normal distribution? r-squared is: 0.762
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 320

Mercury 95% UCL Calculation

DATA	ID
0.013	J1V349/ J1V352
0.0027	J1V340
0.0027	J1V341
0.0029	J1V342
0.0061	J1V343
0.0025	J1V344
0.0029	J1V345
0.0067	J1V346
0.0089	J1V347
0.0079	J1V348
0.0060	J1V350
0.0071	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	0.0058
Censored		Lognormal mean	0.0059
Detection limit or PQL		Std. devn.	0.0033
Method detection limit		Median	0.0061
TOTAL	12	Min.	0.0025
		Max.	0.013

Lognormal distribution? r-squared is: 0.891
Normal distribution? r-squared is: 0.870
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 0.0070

Nickel 95% UCL Calculation

DATA	ID
11.5	J1V349/ J1V352
7.6	J1V340
7.7	J1V341
8.1	J1V342
7.7	J1V343
8.7	J1V344
7.5	J1V345
8.3	J1V346
8.3	J1V347
8.8	J1V348
8.6	J1V350
11.0	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	8.7
Censored		Lognormal mean	8.7
Detection limit or PQL		Std. devn.	1.3
Method detection limit		Median	8.3
TOTAL	12	Min.	7.5
		Max.	11.5

Lognormal distribution? r-squared is: 0.816
Normal distribution? r-squared is: 0.776
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 9.3

Vanadium 95% UCL Calculation

DATA	ID
48.3	J1V349/ J1V352
73.6	J1V340
66.6	J1V341
64.9	J1V342
83.1	J1V343
77.7	J1V344
78.6	J1V345
64.2	J1V346
80.5	J1V347
61.5	J1V348
63.2	J1V350
49.6	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	67.6
Censored		Lognormal mean	67.8
Detection limit or PQL		Std. devn.	11.4
Method detection limit		Median	65.8
TOTAL	12	Min.	48.3
		Max.	83.1

Lognormal distribution? r-squared is: 0.921
Normal distribution? r-squared is: 0.943
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 74.7

Zinc 95% UCL Calculation

DATA	ID
36.6	J1V349/ J1V352
43.0	J1V340
42.9	J1V341
42.5	J1V342
48.2	J1V343
48.5	J1V344
44.4	J1V345
41.4	J1V346
46.4	J1V347
42.1	J1V348
41.2	J1V350
37.2	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	42.9
Censored		Lognormal mean	42.9
Detection limit or PQL		Std. devn.	3.7
Method detection limit		Median	42.7
TOTAL	12	Min.	36.6
		Max.	48.5

Lognormal distribution? r-squared is: 0.944
Normal distribution? r-squared is: 0.950
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 44.9

Fluoride 95% UCL Calculation

DATA	ID
1.2	J1V349/ J1V352
1.1	J1V340
1.1	J1V341
1.0	J1V342
1.2	J1V343
1.1	J1V344
1.2	J1V345
1.2	J1V346
1.5	J1V347
1.4	J1V348
1.3	J1V350
1.3	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	1.2
Censored		Lognormal mean	1.2
Detection limit or PQL		Std. devn.	0.14
Method detection limit		Median	1.2
TOTAL	12	Min.	1.0
		Max.	1.5

Lognormal distribution? r-squared is: 0.952
Normal distribution? r-squared is: 0.939
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 1.3

Nitrogen in nitrate 95% UCL Calculation

DATA	ID
0.71	J1V349/ J1V352
0.83	J1V340
1.0	J1V341
1.1	J1V342
0.68	J1V343
0.67	J1V344
0.78	J1V345
0.68	J1V346
	J1V347
0.76	J1V348
	J1V350
0.71	J1V351

Number of samples		Uncensored values	
Uncensored	10	Mean	0.79
Censored		Lognormal mean	0.80
Detection limit or PQL		Std. devn.	0.15
Method detection limit		Median	0.74
TOTAL	10	Min.	0.67
		Max.	1.1

Lognormal distribution? r-squared is: 0.605
Normal distribution? r-squared is: 0.777
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 0.87

Sulfate 95% UCL Calculation

DATA	ID
3.9	J1V349/ J1V352
7.3	J1V340
8.8	J1V341
7.7	J1V342
8.1	J1V343
0.85	J1V344
15.5	J1V345
8.7	J1V346
7.4	J1V347
7.4	J1V348
0.85	J1V350
7.2	J1V351

Number of samples		Uncensored values	
Uncensored	12	Mean	7.0
Censored		Lognormal mean	8.2
Detection limit or PQL		Std. devn.	3.9
Method detection limit		Median	7.4
TOTAL	12	Min.	0.85
		Max.	15.5

Lognormal distribution? r-squared is: 0.718
Normal distribution? r-squared is: 0.846
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 8.8

CALCULATION SHEET

Washington Closure Hanford

Originator	J. D. Skoglie	**Date**	03/26/15	**Calc. No.**	0100D-CA-V0592
Project	100-D Area Closure Operations	**Job No.**	14655	**Checked**	I. B. Berezovskiy
Subject	100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations				

Rev. No. 0
Date 03/26/15
Sheet No. 17 of 18

Duplicate Analysis - 100-D-85:2 Subsite Excavation

Sampling Area	Sample Number	Sample Date	Potassium-40 pCi/g	Q	MDA	Uranium-234 pCi/g	Q	MDA	Uranium-238 pCi/g	Q	MDA	Aluminum mg/kg	Q	PQL	Antimony mg/kg	Q	PQL	Arsenic mg/kg	Q	PQL	Barium mg/kg	Q	PQL	Beryllium mg/kg	Q	PQL	Cadmium mg/kg	Q	PQL	Calcium mg/kg	Q	PQL
EXC-5	J1V325	1/20/15	13.4		0.235	0.154		0.0624	0.120		0.0465	8940		7.1	0.69		0.35	3.1		0.60	84.2		0.35	0.42		0.030	0.13	B	0.038	4730		64.5
Duplicate of J1V325	J1V333	1/20/15	12.7		0.185	0.142		0.0549	0.161		0.0737	8470		8.2	0.83		0.40	2.5		0.70	84.2		0.40	0.39		0.035	0.13	B	0.043	4960		74.7

Analysis:

		Potassium-40	Uranium-234	Uranium-238	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium
TDL		0.5	1	1	5	0.6	10	2	0.5	0.2	100
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)
	RPD	5.4%			5.4%			0.0%			4.7%
	Difference > 2 TDL?	Not applicable	No - acceptable	No - acceptable	Not applicable	No - acceptable	No - acceptable	Not applicable	No - acceptable	No - acceptable	Not applicable

Duplicate Analysis - 100-D-85:2 Subsite Excavation

Sampling Area	HEIS Number	Sample Date	Chromium mg/kg	Q	PQL	Cobalt mg/kg	Q	PQL	Copper mg/kg	Q	PQL	Hexavalent Chromium mg/kg	Q	PQL	Iron mg/kg	Q	PQL	Lead mg/kg	Q	PQL	Magnesium mg/kg	Q	PQL	Manganese mg/kg	Q	PQL	Mercury mg/kg	Q	PQL	Nickel mg/kg	Q	PQL
EXC-5	J1V325	1/20/15	10.2		0.053	7.5		0.091	15.0		0.99	0.195		0.155	24300		17.4	4.2		0.25	4670		16.9	358		0.46	0.012	BC	0.0055	10.6		0.11
Duplicate of J1V325	J1V333	1/20/15	11.5		0.061	7.8		0.11	15.9		1.1	0.279		0.155	25200		20.1	4.1		0.29	4920		19.6	366		0.53	0.013	BC	0.0062	12.3		0.13

Analysis:

		Chromium	Cobalt	Copper	Hexavalent Chromium	Iron	Lead	Magnesium	Manganese	Mercury	Nickel
TDL		1	2	1	0.5	5	5	75	5	0.2	4
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD	12.0%		5.8%		3.6%		5.2%	2.2%		
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	No - acceptable	Not applicable	No - acceptable	Not applicable	Not applicable	No - acceptable	No - acceptable

Duplicate Analysis - 100-D-85:2 Subsite Excavation

Sampling Area	HEIS Number	Sample Date	Potassium mg/kg	Q	PQL	Silicon mg/kg	Q	PQL	Sodium mg/kg	Q	PQL	Vanadium mg/kg	Q	PQL	Zinc mg/kg	Q	PQL	Fluoride mg/kg	Q	PQL	Sulfate mg/kg	Q	PQL
EXC-5	J1V325	1/20/15	1550		188	219	N	25.9	209		54.0	55.3		0.43	49.0		1.8	1.2	B	0.84	4.9	BC	1.7
Duplicate of J1V325	J1V333	1/20/15	1350		43.4	241	N	30.0	187		62.5	59.5		0.50	45.1		2.1	1.2	BM	0.86	4.1	BC	1.8

Analysis:

		Potassium	Silicon	Sodium	Vanadium	Zinc	Fluoride	Sulfate
TDL		400	2	50	2.5	1	5	5
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD		9.6%		7.3%	8.3%		
	Difference > 2 TDL?	No - acceptable	Not applicable	No - acceptable	Not applicable	Not applicable	No - acceptable	No - acceptable

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-D Area Closure Operations
Subject 100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations

Date 03/26/15
Job No. 14655

Calc. No. 0100D-CA-V0592
Checked I. B. Berezovskiy

Rev. No. 0
Date 03/26/15
Sheet No. 18 of 18

Duplicate Analysis - 100-D-85:2 Subsite Staging Pile Area

Sampling Area	Sample Number	Sample Date	Potassium-40			Uranium-238			Aluminum			Antimony			Arsenic			Barium			Beryllium			Cadmium			Calcium		
			pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
SPA-10	J1V349	1/21/15	14		0.23	0.194		0.0646	7250		1.4	0.48	JB	0.35	3.2		0.61	76.0	X	0.071	0.39		0.031	0.16	B	0.038	8290	J	13.1
Duplicate of J1V349	J1V352	1/21/15	13.7		0.219	0.203		0.053	7320		1.5	0.57	J	0.36	2.9		0.62	72.1	X	0.072	0.42		0.031	0.13	B	0.039	7830	J	13.3

Analysis:

TDL			0.5			1			5			0.6			10			2			0.5			0.2			100		
Duplicate Analysis	Both > PQL?		Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)		
	Both >5xTDL?		Yes (calc RPD)			No-Stop (acceptable)			Yes (calc RPD)			No-Stop (acceptable)			No-Stop (acceptable)			Yes (calc RPD)			No-Stop (acceptable)			No-Stop (acceptable)			Yes (calc RPD)		
	RPD		2.2%						1.0%									5.3%									5.7%		
	Difference > 2 TDL?		Not applicable			No - acceptable			Not applicable			No - acceptable			No - acceptable			Not applicable			No - acceptable			No - acceptable			Not applicable		

Duplicate Analysis - 100-D-85:2 Subsite Staging Pile Area

Sampling Area	HEIS Number	Sample Date	Chromium			Cobalt			Copper			Iron			Lead			Magnesium			Manganese			Mercury			Nickel		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
SPA-10	J1V349	1/21/15	11.3	X	0.054	7.8		0.093	14.3		0.20	19500	X	3.5	4.0		0.25	4460	X	3.4	320	X	0.093	0.0077	B	0.0057	11.5	X	0.11
Duplicate of J1V349	J1V352	1/21/15	11.4	X	0.055	7.6		0.094	14.8		0.20	19500	X	3.6	4.0		0.25	4360	X	3.5	299	X	0.094	0.019		0.0059	11.5	X	0.12

Analysis:

TDL			1			2			1			5			5			75			5			0.2			4		
Duplicate Analysis	Both > PQL?		Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)		
	Both >5xTDL?		Yes (calc RPD)			No-Stop (acceptable)			Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)			Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)			No-Stop (acceptable)		
	RPD		0.9%						3.4%			0.0%						2.3%			6.8%								
	Difference > 2 TDL?		Not applicable			No - acceptable			Not applicable			Not applicable			No - acceptable			Not applicable			Not applicable			No - acceptable			No - acceptable		

Duplicate Analysis - 100-D-85:2 Subsite Staging Pile Area

Sampling Area	HEIS Number	Sample Date	Potassium			Silicon			Sodium			Vanadium			Zinc			Fluoride			Nitrogen in Nitrate		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
SPA-10	J1V349	1/21/15	1180		38.0	426	J	5.3	185		54.7	47.9	JX	0.087	37.0	X	0.37	1.2	B	0.87	0.70	JB	0.33
Duplicate of J1V349	J1V352	1/21/15	1180		38.7	384	J	5.3	180		55.7	48.6	JX	0.089	36.1	X	0.38	1.2	B	0.87	0.71	JB	0.33

Analysis:

TDL			400			2			50			2.5			1			5			0.75								
Duplicate Analysis	Both > PQL?		Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)								
	Both >5xTDL?		No-Stop (acceptable)			Yes (calc RPD)			No-Stop (acceptable)			Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)			No-Stop (acceptable)								
	RPD					10.4%						1.5%			2.5%														
	Difference > 2 TDL?		No - acceptable			Not applicable			No - acceptable			Not applicable			Not applicable			No - acceptable			No - acceptable								

Attachment 1. 100-D-85:2 Subsite Verification Sample Results (Radionuclides).

