1221565

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-NR-1 **Control No.:** 2013-036

Waste Site Code(s)/Subsite Code(s): UPR-100-N-4

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 UPR-100-N-4, 1322-A Sump Overflow waste site was identified as a 100-NR-1 Operable Unit waste site requiring remediation in the *Interim Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington* (100-N Area ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999).

The UPR-100-N-4 waste site is the location of an unplanned release of radioactively contaminated water at the 1322-N/NA Building. On May 7, 1977, approximately 760 L (200 gal) of water leaked to the ground covering about 140 m^2 (1,500 ft^2). The UPR-100-N-4 waste site is located approximately 195 m (640 ft) northeast of the 105-N Reactor.

The UPR-100-N-4 waste site was located in close proximity to the UPR-100-N-8 and UPR-100-N-31 waste sites. The remediation of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites resulted in one large excavation with no demarcation of the individual sites.

The 1322N, 1322NA, 1322NB, and 1322NC above-ground buildings and slabs in the vicinity of the unplanned release sites were removed during the 100-N deactivation, decommission, decontamination, and demolition (D4) activities. The removal resulted in an excavation that measured approximately 3.7 m (12 ft) deep. Further remedial action at the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites was performed between December 13, 2011, and March 19, 2012, resulting in a combined excavation approximately 7 m (23 ft) deep. Approximately 5,683 bank cubic meters (BCM) (7,433 bank cubic yards [BCY]) of contaminated soil, rocks, and concrete was removed for disposal at the Environmental Restoration Disposal Facility (ERDF). Additional remediation was conducted between January 30, 2013 and February 4, 2013, to remove residual radiologically contaminated soil in the shallow zone of the site resulting in an additional 189 BCM (247 BCY) of contaminated soil removed for disposal to ERDF.

Cleanup verification samples were collected to determine if the waste site met the remedial action objectives (RAOs) and remedial action goals (RAGs) established by the 100-N Area 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 as Interim Closed Out.

Basis for reclassification:

The cleanup verification sampling results and modeling for the UPR-100-N-4 waste site support a reclassification to Interim Closed Out. The current site conditions achieve the RAOs and the corresponding RAGs established by the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area,* DOE/RL-2005-93, Rev. 0, U.S. Department of Energy, Richland, Washington, and the 100-N Area ROD (EPA 1999). These results show that residual soil concentrations support future use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). Remediation of the combined UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste site group extended to residual deep zone contamination associated with the adjacent 116-N-1 crib. The liquid waste effluents associated with the UPR-100-N-31 and 116-N-1 waste sites are the same; contamination extends to the groundwater table in this area. The 116-N-1 waste site has been reclassified as Interim Closed Out with associated institutional controls, as described in the *Cleanup Verification Package for the Soil Column of the 116-N-1 Crib and Trench,* CVP-2006-00004, Rev. 1, Washington Closure Hanford, Richland, Washington. The basis for reclassification of the UPR-100-N-4 waste site is described in detail in the *Remaining Sites Verification Package for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Unplanned Release Waste Sites* (attached).

Attached to: 1221564

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A-6006-136 (REV 0)

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-NR-1 **Control No.:** 2013-036

Waste Site Code(s)/Subsite Code(s): UPR-100-N-4

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:

Remediation of the combined UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste site group extended to residual deep zone contamination associated with the adjacent 116-N-1 crib. Institutional controls for the 116-N-1 waste site are identified in the *Cleanup Verification Package for the Soil Column of the 116-N-1 Crib and Trench,* CVP-2006-00004, Rev. 1, Washington Closure Hanford, Richland, Washington

J. P. Neath	J P Neath	8/7/13
DOE Federal Project Director (printed)	Signature	Date
N. Menard	Nina M. Menard	8/13/13
Ecology Project Manager (printed)	Signature	Date
N/A		
EPA Project Manager (printed)	Signature	Date

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WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-NR-1 **Control No.:** 2013-037

Waste Site Code(s)/Subsite Code(s): UPR-100-N-8

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 UPR-100-N-8, 1322-A Sump Overflow waste site was identified as a 100-NR-1 Operable Unit waste site requiring remediation in the *Interim Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington* (100-N Area ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999).