Sample Location	HEIS Number	Sample Date	Americium-241 - AEA			Americium-241 - GEA			Cesium-137			Cobalt-60			Europium-152		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-5	J1V325	1/20/15	0.00558	U	0.0996	-0.0002	U	0.0291	-0.0139	U	0.0195	0.00873	U	0.0257	0.0147	U	0.0519
Duplicate of J1V325	J1V333	1/20/15	-0.00422	U	0.0704	0.00559	U	0.0304	0.0104	U	0.0215	-0.00154	U	0.0246	0.0488	U	0.0491
EXC-1	J1V321	1/20/15	0.0199	U	0.0987	-0.0429	U	0.0938	-0.0107	U	0.0289	-0.000913	U	0.0322	-0.0199	U	0.0696
EXC-2	J1V322	1/20/15	0.00626	U	0.0987	-0.0274	U	0.116	0.0147	U	0.0271	-0.00643	U	0.024	-0.371	U	0.0677
EXC-3	J1V323	1/20/15	0.00508	U	0.104	-0.0275	U	0.143	-0.00497	U	0.022	0.00195	U	0.0249	-0.0135	U	0.0515
EXC-4	J1V324	1/20/15	0.0184	U	0.105	0.0064	U	0.0353	-0.00054	U	0.023	0.00356	U	0.0253	-0.0123	U	0.0609
EXC-6	J1V326	1/20/15	0.00918	U	0.0864	-0.00575	U	0.0268	0.00367	U	0.0196	0.00248	U	0.0202	-0.00411	U	0.0427
EXC-7	J1V327	1/20/15	0.00396	U	0.094	-0.00088	U	0.0291	0.277		0.0227	-0.00192	U	0.0252	0.222		0.049
EXC-8	J1V328	1/20/15	-0.011	U	0.0977	0.0434	U	0.105	0.00219	U	0.0342	-0.0184	U	0.0341	0.0156	U	0.0795
EXC-9	J1V329	1/20/15	0.00271	U	0.093	-0.0122	U	0.12	0.0384	U	0.0323	-0.0195	U	0.0223	-0.166	U	0.0822
EXC-10	J1V330	1/20/15	0.0268	U	0.0498	-0.0294	U	0.158	0.00202	U	0.0252	-0.00874	U	0.0252	-0.00661	U	0.0595
EXC-11	J1V331	1/20/15	0.0267	U	0.0711	-0.011	U	0.0339	0.0108	U	0.0257	-0.000622	U	0.0235	0.00933	U	0.0575
EXC-12	J1V332	1/20/15	0.0137	U	0.0519	-0.0011	U	0.0256	0.00651	U	0.023	0.0102	U	0.0266	0.00953	U	0.047
SPA-10	J1V349	1/21/15	0.00412	U	0.102	-0.0446	U	0.15	0.000513	U	0.0321	0.0219	U	0.0336	0.0516	U	0.0833
Duplicate of J1V349	J1V352	1/21/15	0.0094	U	0.0738	-0.0679	U	0.141	0.00885	U	0.0306	-0.0053	U	0.0277	-0.0302	U	0.0859
SPA-1	J1V340	1/21/15	-0.0122	U	0.122	-0.00521	U	0.0931	0.00727	U	0.036	-0.0127	U	0.0287	-0.0301	U	0.0754
SPA-2	J1V341	1/21/15	0.021	U	0.0901	-0.0338	U	0.13	0.0268	U	0.0322	-0.00634	U	0.027	0.106	U	0.0762
SPA-3	J1V342	1/21/15	-0.0119	U	0.102	-0.0068	U	0.0369	0.00241	U	0.0254	0.00427	U	0.0249	-0.00858	U	0.0573
SPA-4	J1V343	1/21/15	0.0499	U	0.0984	0.00553	U	0.0261	0.436		0.0208	0.000103	U	0.0233	0.026	U	0.05
SPA-5	J1V344	1/21/15	-0.0117	U	0.1	-0.00925	U	0.0249	0.00683	U	0.0199	0.00953	U	0.0212	0.018	U	0.0439
SPA-6	J1V345	1/21/15	-0.00637	U	0.0838	0.0371	U	0.0963	-0.0109	U	0.0306	0.0148	U	0.0324	-0.0723	U	0.0706
SPA-7	J1V346	1/21/15	0.0181	U	0.0943	-0.0528	U	0.131	0.0383	U	0.0342	0.0173	U	0.0304	-0.0331	U	0.078
SPA-8	J1V347	1/21/15	-0.0106	U	0.0946	-0.00342	U	0.0359	0.00363	U	0.0245	0.0027	U	0.0232	-0.0027	U	0.0582
SPA-9	J1V348	1/21/15	-0.0112	U	0.0957	0.00603	U	0.104	0.0579		0.0338	-0.00783	U	0.031	-0.0399	U	0.0766
SPA-11	J1V350	1/21/15	-0.00288	U	0.069	0.00815	U	0.0403	-0.0118	U	0.0231	-0.00624	U	0.0226	-0.00651	U	0.0613
SPA-12	J1V351	1/21/15	0.0141	U	0.0533	0.0235	U	0.118	0.00295	U	0.0393	-0.00329	U	0.0367	-0.068	U	0.0845

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

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

B = blank contamination (inorganic constituents)
C = </= 5x the blank concentration
EXC = excavation
HEIS = Hanford Environmental Information
J = estimate
M = sample duplicate precision not met
MDA = minimum dection allowed
N = recovery is outside control limits
PCB = polychlorinated biphenyls
PQL = practical quantitation limit
Q = qualifier
R = rejected
SPA = staging pile area
U = undetected
X (metals) = serial dilution in the analytical batch indicates that physical and chemical interferences are present.

Attachment	1	Sheet No.	1 of 10
Originator	J. D. Skoglic	Date	3/26/15
Checked	I. B. Berezovskiy	Date	3/26/15
Calc. No.	0100D-CA-V0592	Rev. No.	0
		Job No.	14655

Attachment 1. 100-D-85:2 Subsite Verification Sample Results (Radionuclides).

Sample Location	HEIS Number	Sample Date	Europium-154			Europium-155			Nickel-63			Plutonium-238			Plutonium-239/240		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-5	J1V325	1/20/15	-0.0288	U	0.0756	0.0449	U	0.0449	1.28	U	7.19	0.0349	U	0.112	-0.00194	U	0.0697
Duplicate of J1V325	J1V333	1/20/15	-0.0188	U	0.0711	0.0427	U	0.0465	3.22	U	7.05	-0.000543	U	0.0494	0.0109	U	0.065
EXC-1	J1V321	1/20/15	-0.0361	U	0.104	0.0613	U	0.0776	1.81	U	6.84	0.0211	U	0.0952	-0.00121	U	0.0607
EXC-2	J1V322	1/20/15	-0.043	U	0.0687	0.00925	U	0.0874	4.1	U	7.55	-0.0121	U	0.122	0.0159	U	0.0865
EXC-3	J1V323	1/20/15	-0.00388	U	0.0713	0.06	U	0.0639	2.48	U	6.79	0.0053	U	0.0947	-0.00059	U	0.0536
EXC-4	J1V324	1/20/15	0.012	U	0.078	0.0177	U	0.0548	0.958	U	7.08	0.00379	U	0.107	0	U	0.0428
EXC-6	J1V326	1/20/15	-0.0172	U	0.0683	0.0564		0.0398	4.18	U	7.25	-0.00469	U	0.0783	-0.00176	U	0.0634
EXC-7	J1V327	1/20/15	0.0196	U	0.0814	0.0588	U	0.0484	0.638	U	7.44	0.000561	U	0.102	0.0387	U	0.07
EXC-8	J1V328	1/20/15	-0.00633	U	0.109	0.0635	U	0.0846	3.21	U	6.31	-0.0123	U	0.099	0.0134	U	0.0509
EXC-9	J1V329	1/20/15	-0.0367	U	0.077	-0.011	U	0.0863	0.997	U	7.03	0.00176	U	0.104	0.0135	U	0.0589
EXC-10	J1V330	1/20/15	0.00709	U	0.0863	0.0286	U	0.0692	0.798	U	6.35	-0.00575	U	0.0812	-0.00173	U	0.0621
EXC-11	J1V331	1/20/15	-0.0277	U	0.0761	0.0183	U	0.0526	4.22	U	6.6	0.0273	U	0.0679	0.0149	U	0.0402
EXC-12	J1V332	1/20/15	0.00412	U	0.0869	0.0261	U	0.0392	0.787	U	6.87	0.0133	U	0.0584	0.0139	U	0.0528
SPA-10	J1V349	1/21/15	-0.0329	U	0.0902	-0.00595	U	0.106	-0.0601	UJ	3.91	0.00818	UJ	0.129	-0.00164	U	0.0823
Duplicate of J1V349	J1V352	1/21/15	-0.0159	U	0.0885	0.0279	U	0.105	0.764	UJ	3.47	-0.00442	UJ	0.0738	-0.00111	U	0.0557
SPA-1	J1V340	1/21/15	0.0127	U	0.113	0.0278	U	0.0768	-0.894	UJ	3.83	0.00548	UJ	0.0979	-0.00183	U	0.0658
SPA-2	J1V341	1/21/15	-0.00435	U	0.0881	-6.7E-05	U	0.0945	-0.281	UJ	4	-0.00873	UJ	0.0919	-0.00175	U	0.0629
SPA-3	J1V342	1/21/15	0.00876	U	0.0775	0.0275	U	0.0574	-0.344	UJ	3.77	-0.0101	UJ	0.0974	-0.0006	U	0.0541
SPA-4	J1V343	1/21/15	-0.0604	U	0.0686	0.0413	U	0.0406	2	UJ	3.92	-0.0111	UJ	0.107	0.0327	U	0.0443
SPA-5	J1V344	1/21/15	0.00758	U	0.0732	0.0232	U	0.0406	1	UJ	3.78	0.00525	UJ	0.0938	0.0134	U	0.0587
SPA-6	J1V345	1/21/15	0.0183	U	0.108	-0.0116	U	0.0735	-0.121	UJ	3.87	0.0242	UJ	0.077	-0.00173	U	0.0623
SPA-7	J1V346	1/21/15	-0.0141	U	0.0838	0.0616	U	0.0963	0.0346	UJ	3.8	-0.0122	UJ	0.102	-0.00292	U	0.0698
SPA-8	J1V347	1/21/15	0.00811	U	0.0748	0.0266	U	0.0575	-0.104	UJ	4.17	0.00616	UJ	0.0866	0.0134	U	0.0509
SPA-9	J1V348	1/21/15	0.0342	U	0.111	-0.0161	U	0.0766	0.291	UJ	3.57	-0.0109	UJ	0.104	-0.00064	U	0.0581
SPA-11	J1V350	1/21/15	-0.00608	U	0.0735	0.0355	U	0.0613	-0.467	UJ	3.76	-0.00291	UJ	0.0697	0	U	0.0394
SPA-12	J1V351	1/21/15	-0.12	U	0.101	0.0444	U	0.0915	-0.224	UJ	3.58	0.0276	UJ	0.0578	-0.00287	U	0.0688

Attachment	1	Sheet No.	2 of 10
Originator	J. D. Skoglic	Date	3/26/15
Checked	I. B. Berezovskiy	Date	3/26/15
Calc. No.	0100D-CA-V0592	Rev. No.	0
		Job No.	14655

Attachment 1. 100-D-85:2 Subsite Verification Sample Results (Radionuclides).

Sample Location	HEIS Number	Sample Date	Potassium-40			Total beta radiostrontium			Uranium-234			Uranium-235			Uranium-238		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-5	J1V325	1/20/15	13.4		0.235	0.0515	U	0.373	0.154		0.0624	0	U	0.0465	0.12		0.0465
Duplicate of J1V325	J1V333	1/20/15	12.7		0.185	0.159	U	0.489	0.142		0.0549	-0.00081	U	0.0737	0.161		0.0737
EXC-1	J1V321	1/20/15	9.95		0.208	0.175	U	0.423	0.224		0.0819	0	U	0.0609	0.292		0.0609
EXC-2	J1V322	1/20/15	9.91		0.183	-0.0108	U	0.397	0.132		0.0357	0.0127	U	0.048	0.117		0.057
EXC-3	J1V323	1/20/15	9.13		0.204	0.238	U	0.574	0.119		0.0621	0.0171	U	0.0462	0.0853		0.0462
EXC-4	J1V324	1/20/15	8.49		0.216	0.188	U	0.387	0.147		0.0982	0.0421	U	0.0782	0.129		0.0583
EXC-6	J1V326	1/20/15	12.8		0.181	0.142	U	0.393	0.126		0.0577	-0.000634	U	0.0577	0.143		0.0429
EXC-7	J1V327	1/20/15	12.3		0.178	0.417		0.411	1.64		0.0549	0.0607		0.0549	1.28		0.0549
EXC-8	J1V328	1/20/15	11.7		0.260	-0.00389	U	0.39	0.224		0.0649	0.0303	U	0.0697	0.21		0.0437
EXC-9	J1V329	1/20/15	9.65		0.169	-0.00125	U	0.353	0.211		0.103	0	U	0.0645	0.167		0.0645
EXC-10	J1V330	1/20/15	12.3		0.239	0.158	U	0.39	0.212		0.115	-0.000963	U	0.0876	0.239		0.0969
EXC-11	J1V331	1/20/15	8.67		0.186	0.161	U	0.441	0.0731		0.0536	-0.00236	U	0.0673	0.161		0.0536
EXC-12	J1V332	1/20/15	10.5		0.235	0.0751	U	0.416	0.301		0.064	0.0153	U	0.0579	0.38		0.064
SPA-10	J1V349	1/21/15	14.0		0.230	-0.126	U	0.401	0.124		0.0481	-0.00071	UJ	0.0646	0.194		0.0646
Duplicate of J1V349	J1V352	1/21/15	13.7		0.219	0.0949	U	0.387	0.0285	U	0.053	0.014	UJ	0.053	0.203		0.053
SPA-1	J1V340	1/21/15	10.3		0.142	0.179	U	0.405	0.198		0.0617	-0.00123	UJ	0.0617	0.137		0.0617
SPA-2	J1V341	1/21/15	10.9		0.204	-0.146	U	0.418	0.23		0.0665	-0.000582	UJ	0.0529	0.232		0.0529
SPA-3	J1V342	1/21/15	10.2		0.180	-0.0631	U	0.375	0.229		0.0388	0.0143	UJ	0.0388	0.157		0.0388
SPA-4	J1V343	1/21/15	9.97		0.225	0.35	U	0.396	0.132		0.0596	0.0142	UJ	0.0539	0.192		0.0539
SPA-5	J1V344	1/21/15	9.73		0.155	0.0778	U	0.413	0.119		0.0604	-0.0006	UJ	0.0546	0.0894		0.0546
SPA-6	J1V345	1/21/15	9.98		0.231	0.0779	U	0.42	0.235		0.0559	0	UJ	0.0376	0.277		0.0506
SPA-7	J1V346	1/21/15	11.7		0.205	0.0396	U	0.415	0.161		0.0437	-0.000644	UJ	0.0586	0.193		0.0437
SPA-8	J1V347	1/21/15	10.1		0.203	-0.0832	U	0.431	0.122		0.0765	0.034	UJ	0.0712	0.193		0.0712
SPA-9	J1V348	1/21/15	12.0		0.311	0.156	U	0.404	0.144		0.0638	0.0394	UJ	0.0485	0.211		0.0575
SPA-11	J1V350	1/21/15	10.9		0.209	0.0784	U	0.486	0.227		0.041	-0.000605	UJ	0.055	0.271		0.055
SPA-12	J1V351	1/21/15	13.0		0.340	0.122	U	0.407	0.15		0.0551	0	UJ	0.0371	0.233		0.0371

Attachment	1	Sheet No.	3 of 10
Originator	J. D. Skoglie	Date	3/26/15
Checked	I. B. Berezovskiy	Date	3/26/15
Calc. No.	0100D-CA-V0592	Rev. No.	0
		Job No.	14655

Attachment 1. 100-D-85:2 Subsite Verification Sample Results (Metals, Anions, and Physical).

Sample Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-5	J1V325	1/20/15	8940		7.1	0.69		0.35	3.1		0.60	84.2		0.35
Duplicate of J1V325	J1V333	1/20/15	8470		8.2	0.83		0.40	2.5		0.70	84.2		0.40
EXC-1	J1V321	1/20/15	5090		7.5	1.2		0.37	1.4	N	0.64	54.8	M	0.37
EXC-2	J1V322	1/20/15	5700		7.9	1.1		0.39	1.9		0.67	56.3		0.39
EXC-3	J1V323	1/20/15	6070		8.1	1.0		0.40	2.2		0.69	59.9		0.40
EXC-4	J1V324	1/20/15	4250		7.2	1.8	B	1.8	1.2		0.62	57.0		0.35
EXC-6	J1V326	1/20/15	7160		1.7	0.96		0.41	3.0		0.71	66.7		0.082
EXC-7	J1V327	1/20/15	7180		7.5	1.2		0.37	2.6		0.64	67.2		0.37
EXC-8	J1V328	1/20/15	6470		7.7	0.88		0.38	2.4		0.65	66.7		0.38
EXC-9	J1V329	1/20/15	5300		7.1	0.86		0.35	1.1		0.61	65.1		0.35
EXC-10	J1V330	1/20/15	5580		1.6	0.41	B	0.38	2.1		0.67	56.6		0.077
EXC-11	J1V331	1/20/15	4710		7.9	0.93		0.39	1.0		0.67	57.6		0.39
EXC-12	J1V332	1/20/15	5990		8.0	0.83		0.39	2.5		0.68	67.3		0.39
SPA-10	J1V349	1/21/15	7250		1.4	0.48	JB	0.35	3.2		0.61	76.0	X	0.071
Duplicate of J1V349	J1V352	1/21/15	7320		1.5	0.57	J	0.36	2.9		0.62	72.1	X	0.072
SPA-1	J1V340	1/21/15	4540		1.5	1.9	UJ	1.9	2.2		0.64	42.7	X	0.074
SPA-2	J1V341	1/21/15	4490		1.5	1.2	J	0.36	2.1		0.63	56.7	X	0.073
SPA-3	J1V342	1/21/15	5040		1.4	1.1	J	0.33	2.3		0.58	51.4	X	0.067
SPA-4	J1V343	1/21/15	5310		1.6	2.0	UJ	2.0	2.8		0.69	64.7	X	0.079
SPA-5	J1V344	1/21/15	4980		1.6	1.2	J	0.39	2.1		0.68	48.2	X	0.079
SPA-6	J1V345	1/21/15	4480		1.5	2.1	JB	1.8	2.3		0.64	48.9	X	0.074
SPA-7	J1V346	1/21/15	5090		1.6	1.1	J	0.40	2.6		0.70	51.8	X	0.080
SPA-8	J1V347	1/21/15	5590		1.5	1.8	UJ	1.8	2.7		0.62	56.6	X	0.071
SPA-9	J1V348	1/21/15	6140		1.6	1.1	J	0.40	2.7		0.69	55.3	X	0.079
SPA-11	J1V350	1/21/15	5340		1.4	1.2	J	0.33	2.4		0.58	55.6	X	0.067
SPA-12	J1V351	1/21/15	7090		1.6	0.55	JB	0.40	2.8		0.69	65.6	X	0.079
Equipment Blank	J1V353	1/21/15	221		1.5	0.37	UJ	0.37	1.8		0.63	1.8	X	0.073

Sample Location	HEIS Number	Sample Date	Beryllium			Boron			Cadmium			Calcium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-5	J1V325	1/20/15	0.42		0.030	0.90	B	0.90	0.13	B	0.038	4730		64.5
Duplicate of J1V325	J1V333	1/20/15	0.39		0.035	1.0	U	1.0	0.13	B	0.043	4960		74.7
EXC-1	J1V321	1/20/15	0.37		0.032	0.95	UN	0.95	0.14	BM	0.040	6040		68.7
EXC-2	J1V322	1/20/15	0.37		0.034	1.0	U	1.0	0.11	B	0.042	7400		71.6
EXC-3	J1V323	1/20/15	0.34		0.035	1.0	U	1.0	0.11	B	0.043	6910		74.1
EXC-4	J1V324	1/20/15	0.41	B	0.15	0.91	U	0.91	0.11	B	0.038	5860		65.7
EXC-6	J1V326	1/20/15	0.37		0.035	1.1	U	1.1	0.13	B	0.044	8340		15.2
EXC-7	J1V327	1/20/15	0.38		0.032	0.95	U	0.95	0.15	B	0.040	9820		68.3
EXC-8	J1V328	1/20/15	0.35		0.033	0.97	U	0.97	0.11	B	0.040	9590		69.6
EXC-9	J1V329	1/20/15	0.31		0.030	0.90	U	0.90	0.11	B	0.038	6400		65.0
EXC-10	J1V330	1/20/15	0.29		0.033	0.99	U	0.99	0.089	B	0.041	5170		14.3
EXC-11	J1V331	1/20/15	0.33		0.034	1.0	U	1.0	0.086	B	0.042	6110		71.6
EXC-12	J1V332	1/20/15	0.32		0.034	1.0	U	1.0	0.11	B	0.042	6730		72.7
SPA-10	J1V349	1/21/15	0.39		0.031	0.91	U	0.91	0.16	B	0.038	8290	J	13.1
Duplicate of J1V349	J1V352	1/21/15	0.42		0.031	0.93	U	0.93	0.13	B	0.039	7830	J	13.3
SPA-1	J1V340	1/21/15	0.66	B	0.16	0.96	U	0.96	0.10	B	0.040	6080	J	13.7
SPA-2	J1V341	1/21/15	0.42		0.032	0.94	U	0.94	0.13	B	0.039	6220	J	13.5
SPA-3	J1V342	1/21/15	0.55		0.029	0.86	U	0.86	0.10	B	0.036	6760	J	12.4
SPA-4	J1V343	1/21/15	0.82	B	0.17	1.0	U	1.0	0.15	B	0.043	7560	J	14.7
SPA-5	J1V344	1/21/15	0.47		0.034	1.0	U	1.0	0.12	B	0.043	6940	J	14.6
SPA-6	J1V345	1/21/15	0.70	B	0.16	0.95	U	0.95	0.10	B	0.040	6360	J	13.7
SPA-7	J1V346	1/21/15	0.43		0.035	1.0	U	1.0	0.12	B	0.043	7250	J	14.9
SPA-8	J1V347	1/21/15	0.77	B	0.15	0.92	U	0.92	0.13	B	0.038	8790	J	13.2
SPA-9	J1V348	1/21/15	0.44		0.034	1.0	U	1.0	0.11	B	0.043	7430	J	14.7
SPA-11	J1V350	1/21/15	0.44		0.029	0.86	U	0.86	0.11	B	0.036	7400	J	12.4
SPA-12	J1V351	1/21/15	0.39		0.035	1.0	U	1.0	0.13	B	0.043	6840	J	14.7
Equipment Blank	J1V353	1/21/15	0.12	B	0.032	0.94	U	0.94	0.039	U	0.039	48.2	UJC	13.6