The UPR-100-N-8 waste site is the location of an unplanned release of radioactively contaminated water at the 1322-N/NA Building. On May 1, 1975, approximately 190 to 380 L (50 to 100 gal) of water had drained to the rear of the 1322-N/NA Building and had run out the back door contaminating approximately 2.3 m^2(25 ft^2) of soil. The UPR-100-N-8 waste site is located approximately 195 m (640 ft) northeast of the 105-N Reactor.

The UPR-100-N-8 waste site was located in close proximity to the UPR-100-N-4 and UPR-100-N-31 waste sites. The remediation of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites resulted in one large excavation with no demarcation of the individual sites.

The 1322N, 1322NA, 1322NB, and 1322NC above-ground buildings and slabs in the vicinity of the unplanned release sites were removed during the 100-N deactivation, decommission, decontamination, and demolition (D4) activities. The removal resulted in an excavation that measured approximately 3.7 m (12 ft) deep.

Further remedial action at the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites was performed between December 13, 2011, and March 19, 2012, resulting in a combined excavation approximately 7 m (23 ft) deep. Approximately 5,683 bank cubic meters (BCM) (7,433 bank cubic yards [BCY]) of contaminated soil, rocks, and concrete was removed for disposal at the Environmental Restoration Disposal Facility (ERDF). Additional remediation was conducted between January 30, 2013 and February 4, 2013, to remove residual radiologically contaminated soil in the shallow zone of the site resulting in an additional 189 BCM (247 BCY) of contaminated soil removed for disposal to ERDF.

Cleanup verification samples were collected to determine if the waste site met the remedial action objectives (RAOs) and remedial action goals (RAGs) established by the 100-N Area 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 as Interim Closed Out.

Basis for reclassification:

The cleanup verification sampling results and modeling for the UPR-100-N-8 waste site support a reclassification to Interim Closed Out. The current site conditions achieve the RAOs and the corresponding RAGs established by the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area,* DOE/RL-2005-93, Rev. 0, U.S. Department of Energy, Richland, Washington, and the 100-N Area ROD (EPA 1999). These results show that residual soil concentrations support future use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). Remediation of the combined UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste site group extended to residual deep zone contamination associated with the adjacent 116-N-1 crib. The liquid waste effluents associated with the UPR-100-N-31 and 116-N-1 waste sites are the same; contamination extends to the groundwater table in this area. The 116-N-1 waste site has been reclassified as Interim Closed Out with associated institutional controls, as described in the *Cleanup Verification Package for the Soil Column of the 116-N-1 Crib and Trench,* CVP-2006-00004, Rev. 1, Washington Closure Hanford, Richland, Washington. The basis for reclassification of the UPR-100-N-8 waste site is described in detail in the *Remaining Sites Verification Package for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Unplanned Release Waste Sites* (attached).

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-NR-1 **Control No.:** 2013-037

Waste Site Code(s)/Subsite Code(s): UPR-100-N-8

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:

Remediation of the combined UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste site group extended to residual deep zone contamination associated with the adjacent 116-N-1 crib. Institutional controls for the 116-N-1 waste site are identified in the *Cleanup Verification Package for the Soil Column of the 116-N-1 Crib and Trench,* CVP-2006-00004, Rev. 1, Washington Closure Hanford, Richland, Washington.

J. P. Neath	JP Neath	8/7/13
DOE Federal Project Director (printed)	Signature	Date
N. Menard	Nina M. Menard	8/13/13
Ecology Project Manager (printed)	Signature	Date
N/A		
EPA Project Manager (printed)	Signature	Date

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-NR-1 **Control No.:** 2013-038

Waste Site Code(s)/Subsite Code(s): UPR-100-N-31

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 UPR-100-N-31, Radioactive Effluent Water Spill Near 1301-N waste site was identified as a 100-NR-1 Operable Unit waste site requiring remediation in the *Interim Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington* (100-N Area ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999).

The UPR-100-N-31 waste site is the location of an unplanned release of radioactively contaminated effluent water west of the 116-N-1 Crib and Trench. On July 22, 1974, during the installation of sample lines on a 15-cm (6-in.) steel casing, the water level in the 116-N-1 crib was raised 38 to 46 cm (15 to 18 in.) as a result of an emergency dump tank draw-down test being conducted. Due to the increased water level, approximately 8,800 L (1,000 gal) of effluent water flowed through the casing and was released to the soil. An area of approximately 188 m^2 (2,025 ft^2) was contaminated. The UPR-100-N-31 waste site is located approximately 195 m (640 ft) northeast of the 105-N Reactor.