Attachment	1	Sheet No.	4 of 10
Originator	J. D. Skoglie	Date	3/26/15
Checked	I. B. Berezovskiy	Date	3/26/15
Calc. No.	0100D-CA-V0592	Rev. No.	0
		Job No.	14655

Attachment 1. 100-D-85:2 Subsite Verification Sample Results (Metals, Anions, and Physical).

Sample Location	HEIS Number	Sample Date	Chromium			Cobalt			Copper			Hexavalent Chromium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-5	J1V325	1/20/15	10.2		0.053	7.5		0.091	15.0		0.99	0.195		0.155
Duplicate of J1V325	J1V333	1/20/15	11.5		0.061	7.8		0.11	15.9		1.1	0.279		0.155
EXC-1	J1V321	1/20/15	4.9		0.056	13.1		0.49	17.0		1.1	0.155	U	0.155
EXC-2	J1V322	1/20/15	5.2		0.059	8.4		0.10	15.2		1.1	0.155	U	0.155
EXC-3	J1V323	1/20/15	6.8		0.061	8.7		0.11	16.1		1.1	0.194		0.155
EXC-4	J1V324	1/20/15	3.9		0.054	13.2		0.47	15.6		1.0	0.167		0.155
EXC-6	J1V326	1/20/15	9.6		0.062	7.1		0.11	15.0		0.23	0.195		0.155
EXC-7	J1V327	1/20/15	11.3		0.056	7.6		0.097	17.5		1.1	0.263		0.155
EXC-8	J1V328	1/20/15	6.2		0.057	8.1		0.099	17.1		1.1	0.217		0.155
EXC-9	J1V329	1/20/15	4.2		0.053	7.3		0.092	16.7		1.0	0.155	U	0.155
EXC-10	J1V330	1/20/15	7.6		0.059	5.8		0.10	13.8		0.22	0.155	U	0.155
EXC-11	J1V331	1/20/15	5.7		0.059	9.2		0.10	17.3		1.1	0.155	U	0.155
EXC-12	J1V332	1/20/15	6.8		0.060	7.7		0.10	15.3		1.1	0.155	U	0.155
SPA-10	J1V349	1/21/15	11.3	X	0.054	7.8		0.093	14.3		0.20	0.155	U	0.155
Duplicate of J1V349	J1V352	1/21/15	11.4	X	0.055	7.6		0.094	14.8		0.20	0.155	U	0.155
SPA-1	J1V340	1/21/15	4.4	X	0.057	11.9		0.49	16.0		1.1	0.282		0.155
SPA-2	J1V341	1/21/15	5.1	X	0.056	10.2		0.096	14.2		0.21	0.155	U	0.155
SPA-3	J1V342	1/21/15	5.2	X	0.051	10.2		0.088	13.4		0.19	0.155	U	0.155
SPA-4	J1V343	1/21/15	5.0	X	0.061	13.2		0.52	17.2		1.1	0.155	U	0.155
SPA-5	J1V344	1/21/15	4.5	X	0.060	11		0.10	15.1		0.23	0.155	U	0.155
SPA-6	J1V345	1/21/15	4.7	X	0.056	12.4		0.49	16.6		1.1	0.155	U	0.155
SPA-7	J1V346	1/21/15	6.1	X	0.061	9.5		0.11	13.4		0.23	0.155	U	0.155
SPA-8	J1V347	1/21/15	6.5	X	0.054	12.5		0.47	17.4		1.0	0.175		0.155
SPA-9	J1V348	1/21/15	6.8	X	0.061	9.4		0.10	15.5		0.23	0.179		0.155
SPA-11	J1V350	1/21/15	6.7	X	0.051	9.3		0.088	14.6		0.19	0.155	U	0.155
SPA-12	J1V351	1/21/15	10.2	X	0.061	7.8		0.10	13.0		0.23	0.173		0.155
Equipment Blank	J1V353	1/21/15	1.5	X	0.056	0.43	B	0.096	1.1		0.21			

Sample Location	HEIS Number	Sample Date	Iron			Lead			Magnesium			Manganese		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-5	J1V325	1/20/15	24300		17.4	4.2		0.25	4670		16.9	358		0.46
Duplicate of J1V325	J1V333	1/20/15	25200		20.1	4.1		0.29	4920		19.6	366		0.53
EXC-1	J1V321	1/20/15	29700		18.5	4.6	M	1.3	4880		18.0	331		0.49
EXC-2	J1V322	1/20/15	27100		19.3	2.9		0.27	4790		18.8	328		0.51
EXC-3	J1V323	1/20/15	28000		20.0	2.8		0.28	5300		19.5	338		0.53
EXC-4	J1V324	1/20/15	30800		17.7	2.0	B	1.3	4610		17.2	342		0.47
EXC-6	J1V326	1/20/15	21100		4.1	3.4		0.29	4240		4.0	293		0.11
EXC-7	J1V327	1/20/15	25000		18.4	5.6		0.26	4950		17.9	329		0.48
EXC-8	J1V328	1/20/15	25900		18.8	2.9		0.27	4650		18.3	333		0.49
EXC-9	J1V329	1/20/15	24900		17.5	1.9		0.25	4070		17.0	280		0.46
EXC-10	J1V330	1/20/15	17500		3.8	2.6		0.27	3970		3.7	237		0.10
EXC-11	J1V331	1/20/15	30800		19.3	1.9		0.27	4960		18.8	349		0.51
EXC-12	J1V332	1/20/15	24900		19.6	2.5		0.28	4970		19.1	311		0.52
SPA-10	J1V349	1/21/15	19500	X	3.5	4.0		0.25	4460	X	3.4	320	X	0.093
Duplicate of J1V349	J1V352	1/21/15	19500	X	3.6	4.0		0.25	4360	X	3.5	299	X	0.094
SPA-1	J1V340	1/21/15	24300	X	3.7	2.2	B	1.3	4010	X	3.6	287	X	0.097
SPA-2	J1V341	1/21/15	25500	X	3.6	2.7		0.26	4290	X	3.5	321	X	0.096
SPA-3	J1V342	1/21/15	25300	X	3.3	2.4		0.24	4430	X	3.3	308	X	0.088
SPA-4	J1V343	1/21/15	27900	X	4.0	2.9		1.4	4560	X	3.9	371	X	0.10
SPA-5	J1V344	1/21/15	26800	X	3.9	3.1		0.28	4550	X	3.8	313	X	0.10
SPA-6	J1V345	1/21/15	26200	X	3.7	1.9	B	1.3	4160	X	3.6	301	X	0.097
SPA-7	J1V346	1/21/15	23200	X	4.0	3.0		0.28	4140	X	3.9	304	X	0.11
SPA-8	J1V347	1/21/15	26200	X	3.6	2.3		1.3	4580	X	3.5	319	X	0.094
SPA-9	J1V348	1/21/15	23000	X	4.0	3.4		0.28	4170	X	3.9	300	X	0.10
SPA-11	J1V350	1/21/15	23200	X	3.3	2.7		0.24	4130	X	3.2	293	X	0.088
SPA-12	J1V351	1/21/15	19700	X	4.0	3.2		0.28	4340	X	3.9	294	X	0.10
Equipment Blank	J1V353	1/21/15	2070	X	3.7	0.75		0.26	39.3	X	3.6	6.7	X	0.096

Attachment	1	Sheet No.	5 of 10
Originator	J. D. Skoglie	Date	3/26/15
Checked	I. B. Berezovskiy	Date	3/26/15
Calc. No.	0100D-CA-V0592	Rev. No.	0
		Job No.	14655

Attachment 1. 100-D-85:2 Subsite Verification Sample Results (Metals, Anions, and Physical).

Sample Location	HEIS Number	Sample Date	Mercury			Molybdenum			Nickel			Potassium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-5	J1V325	1/20/15	0.012	BC	0.0055	0.24	U	0.24	10.6		0.11	1550		188
Duplicate of J1V325	J1V333	1/20/15	0.013	BC	0.0062	0.28	U	0.28	12.3		0.13	1350		43.4
EXC-1	J1V321	1/20/15	0.0095	BC	0.0057	0.25	B	0.25	9.5		0.12	660		39.9
EXC-2	J1V322	1/20/15	0.010	BC	0.0058	0.26	U	0.26	7.6		0.12	775		41.6
EXC-3	J1V323	1/20/15	0.0099	BC	0.0054	0.27	U	0.27	12.5		0.13	813		43.1
EXC-4	J1V324	1/20/15	0.0088	BC	0.0060	0.24	U	0.24	7.9		0.11	504		38.2
EXC-6	J1V326	1/20/15	0.012	BC	0.0063	0.28	U	0.28	10.0		0.13	1200		44.1
EXC-7	J1V327	1/20/15	0.015	BC	0.0056	0.25	U	0.25	9.8		0.12	925		39.7
EXC-8	J1V328	1/20/15	0.011	BC	0.0060	0.26	U	0.26	9.9		0.12	870		40.5
EXC-9	J1V329	1/20/15	0.010	BC	0.0065	0.24	U	0.24	6.9		0.11	550		37.8
EXC-10	J1V330	1/20/15	0.010	BC	0.0058	0.26	U	0.26	8.7		0.12	815		41.5
EXC-11	J1V331	1/20/15	0.0076	BC	0.0048	0.26	U	0.26	8.6		0.12	484		41.7
EXC-12	J1V332	1/20/15	0.010	BC	0.0059	0.27	U	0.27	11.7		0.13	688		42.3
SPA-10	J1V349	1/21/15	0.0077	B	0.0057	0.24	U	0.24	11.5	X	0.11	1180		38.0
Duplicate of J1V349	J1V352	1/21/15	0.019		0.0059	0.25	U	0.25	11.5	X	0.12	1180		38.7
SPA-1	J1V340	1/21/15	0.0053	U	0.0053	0.25	U	0.25	7.6	X	0.12	634		40.0
SPA-2	J1V341	1/21/15	0.0053	U	0.0053	0.25	U	0.25	7.7	X	0.12	749		39.3
SPA-3	J1V342	1/21/15	0.0057	U	0.0057	0.23	U	0.23	8.1	X	0.11	788		36.1
SPA-4	J1V343	1/21/15	0.0061	B	0.0053	0.27	U	0.27	7.7	X	0.13	768		42.8
SPA-5	J1V344	1/21/15	0.0050	U	0.0050	0.27	U	0.27	8.7	X	0.13	716		42.5
SPA-6	J1V345	1/21/15	0.0057	U	0.0057	0.25	U	0.25	7.5	X	0.12	651		39.8
SPA-7	J1V346	1/21/15	0.0067	B	0.0058	0.27	U	0.27	8.3	X	0.13	788		43.2
SPA-8	J1V347	1/21/15	0.0089	B	0.0052	0.24	U	0.24	8.3	X	0.12	759		38.4
SPA-9	J1V348	1/21/15	0.0079	B	0.0057	0.27	U	0.27	8.8	X	0.13	992		42.8
SPA-11	J1V350	1/21/15	0.0060	B	0.0054	0.23	U	0.23	8.6	X	0.11	757		36.0
SPA-12	J1V351	1/21/15	0.0071	B	0.0051	0.27	U	0.27	11.0	X	0.13	1200		42.9
Equipment Blank	J1V353	1/21/15	0.0051	U	0.0051	0.25	U	0.25	1.3	BX	0.12	51.5	B	39.4

Sample Location	HEIS Number	Sample Date	Selenium			Silicon			Silver			Sodium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-5	J1V325	1/20/15	0.79	U	0.79	219	N	25.9	0.15	U	0.15	209		54.0
Duplicate of J1V325	J1V333	1/20/15	0.91	U	0.91	241	N	30.0	0.17	U	0.17	187		62.5
EXC-1	J1V321	1/20/15	0.84	UN	0.84	123	N	27.6	0.16	U	0.16	452		57.5
EXC-2	J1V322	1/20/15	0.87	U	0.87	142	N	28.7	0.16	U	0.16	329		59.9
EXC-3	J1V323	1/20/15	0.90	U	0.90	177	N	29.8	0.17	U	0.17	283		62.0
EXC-4	J1V324	1/20/15	0.80	U	0.80	101	N	26.4	0.15	U	0.15	313		55.0
EXC-6	J1V326	1/20/15	0.92	U	0.92	189	N	6.1	0.17	U	0.17	204		63.4
EXC-7	J1V327	1/20/15	0.83	U	0.83	173	N	27.4	0.15	U	0.15	288		57.1
EXC-8	J1V328	1/20/15	0.85	U	0.85	150	N	28.0	0.16	U	0.16	268		58.3
EXC-9	J1V329	1/20/15	0.79	U	0.79	133	N	26.1	0.15	U	0.15	354		54.4
EXC-10	J1V330	1/20/15	0.87	U	0.87	193	N	5.7	0.16	U	0.16	243		59.7
EXC-11	J1V331	1/20/15	0.87	U	0.87	111	N	28.8	0.16	U	0.16	254		59.9
EXC-12	J1V332	1/20/15	0.89	U	0.89	157	N	29.2	0.17	U	0.17	260		60.9
SPA-10	J1V349	1/21/15	0.80	U	0.80	426	J	5.3	0.15	U	0.15	185		54.7
Duplicate of J1V349	J1V352	1/21/15	0.81	U	0.81	384	J	5.3	0.15	U	0.15	180		55.7
SPA-1	J1V340	1/21/15	0.84	U	0.84	222	J	5.5	0.16	U	0.16	335		57.5
SPA-2	J1V341	1/21/15	0.83	U	0.83	228	J	5.4	0.15	U	0.15	291		56.6
SPA-3	J1V342	1/21/15	0.76	U	0.76	248	J	5.0	0.14	U	0.14	324		52.0
SPA-4	J1V343	1/21/15	0.90	U	0.90	288	J	5.9	0.17	U	0.17	315		61.7
SPA-5	J1V344	1/21/15	0.89	U	0.89	247	J	5.9	0.17	U	0.17	383		61.2
SPA-6	J1V345	1/21/15	0.83	U	0.83	222	J	5.5	0.16	U	0.16	362		57.3
SPA-7	J1V346	1/21/15	0.91	U	0.91	283	J	6.0	0.17	U	0.17	291		62.2
SPA-8	J1V347	1/21/15	0.81	U	0.81	271	J	5.3	0.15	U	0.15	322		55.3
SPA-9	J1V348	1/21/15	0.90	U	0.90	425	J	5.9	0.17	U	0.17	336		61.6
SPA-11	J1V350	1/21/15	0.75	U	0.75	233	J	5.0	0.14	U	0.14	276		51.8
SPA-12	J1V351	1/21/15	0.90	U	0.90	397	J	5.9	0.17	U	0.17	218		61.7
Equipment Blank	J1V353	1/21/15	0.83	U	0.83	100	J	5.4	0.15	U	0.15	56.7	U	56.7

Attachment	1	Sheet No.	6 of 10
Originator	J. D. Skoglie	Date	3/26/15
Checked	I. B. Berezovskiy	Date	3/26/15
Calc. No.	0100D-CA-V0592	Rev. No.	0
		Job No.	14655

Attachment 1. 100-D-85:2 Subsite Verification Sample Results (Metals, Anions, and Physical).

Sample Location	HEIS Number	Sample Date	Vanadium			Zinc			Bromide			Chloride		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-5	J1V325	1/20/15	55.3		0.43	49.0		1.8	0.40	U	0.40	2.1	U	2.1
Duplicate of J1V325	J1V333	1/20/15	59.5		0.50	45.1		2.1	0.41	U	0.41	2.1	U	2.1
EXC-1	J1V321	1/20/15	80.9		0.46	52.1		1.9	0.40	U	0.40	2.3	B	2.1
EXC-2	J1V322	1/20/15	68.3		0.48	48.6		2.0	0.40	U	0.40	2.1	U	2.1
EXC-3	J1V323	1/20/15	70.2		0.49	48.9		2.1	0.41	U	0.41	2.1	U	2.1
EXC-4	J1V324	1/20/15	83.4		0.44	54.0		1.9	0.39	U	0.39	2.0	U	2.0
EXC-6	J1V326	1/20/15	51.5		0.10	38.0		0.43	0.41	U	0.41	5.5		2.1
EXC-7	J1V327	1/20/15	64.2		0.46	56.9		1.9	0.40	U	0.40	3.3	B	2.1
EXC-8	J1V328	1/20/15	64.0		0.46	46.6		2.0	0.42	U	0.42	2.1	U	2.1
EXC-9	J1V329	1/20/15	64.2		0.43	45.5		1.8	0.38	U	0.38	2.0	U	2.0
EXC-10	J1V330	1/20/15	45.9		0.095	33.1		0.4	0.40	U	0.40	2.0	U	2.0
EXC-11	J1V331	1/20/15	80.2		0.48	52.1		2.0	0.39	U	0.39	2.0	B	2.0
EXC-12	J1V332	1/20/15	68.8		0.48	47.1		2.1	0.40	U	0.40	2.1	U	2.1
SPA-10	J1V349	1/21/15	47.9	JX	0.087	37.0	X	0.37	0.41	U	0.41	8.9	UC	2.1
Duplicate of J1V349	J1V352	1/21/15	48.6	JX	0.089	36.1	X	0.38	0.41	U	0.41	8.7	UC	2.1
SPA-1	J1V340	1/21/15	73.6	JX	0.46	43.0	X	0.39	0.40	U	0.40	7.7	UC	2.0
SPA-2	J1V341	1/21/15	66.6	JX	0.090	42.9	X	0.38	0.40	U	0.40	8.1	UC	2.1
SPA-3	J1V342	1/21/15	64.9	JX	0.083	42.5	X	0.35	0.40	U	0.40	14.1	UC	2.0
SPA-4	J1V343	1/21/15	83.1	JX	0.49	48.2	X	0.42	0.40	U	0.40	8.0	UC	2.1
SPA-5	J1V344	1/21/15	77.7	JX	0.097	48.5	X	0.41	0.40	U	0.40	8.2	UC	2.0
SPA-6	J1V345	1/21/15	78.6	JX	0.46	44.4	X	0.39	0.38	U	0.38	7.8	UC	2.0
SPA-7	J1V346	1/21/15	64.2	JX	0.099	41.4	X	0.42	0.39	U	0.39	8.2	UC	2.0
SPA-8	J1V347	1/21/15	80.5	JX	0.44	46.4	X	0.37	0.40	U	0.40	8.0	UC	2.1
SPA-9	J1V348	1/21/15	61.5	JX	0.098	42.1	X	0.42	0.40	U	0.40	8.1	UC	2.0
SPA-11	J1V350	1/21/15	63.2	JX	0.083	41.2	X	0.35	0.39	U	0.39	7.8	UC	2.0
SPA-12	J1V351	1/21/15	49.6	JX	0.098	37.2	X	0.42	0.41	U	0.41	8.4	UC	2.1
Equipment Blank	J1V353	1/21/15	7.0	JX	0.090	2.0	X	0.38						

Sample Location	HEIS Number	Sample Date	Fluoride			Nitrogen in Nitrate			Nitrogen in Nitrate and Nitrite			Nitrogen in Nitrite		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-5	J1V325	1/20/15	1.2	B	0.84	0.32	UR	0.32	0.38	U	0.38	0.34	UR	0.34
Duplicate of J1V325	J1V333	1/20/15	1.2	BM	0.86	0.33	UR	0.33	0.38	U	0.38	0.35	UR	0.35
EXC-1	J1V321	1/20/15	1.4	B	0.85	0.70	B	0.33	0.37	U	0.37	0.35	UR	0.35
EXC-2	J1V322	1/20/15	1.2	B	0.84	0.32	UR	0.32	0.38	U	0.38	0.34	UR	0.34
EXC-3	J1V323	1/20/15	1.1	B	0.86	0.63	B	0.33	0.36	U	0.36	0.35	UR	0.35
EXC-4	J1V324	1/20/15	0.81	U	0.81	0.31	UR	0.31	0.36	U	0.36	0.33	UR	0.33
EXC-6	J1V326	1/20/15	1.5	B	0.86	0.87	B	0.33	0.38	U	0.38	0.35	UR	0.35
EXC-7	J1V327	1/20/15	0.88	B	0.84	1.0	B	0.32	0.47	B	0.39	0.35	UR	0.35
EXC-8	J1V328	1/20/15	1.4	B	0.87	0.33	UR	0.33	0.36	U	0.36	0.36	UR	0.36
EXC-9	J1V329	1/20/15	0.81	U	0.81	0.31	UR	0.31	0.35	U	0.35	0.33	UR	0.33
EXC-10	J1V330	1/20/15	0.9	B	0.84	0.76	B	0.32	0.36	U	0.36	0.34	UR	0.34
EXC-11	J1V331	1/20/15	0.82	U	0.82	0.71	B	0.31	0.37	U	0.37	0.34	UR	0.34
EXC-12	J1V332	1/20/15	0.85	U	0.85	0.33	UR	0.33	0.37	U	0.37	0.35	UR	0.35
SPA-10	J1V349	1/21/15	1.2	B	0.87	0.70	JB	0.33	0.38	U	0.38	0.36	UR	0.36
Duplicate of J1V349	J1V352	1/21/15	1.2	B	0.87	0.71	JB	0.33	0.38	U	0.38	0.36	UR	0.36
SPA-1	J1V340	1/21/15	1.1	B	0.83	0.83	JB	0.32	0.36	U	0.36	0.34	UR	0.34
SPA-2	J1V341	1/21/15	1.1	B	0.84	1.0	JB	0.32	0.37	U	0.37	0.34	UR	0.34
SPA-3	J1V342	1/21/15	1.0	B	0.84	1.1	JB	0.32	0.37	U	0.37	0.34	UR	0.34
SPA-4	J1V343	1/21/15	1.2	B	0.84	0.68	JB	0.32	0.37	U	0.37	0.34	UR	0.34
SPA-5	J1V344	1/21/15	1.1	B	0.83	0.67	JB	0.32	0.36	U	0.36	0.34	UR	0.34
SPA-6	J1V345	1/21/15	1.2	B	0.81	0.78	JB	0.31	0.35	U	0.35	0.33	UR	0.33
SPA-7	J1V346	1/21/15	1.2	B	0.83	0.68	JB	0.32	0.36	U	0.36	0.34	UR	0.34
SPA-8	J1V347	1/21/15	1.5	B	0.84	0.32	UR	0.32	0.37	U	0.37	0.34	UR	0.34
SPA-9	J1V348	1/21/15	1.4	B	0.84	0.76	JB	0.32	0.36	U	0.36	0.34	UR	0.34
SPA-11	J1V350	1/21/15	1.3	B	0.82	0.31	UR	0.31	0.36	U	0.36	0.33	UR	0.33
SPA-12	J1V351	1/21/15	1.3	B	0.85	0.71	JB	0.33	0.37	U	0.37	0.35	UR	0.35

Attachment	1	Sheet No.	7 of 10
Originator	J. D. Skoglie	Date	3/26/15
Checked	I. B. Berezovskiy	Date	3/26/15
Calc. No.	0100D-CA-V0592	Rev. No.	0
		Job No.	14655

Attachment 1. 100-D-85:2 Subsite Verification Sample Results (Metals, Anions, and Physical).

Sample Location	HEIS Number	Sample Date	Phosphorous in phosphate			Sulfate			Percent moisture (wet sample)		
			mg/kg	Q	PQL	mg/kg	Q	PQL	%	Q	PQL
EXC-5	J1V325	1/20/15	1.3	UR	1.3	4.9	BC	1.7	6.6		0.10
Duplicate of J1V325	J1V333	1/20/15	1.3	UR	1.3	4.1	BC	1.8	6.5		0.10
EXC-1	J1V321	1/20/15	1.3	UR	1.3	9.5	C	1.8	4.9		0.10
EXC-2	J1V322	1/20/15	1.3	UR	1.3	6.0	C	1.7	5.3		0.10
EXC-3	J1V323	1/20/15	1.3	UR	1.3	5.4	C	1.8	5.8		0.10
EXC-4	J1V324	1/20/15	1.2	UR	1.2	4.6	BC	1.7	3.3		0.10
EXC-6	J1V326	1/20/15	1.3	UR	1.3	6.2	C	1.8	7.0		0.10
EXC-7	J1V327	1/20/15	1.3	UR	1.3	12.7	C	1.7	7.8		0.10
EXC-8	J1V328	1/20/15	1.3	UR	1.3	6.4	C	1.8	7.1		0.10
EXC-9	J1V329	1/20/15	1.2	UR	1.2	5.1	C	1.7	3.1		0.10
EXC-10	J1V330	1/20/15	1.3	UR	1.3	216		1.7	5.9		0.10
EXC-11	J1V331	1/20/15	1.2	UR	1.2	4.6	BC	1.7	3.5		0.10
EXC-12	J1V332	1/20/15	1.3	UR	1.3	4.3	BC	1.8	4.9		0.10
SPA-10	J1V349	1/21/15	1.3	UR	1.3	1.8	U	1.8	7.9		0.10
Duplicate of J1V349	J1V352	1/21/15	1.3	URN	1.3	6.9		1.8	7.1		0.10
SPA-1	J1V340	1/21/15	1.3	UR	1.3	7.3		1.7	5.0		0.10
SPA-2	J1V341	1/21/15	2.2	JB	1.3	8.8		1.7	5.2		0.10
SPA-3	J1V342	1/21/15	2.2	JB	1.3	7.7		1.7	4.6		0.10
SPA-4	J1V343	1/21/15	1.3	UR	1.3	8.1		1.7	4.3		0.10
SPA-5	J1V344	1/21/15	1.3	UR	1.3	1.7	U	1.7	4.5		0.10
SPA-6	J1V345	1/21/15	1.2	UR	1.2	15.5		1.7	3.7		0.10
SPA-7	J1V346	1/21/15	1.3	UR	1.3	8.7		1.7	6.1		0.10
SPA-8	J1V347	1/21/15	1.3	UR	1.3	7.4		1.7	5.6		0.10
SPA-9	J1V348	1/21/15	1.9	JB	1.3	7.4		1.7	6.1		0.10
SPA-11	J1V350	1/21/15	1.2	UR	1.2	1.7	U	1.7	4.3		0.10
SPA-12	J1V351	1/21/15	1.3	UR	1.3	7.2		1.8	5.3		0.10
Equipment Blank	J1V353	1/21/15							0.10	U	0.10

Attachment	1	Sheet No.	8 of 10
Originator	J. D. Skoglie	Date	3/26/15
Checked	I. B. Berezovskiy	Date	3/26/15
Calc. No.	0100D-CA-V0592	Rev. No.	0
		Job No.	14655

Attachment 1. 100-D-85:2 Subsite Verification Sample Results (PCB's).

CONSTITUENT	CLASS	EXC-5 - J1V325			Duplicate of J1V325 - J1V333			EXC-1 - J1V321			EXC-2 - J1V322		
		1/20/15			1/20/15			1/20/15			1/20/15		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	3.0	U	3.0	2.9	U	2.9	2.8	U	2.8	2.9	U	2.9
Aroclor-1221	PCB	8.6	U	8.6	8.3	U	8.3	8.0	U	8.0	8.4	U	8.4
Aroclor-1232	PCB	2.1	U	2.1	2.1	U	2.1	2.0	U	2.0	2.1	U	2.1
Aroclor-1242	PCB	5.0	U	5.0	4.8	U	4.8	4.6	U	4.6	4.9	U	4.9
Aroclor-1248	PCB	5.0	U	5.0	4.8	U	4.8	4.6	U	4.6	4.9	U	4.9
Aroclor-1254	PCB	2.8	U	2.8	2.7	U	2.7	2.6	U	2.6	2.7	U	2.7
Aroclor-1260	PCB	2.8	U	2.8	2.7	U	2.7	2.6	U	2.6	2.7	U	2.7

CONSTITUENT	CLASS	EXC-3 - J1V323			EXC-4 - J1V324			EXC-6 - J1V326			EXC-7 - J1V327		
		1/20/15			1/20/15			1/20/15			1/20/15		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.8	U	2.8	2.8	U	2.8	2.9	U	2.9	2.9	U	2.9
Aroclor-1221	PCB	8.1	U	8.1	8.1	U	8.1	8.4	U	8.4	8.4	U	8.4
Aroclor-1232	PCB	2.0	U	2.0	2.0	U	2.0	2.1	U	2.1	2.1	U	2.1
Aroclor-1242	PCB	4.7	U	4.7	4.7	U	4.7	4.9	U	4.9	4.9	U	4.9
Aroclor-1248	PCB	4.7	U	4.7	4.7	U	4.7	4.9	U	4.9	4.9	U	4.9
Aroclor-1254	PCB	2.6	U	2.6	2.6	U	2.6	2.7	U	2.7	88		2.7
Aroclor-1260	PCB	2.6	U	2.6	2.6	U	2.6	2.7	U	2.7	2.7	U	2.7

CONSTITUENT	CLASS	EXC-8 - J1V328			EXC-9 - J1V329			EXC-10 - J1V330			EXC-11 - J1V331		
		1/20/15			1/20/15			1/20/15			1/20/15		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.9	U	2.9	2.7	U	2.7	2.9	U	2.9	2.6	U	2.6
Aroclor-1221	PCB	8.4	U	8.4	7.9	U	7.9	8.4	U	8.4	7.6	U	7.6
Aroclor-1232	PCB	2.1	U	2.1	2.0	U	2.0	2.1	U	2.1	1.9	U	1.9
Aroclor-1242	PCB	4.9	U	4.9	4.6	U	4.6	4.9	U	4.9	4.4	U	4.4
Aroclor-1248	PCB	4.9	U	4.9	4.6	U	4.6	4.9	U	4.9	4.4	U	4.4
Aroclor-1254	PCB	2.7	U	2.7	2.6	U	2.6	2.7	U	2.7	2.5	U	2.5
Aroclor-1260	PCB	2.7	U	2.7	2.6	U	2.6	2.7	U	2.7	2.5	U	2.5

CONSTITUENT	CLASS	EXC-12 - J1V332			SPA-10 - J1V349			Duplicate of J1V349 - J1V352			SPA-1 - J1V340		
		1/20/15			1/21/15			1/21/15			1/21/15		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.9	U	2.9	3.0	U	3.0	2.9	U	2.9	2.8	U	2.8
Aroclor-1221	PCB	8.3	U	8.3	8.6	U	8.6	8.5	U	8.5	8.2	U	8.2
Aroclor-1232	PCB	2.1	U	2.1	2.2	U	2.2	2.1	U	2.1	2.1	U	2.1
Aroclor-1242	PCB	4.8	U	4.8	5.0	U	5.0	5.0	U	5.0	4.8	U	4.8
Aroclor-1248	PCB	4.8	U	4.8	5.0	U	5.0	5.0	U	5.0	4.8	U	4.8
Aroclor-1254	PCB	2.7	U	2.7	2.8	U	2.8	2.8	U	2.8	2.7	U	2.7
Aroclor-1260	PCB	2.7	U	2.7	2.8	U	2.8	2.8	U	2.8	2.7	U	2.7

Attachment	1	Sheet No.	9 of 10
Originator	J. D. Skoglie	Date	3/26/15
Checked	I. B. Berezovskiy	Date	3/26/15
Calc. No.	0100D-CA-V0592	Rev. No.	0
		Job No.	14655

Attachment 1. 100-D-85:2 Subsite Verification Sample Results (PCB's).

CONSTITUENT	CLASS	SPA-2 - J1V341			SPA-3 - J1V342			SPA-4 - J1V343			SPA-5 - J1V344		
		1/21/15			1/21/15			1/21/15			1/21/15		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.9	U	2.9	2.8	U	2.8	2.9	U	2.9	2.9	U	2.9
Aroclor-1221	PCB	8.3	U	8.3	8.2	U	8.2	8.4	U	8.4	8.3	U	8.3
Aroclor-1232	PCB	2.1	U	2.1	2.0	U	2.0	2.1	U	2.1	2.1	U	2.1
Aroclor-1242	PCB	4.8	U	4.8	4.8	U	4.8	4.9	U	4.9	4.8	U	4.8
Aroclor-1248	PCB	4.8	U	4.8	4.8	U	4.8	4.9	U	4.9	4.8	U	4.8
Aroclor-1254	PCB	2.7	U	2.7	2.7	U	2.7	2.7	U	2.7	2.7	U	2.7
Aroclor-1260	PCB	2.7	U	2.7	2.7	U	2.7	2.7	U	2.7	2.7	U	2.7

CONSTITUENT	CLASS	SPA-6 - J1V345			SPA-7 - J1V346			SPA-8 - J1V347			SPA-9 - J1V348		
		1/21/15			1/21/15			1/21/15			1/21/15		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.8	U	2.8	2.8	U	2.8	2.8	U	2.8	2.9	U	2.9
Aroclor-1221	PCB	8.0	U	8.0	8.2	U	8.2	8.1	U	8.1	8.3	U	8.3
Aroclor-1232	PCB	2.0	U	2.0	2.1	U	2.1	2.0	U	2.0	2.1	U	2.1
Aroclor-1242	PCB	4.7	U	4.7	4.8	U	4.8	4.7	U	4.7	4.8	U	4.8
Aroclor-1248	PCB	4.7	U	4.7	4.8	U	4.8	4.7	U	4.7	4.8	U	4.8
Aroclor-1254	PCB	2.6	U	2.6	2.7	U	2.7	2.6	U	2.6	2.7	U	2.7
Aroclor-1260	PCB	2.6	U	2.6	2.7	U	2.7	2.6	U	2.6	2.7	U	2.7

CONSTITUENT	CLASS	SPA-11 - J1V350			SPA-12 - J1V351		
		1/21/15			1/21/15		
		ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.8	U	2.8	2.9	U	2.9
Aroclor-1221	PCB	8.2	U	8.2	8.4	U	8.4
Aroclor-1232	PCB	2.0	U	2.0	2.1	U	2.1
Aroclor-1242	PCB	4.8	U	4.8	4.9	U	4.9
Aroclor-1248	PCB	4.8	U	4.8	4.9	U	4.9
Aroclor-1254	PCB	2.7	U	2.7	2.7	U	2.7
Aroclor-1260	PCB	2.7	U	2.7	2.7	U	2.7

Attachment	1	Sheet No.	10 of 10
Originator	J. D. Skoglie	Date	3/26/15
Checked	I. B. Berezovskiy	Date	3/26/15
Calc. No.	0100D-CA-V0592	Rev. No.	0
		Job No.	14655

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 100-D Area Closure Operations **Job No. 14655**

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0593

Subject: 100-D-85:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations

Computer Program: Excel Program No: Excel 2010

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 5 Total = 6	J. D. Skoglie	I. B. Berezovskiy	R. J. Nielson	S. G. Wilkinson	6/11/15

SUMMARY OF REVISION

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

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	03/30/15	Calc. No.:	0100D-CA-V0593	Rev.:	0
Project:	100-D Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	03/30/15
Subject:	100-D-85:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No.	1 of 5

PURPOSE:

Provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 100-D-85:2 subsite. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009b), the following criteria must be met:

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

This calculation also provides documentation to support the calculation of the sum of fractions evaluation for radionuclide direct exposure risk. Attainment of direct exposure remedial action goals (RAGs) is demonstrated using the single-radionuclide dose-equivalence lookup values to perform sum of fractions evaluations for comparison of the total radionuclide dose to the RAG of 15 mrem/yr above background. The model used to develop these dose-equivalence lookup values is presented in the 100 Area RDR/RAWP (DOE-RL 2009b).

GIVEN/REFERENCES:

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

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

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

4) WCH, 2015, *100-D-85:2 Subsite Cleanup Verification 95% UCL Calculation,* 0100D-CA-V0592, Rev. 0, Washington Closure Hanford, Richland, Washington.

SOLUTION:

1) Generate an HQ for each noncarcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the individual HQ of <1.0 (DOE-RL 2009b).

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

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

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

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	03/30/15	Calc. No.:	0100D-CA-V0593	Rev.:	0
Project:	100-D Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	03/30/15
Subject:	100-D-85:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No.	2 of 5

Summation of Fractions

The sum-of-fractions compares the radionuclide cleanup verification results from the 100-D-85:2 subsite shallow zone excavation and staging pile area to direct exposure single radionuclide 15 mrem/yr dose-equivalence values and shows the sum-of-fractions evaluation for comparison of the total radionuclide dose to the RAG of 15 mrem/yr above background. The first two columns of the table present the COPCs and the maximum radionuclide activities for the samples. The third column presents the single radionuclide 15 mrem/yr dose-equivalence activities, and the last column presents the radionuclide activities divided by the dose-equivalence activities, followed by the sum of the fractions and determination of the total waste site dose for comparison to the 15 mrem/yr RAG.

METHODOLOGY:

The 100-D-85:2 subsite is comprised of two decision units for verification sampling; the excavation and the staging pile area. The direct contact hazard quotient and carcinogenic risk calculations for the 100-D-85:2 subsite was conservatively calculated using the greater of the statistical or maximum value for each analyte within those two decision units from WCH (2015). Of the contaminants of potential concern (COPCs) for this site, boron, hexavalent chromium, molybdenum, and aroclor-1260 require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. All other site nonradionuclide COPCs were not detected or were quantified below background levels. An example of the HQ and risk calculations is presented below:

1) For example, the statistical value for boron is 0.90 mg/kg, divided by the noncarcinogenic RAG value of 7,200 mg/kg (calculated in accordance with the noncarcinogenic toxics effects formula in WAC 173-340-740[3]), is 1.3×10^{-4}. Comparing this value, and all other individual values, to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation. The sum of the HQ values is 1.9×10^{-3}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum or statistical value is divided by the carcinogenic RAG value, then multiplied by 1.0×10^{-6}. For example, the statistical value for hexavalent chromium is 0.282 mg/kg; divided by 2.1 mg/kg, and multiplied as indicated, is 1.3×10^{-7}. Comparing this value to the requirement of $<1 \times 10^{-6}$, this criterion is met.

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk is obtained by summing the individual values. The excess cancer risk for the carcinogenic constituents detected is 3.1×10^{-7}. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	03/30/15	Calc. No.:	0100D-CA-V0593	Rev.:	0
Project:	100-D Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	03/30/15
Subject:	100-D-85:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No.	3 of 5

Summation of Fractions

The sum-of-fractions were calculated for the data set using the greater of the statistical or maximum value for each radionuclide COPC from the 95% upper confidence limit (UCL) calculation (WCH 2015).

Calculations for 100-D-85:2 subsite were performed using RAGs from the 100 Area RDR/RAWP (DOE/RL 2009b). An example of the sum of fractions calculation of COPCs is presented below:

1) To calculate the fraction, the statistical value for europium-152 (0.0400 pCi/g) is divided by the soil activity equivalent of 3.3 pCi/g equivalent to a 15 mrem/yr dose, resulting in a fraction of 0.0121.

2) The fractions for the remaining COPCs are determined and summed. The sum of these fractions equals 0.0727. The sum of fractions is then multiplied by 15 mrem/yr to determine the total equivalent dose of 1.09 mrem/yr for the 100-D-85:2 subsite. Comparing this value to the dose limit of <15 mrem/yr, the requirement is met.

RESULTS:

Hazard Quotient and Excess Cancer Risk Calculations

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

Table 1 shows the results of the calculations.

Summation of Fractions

As demonstrated by the summation of the fractions, the maximum cumulative dose values contributed by the residual radionuclide populations (1.65 mrem/yr) is predicted to be less than the RAG of 15 mrem/yr above background.

Table 2 shows the results of the sum of fraction evaluation for radionuclide direct exposure risk.

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	03/30/15	Calc. No.:	0100D-CA-V0593	Rev.:	0
Project:	100-D Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	03/30/15
Subject:	100-D-85:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No.	4 of 5

Table 1. Direct Contact Hazard Quotient and Excess Cancer Risk Results for the 100-D-85:2 Subsite.

Contaminants of Potential Concern	Maximum or Statistical Value [a] (mg/kg)	Noncarcinogen RAG [b] (mg/kg)	Hazard Quotient	Carcinogen RAG [b] (mg/kg)	Carcinogen Risk
Metals					
Boron	0.90	7,200	1.3E-04	--	--
Chromium, hexavalent [c]	0.282	240	1.2E-03	2.1	1.3E-07
Molybdenum	0.25	400	6.3E-04	--	--
Polychlorinated Biphenyls					
Aroclor-1260	0.088	--	--	0.5	1.8E-07
Totals					
Cumulative Hazard Quotient:			**1.9E-03**		
Cumulative Excess Cancer Risk:					**3.1E-07**

Notes:

[a] = From WCH (2015).

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

[c] = Value for the carcinogen RAG calculated based on the inhalation exposure pathway (WAC) 173-340-750(3), 1996.

-- = not applicable

RAG = remedial action goal

Table 2. Attainment of Radionuclide Direct Exposure Remedial Action Goals at the 100-D-85:2 Subsite.

COPC	95% UCL Statistical or Maximum Values (pCi/g)	Background (pCi/g) [a]	Maximum Value (Background Corrected) (pCi/g)	Soil Activity for 15 mrem/yr Dose (pCi/g) [b]	Fraction
Cesium-137	0.106	1.1	0.106	6.2	0.0171
Europium-152	0.0400	NA	0.0400	3.3	0.0121
Europium-155	0.0468	0.054	0.0468	125	0.000374
Total beta radiostrontium	0.194	0.18	0.194	4.5	0.0431
Uranium-234	0.499	1.1	0.0	1.1	0.0
Uranium-235	0.0241	1.1	0.0	1.1	0.0
Uranium-238	0.433	1.1	0.0	1.1	0.0
				Sum of Fractions	0.0727
				Equivalent Dose (mrem/yr)	1.09

[a] Background is subtracted from all uranium isotopes regardless of the decision unit they were detected in. However, background is subtracted from all other isotopes only if they were detected in the overburden decision unit.

[b] Single radionuclide 15 mrem/yr dose-equivalence values and methodology are presented in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2009b).

COPC = contaminant of potential concern

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	03/30/15	Calc. No.:	0100D-CA-V0593	Rev.:	0
Project:	100-D Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	03/30/15
Subject:	100-D-85:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No.	5 of 5

CONCLUSION:

The calculations in Tables 1 and 2 demonstrate that the 100-D-85:2 subsite meets the requirements for the direct contact hazard quotient, carcinogenic (excess cancer) risk, and radionuclide direct exposure risk as identified in the RDR/RAWP (DOE-RL 2009b) and SAP (DOE-RL 2009a). The direct contact hazard quotient, carcinogenic (excess cancer) risk calculations, and the sum of fractions evaluation for radionuclide direct exposure risk are for use in the RSVP for the 100-D-85:2 subsite.

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CALCULATION COVER SHEET

Project Title: 100-D Area Closure Operations **Job No. 14655**

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0594

Subject: 100-D-85:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater

Computer Program: Excel Program No: Excel 2010

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Summary = 3 Total = 4	J. D. Skoglie	I.B. Berezovskiy	R. J. Nielson	S. G. Wilkinson	6/11/15

SUMMARY OF REVISION

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	3/23/2015	Calc. No.:	0100D-CA-V0594	Rev.:	0
Project:	100-D Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	3/23/2015
Subject:	100-D-85:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No.	1 of 3

PURPOSE:

Provide documentation to support the calculation of the hazard quotient (HQ) and excess carcinogenic risk associated with soil contaminant levels compared to soil cleanup levels for protection of groundwater for the 100-D-85:2 subsite. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009), the following criteria must be met:

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

GIVEN/REFERENCES:

1) BHI, 2005, *100 Area Analogous Sites RESRAD Evaluation*, Calculation No. 0100X-CA-V0050 Rev 0, Bechtel Hanford, Inc., Richland, Washington.

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

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

4) WCH, 2015, *100-D-85:2 Subsite Cleanup Verification 95% UCL Calculations*, 0100D-CA-V0592, Rev. 0, Washington Closure Hanford, Inc., Richland, Washington.

SOLUTION:

1) Generate a HQ for each noncarcinogenic constituent detected above background in soil and with a K_d less than that required to show no migration to groundwater in 1,000 years using the RESRAD generic site model (BHI 2005).

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

3) Generate an excess cancer risk value for each carcinogenic constituent detected above background in soil and with a K_d less than that required to show no migration to groundwater in 1,000 years using the RESRAD generic site model (BHI 2005).

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

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Subject:	100-D-85:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No. 2 of 3	

METHODOLOGY:

The 100-D-85:2 subsite is comprised of two decision units for verification sampling; the excavation and the staging pile area. Hazard quotient and carcinogenic risk calculations for potential impact to groundwater at the 100-D-85:2 subsite were conservatively calculated for the entire waste site using the greater of the statistical or maximum value for each analyte in all decision units from the 95% UCL calculation (WCH 2015). Based on the generic site RESRAD model (BHI 2005) and a vadose zone of approximately 18 m (59 ft) thickness, a K_d of 4.1 mL/g or greater is required to show no predicted migration to groundwater in 1,000 years. Of the contaminants of potential concern (COPCs) for this site, boron and hexavalent chromium are included because no Washington State or Hanford background value has been established and the distribution coefficients are less than that necessary to show no migration to groundwater in 1,000 years using this model. All other site nonradionuclide COPCs were not detected, quantified below background levels, or has a K_d greater than or equal to 4.1 mL/g. An example of the HQ and risk calculations for soil constituents with a potential impact to groundwater is presented below:

1) The hazard quotient is defined as the ratio of the dose of a substance obtained over a specified time (mg/kg/day) to a reference dose for the same substance derived over the same specified time (mg/kg/day). The hazard quotient can also be calculated as the ratio of the concentration in soil (maximum or statistical value) (mg/kg) to the soil RAG (mg/kg) for protection of groundwater, where the RAG is the groundwater cleanup level (mg/L) (calculated with, and related to the hazard quotient through, WAC 173-340-720(3)(a)(ii)(A), 1996) x 100 x 1 mg/1000 mg (conversion factor). This is based on the "100 times rule" of WAC 173-340-740(3)(a)(ii)(A) (1996). For example, the maximum value for boron is 0.90 mg/kg, divided by the noncarcinogenic RAG value of 320 mg/kg is 2.8×10^{-3}. Comparing this value to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation.) The cumulative HQ for the 100-D-85:2 subsite is 6.2×10^{-2}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum or statistical value is divided by the carcinogenic RAG value, and then multiplied by 1×10^{-6}. There were not any detected COPC's that had a carcinogenic RAG. Therefore, the individual cancer risk requirement of $<1 \times 10^{-6}$ is met. The criterion for cumulative excess cancer risk for carcinogens of $<1 \times 10^{-5}$ is also met.

4) The soil cleanup RAGs for protection of groundwater are based on the "100 times" provision in WAC 173-340-740(3)(a)(ii)(A). WAC 173-340-740(3)(a)(ii)(A) (1996) provides the "100 times rule" but also states "unless it can be demonstrated that a higher soil concentration is protective of groundwater at the site." When the "100 times rule" values are exceeded, RESRAD was used to demonstrate that higher soil concentrations may be protective of groundwater.

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RESULTS:

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

Table 1 shows the results of the calculations.

Table 1. Hazard Quotient and Excess Cancer Risk Results for the 100-D-85:2 Subsite.

Contaminants of Potential Concern[a]	Maximum or Statistical Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Metals					
Boron	0.90	320	2.8E-03	--	--
Chromium, hexavalent	0.282	4.8	5.9E-02	--	--
Totals					
Cumulative Hazard Quotient:			**6.2E-02**		
Cumulative Excess Cancer Risk:					**0.0E+00**

Notes:

[a] = From WCH (2015).

[b] = Value obtained from the Cleanup Levels and Risk Calculations (CLARC) database using Groundwater, Method B, results and the "100 times" model.

-- = not applicable

RAG = remedial action goal

CONCLUSION:

This calculation demonstrates that the 100-D-85:2 subsite meets the requirements for the hazard quotients and excess carcinogenic risk for protection of groundwater as identified in the RDR/RAWP (DOE-RL 2009).

APPENDIX C

DATA QUALITY ASSESSMENT

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VERIFICATION SAMPLING

A data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WCH 2015b). This DQA was performed in accordance with site-specific data quality objectives found in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2009).

A review of the sample design (WCH 2015b), the field logbook (WCH 2015a), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design, with minimal alterations, as warranted by field conditions.

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

Verification data from samples collected at the 100-D-85:2 subsite were provided by the laboratories in two sample delivery groups (SDGs): SDG JP0895 and SDG JP0897. SDG JP0897 was submitted for third-party validation. Major and minor deficiencies found in this data set are discussed below. If no comments are made about a specific analysis, it should be assumed that no deficiencies affecting the quality of the data were found.

MAJOR DEFICIENCIES

Due to holding time exceedances in the method 9056M ion chromatography (IC) anions analysis of greater than twice the limit of 48 hours, third-party validation qualified the associated undetected nitrite and orthophosphate results in SDG JP0897 as rejected with "R" flags. Additionally all of the detected method 9056M nitrate and orthophosphate results are qualified as estimated with "J" flags. Similarly, the project has qualified all undetected nitrite and orthophosphate results in SDG JP0895 as rejected with "R" flags.

These results were anticipated and U.S. Environmental Protection Agency (EPA) analytical method 353.2 was also requested to provide acceptable nitrate/nitrite data for decision-making purposes. Therefore, the estimated and rejected data for nitrate and nitrite and do not hinder the evaluation of the 100-D-85:2 subsite. Phosphate is not a regulated chemical under *Washington Administrative Code* 173-340, "Model Toxics Control Act – Cleanup."

MINOR DEFICIENCIES

SDG JP0895

This SDG comprises 13 statistical soil samples (J1V321 through J1V329, J1V330 through J1V33) collected from the 100-D-85:2 excavation. This SDG includes one field duplicate pair (J1V325, J1V333). All samples were analyzed for americium-241, gamma spectroscopy (gamma energy analysis [GEA]), nickel-63, isotopic plutonium, strontium-90, isotopic uranium, hexavalent chromium, sulfate, nitrate, inductively coupled plasma (ICP) metals, mercury, and polychlorinated biphenyls (PCBs). Minor deficiencies are as follows:

In the PCB analysis, the separation between aroclor-1254 and aroclor-1260 in sample J1V327 is insufficient to quantify the constituents individually. The laboratory has quantified these constituents as the predominant peak. This result may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, low levels of cobalt, calcium, magnesium, manganese, and mercury were detected in the method blank (MB). The detections are less than half of the reporting limits and will have no significant impact on the field sampling data. The data are usable for decision-making purposes.

In the ICP metals analysis, the common laboratory contaminant iron was detected in the MB. The iron concentrations reported for the field samples are all more than 20 times the MB concentration, which will have no significant impact. The data are usable for decision-making purposes.

In the ICP metals analysis, recoveries for silicon in the laboratory control sample (LCS) (8%) and matrix spike (MS) (16%) are outside the quality control (QC) limits. The laboratory reports a possible low bias in the data and has qualified the associated data with "N" flags. These data may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the MS recoveries for arsenic (70%), selenium (68%), and boron (78%) are outside the laboratories QC limits. Acceptable LCS recoveries indicate that the analytical system was operating within control. The laboratory has qualified the associated data with "N" flags. These data may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the relative percent difference (RPD) calculated for cadmium (41%), barium (31%), and lead (96%) are outside the QC limits. The laboratory has qualified the associated data with "M" flags. These data may be considered estimated. Estimated data are usable for decision-making purposes.

In the sulfate analysis, sulfate was detected in the MB at a concentration that is more than half of the project-specific reporting limit (PSRL). However, the detected concentration is less than $1/20^{th}$ of the most restrictive applicable remedial action goal (RAG). There is no impact to the evaluation of the 100-D-85:2 subsite. The data are usable for decision-making purposes.

In the analysis for fluoride, the RPD calculated for fluoride (11%) is outside the laboratories QC limits. The laboratory has qualified the associated data with "M" flags. These data may be considered estimated. Estimated data are usable for decision-making purposes.

SDG JP0897

This SDG comprises 12 statistical soil samples (J1V340 through J1V349, J1V350 through J1V352) collected from the 100-D-85:2 staging pile area and an equipment blank (J1V353). This SDG includes one field duplicate pair (J1V349, J1V352). All field samples were analyzed for americium-241, gamma spectroscopy (GEA), nickel-63, isotopic plutonium, strontium-90, isotopic uranium, hexavalent chromium, sulfate, nitrate, ICP metals, mercury, and PCBs. The equipment blank was analyzed for ICP metals and mercury. Minor deficiencies are as follows:

In the chloride analysis, chloride was detected at low levels in the MB and in the field samples. These results are well below the applicable RAGs. Third-party validation qualified all of the associated chloride results as undetected and estimated with "UJ" flags. Undetected and estimated data are usable for decision-making purposes.

In the IC anions analysis and pH analysis, the holding time for the nitrate, nitrite, orthophosphate, and pH was exceeded by more than twice the limit. Undetected nitrate, nitrite, and orthophosphate are discussed above in the "Major Deficiencies" section. Third-party validation qualified all of the associated detected nitrate, nitrite, orthophosphate, and pH data as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, calcium was detected in the MB and at a similar concentration in sample J1V353, which is the equipment blank. Third-party validation qualified the calcium result in sample J1V353 as undetected and estimated. Undetected and estimated data are usable for decision-making purposes.

In the ICP metals analysis, the MS recovery for calcium (145%) is above the QC limits. Third-party validation qualified all detected calcium results in SDG JP0897 as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the MS recoveries for vanadium (131%), antimony (60%), and silicon (20%) are outside the QC limits. Third-party validation qualified all of the associated data as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery for silicon (10%) is outside the QC limits. Third-party validation qualified all associated silicon results as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the radiological analyses, no LCS samples were prepared for plutonium-238 or uranium-235. Third-party validation qualified all associated plutonium-238 and uranium-235 results as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the radiological analyses, the LCS recovery for nickel-63 (89%) is outside QC limits. Third-party validation qualified all associated nickel-63 results as estimated with "J" flags. Estimated data are usable for decision-making purposes.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

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

Field quality assurance (QA)/QC measures are used to assess potential sources of error and cross contamination of samples that could bias results. Field QA/QC samples, listed in the field logbook (WCH 2015a), are shown in Table C-1. The main and QA/QC sample results are presented in Appendix B.

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

Sample Area	Main Sample	Duplicate Sample
Excavation Area	J1V325	J1V333
Staging Pile Area	J1V349	J1V352

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

None of the RPDs calculated for the field duplicate samples are above the acceptance criteria (30%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. There is no indication that the analytical system was operating out of control. The data are usable for decision-making purposes.

A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the TDL, including undetected analytes. In these cases, a control limit of ±2 times the TDL is used (Appendix B) to indicate that a visual check of the data is required by the reviewer. A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are usable for decision-making purposes.

SUMMARY

Limited, random, or sample matrix-specific influenced batch QC issues such as those discussed above, are a potential for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 100-D-85:2 subsite verification sampling data found that the analytical results are accurate within the standard errors associated with the analytical methods, sampling, and sample handling. The DQA review for 100-D-85:2 subsite concludes that the reviewed data are of the right type, quality, and quantity to support the intended use. The analytical data were found acceptable for decision-making purposes.

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

REFERENCES

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

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

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

WAC 173-340, "Model Toxics Control Act—Cleanup," *Washington Administrative Code*, as amended.

WCH, 2015a, *100-D Field Remediation and Miscellaneous Sampling Activities*, Logbook EL-1662-03, pp 84-89, Washington Closure Hanford, Richland, Washington.

WCH, 2015b, *Work Instruction for Verification Sampling of the 100-D-85:2, Additional 105-DR Reactor Effluent Pipelines,* 0100D-WI-G0148, Rev. 0, Washington Closure Hanford, Richland, Washington.