The UPR-100-N-31 waste site was located in close proximity to the UPR-100-N-4 and UPR-100-N-8 waste sites. The remediation of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites resulted in one large excavation with no demarcation of the individual waste sites.

The 1322N, 1322NA, 1322NB, and 1322NC above-ground buildings and slabs in the vicinity of the unplanned release sites were removed during the 100-N deactivation, decommission, decontamination, and demolition (D4) activities. The removal resulted in an excavation that measured approximately 3.7 m (12 ft) deep.

Further remedial action at the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites was performed between December 13, 2011, and March 19, 2012, resulting in a combined excavation approximately 7 m (23 ft) deep. Approximately 5,683 bank cubic meters (BCM) (7,433 bank cubic yards [BCY]) of contaminated soil, rocks, and concrete was removed for disposal at the Environmental Restoration Disposal Facility (ERDF). Additional remediation was conducted between January 30, 2013 and February 4, 2013, to remove residual radiologically contaminated soil in the shallow zone of the site resulting in an additional 189 BCM (247 BCY) of contaminated soil removed for disposal to ERDF.

Cleanup verification samples were collected to determine if the waste site met the remedial action objectives (RAOs) and remedial action goals (RAGs) established by the 100-N Area 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 as Interim Closed Out.

Basis for reclassification:

The cleanup verification sampling results and modeling for the UPR-100-N-31 waste site support a reclassification to Interim Closed Out. The current site conditions achieve the RAOs and the corresponding RAGs established by the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area*, DOE/RL-2005-93, Rev. 0, U.S. Department of Energy, Richland, Washington, and the 100-N Area ROD (EPA 1999). These results show that residual soil concentrations support future use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). Remediation of the combined UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste site group extended to residual deep zone contamination associated with the adjacent 116-N-1 crib. The liquid waste effluents associated with the UPR-100-N-31 and 116-N-1 waste sites are the same; contamination extends to the groundwater table in this area. The 116-N-1 waste site has been reclassified as Interim Closed Out with associated institutional controls, as described in the *Cleanup Verification Package for the Soil Column of the 116-N-1 Crib and Trench*, CVP-2006-00004, Rev. 1, Washington Closure Hanford, Richland, Washington. The basis for reclassification of the UPR-100-N-31 waste site is described in detail in the *Remaining Sites Verification Package for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Unplanned Release Waste Sites* (attached).

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-NR-1 **Control No.:** 2013-038

Waste Site Code(s)/Subsite Code(s): UPR-100-N-31

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:

Remediation of the combined UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste site group extended to residual deep zone contamination associated with the adjacent 116-N-1 crib. Institutional controls for the 116-N-1 waste site are identified in the *Cleanup Verification Package for the Soil Column of the 116-N-1 Crib and Trench,* CVP-2006-00004, Rev. 1, Washington Closure Hanford, Richland, Washington.

J. P. Neath	J P Neath	8/7/13
DOE Federal Project Director (printed)	Signature	Date
N. Menard	Nina M. Menard	8/13/13
Ecology Project Manager (printed)	Signature	Date
N/A		
EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE UPR-100-N-4, UPR-100-N-8, AND UPR-100-N-31 UNPLANNED RELEASE WASTE SITES

Attachment to Waste Site Reclassification Forms 2013-036, 2013-037, and 2013-038

August 2013

REMAINING SITES VERIFICATION PACKAGE FOR THE UPR-100-N-4, UPR-100-N-8, AND UPR-100-N-31 UNPLANNED RELEASE WASTE SITES

EXECUTIVE SUMMARY

The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites, part of the 100-NR-1 Operable Unit, are located approximately 195 m (640 ft) northeast of the 105-N Reactor. Liquid effluent originating from the 105-N Reactor was spilled to the soil on three separate occasions at this location. Two spills were from the 1322-N/NA Building where contaminated water flowed out of the building onto the ground. The third release was due to an increased water level in the nearby 116-N-1 crib resulting in an overflow to the surrounding soil.

Remedial action at the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites was performed between December 13, 2011 and March 19, 2012, resulting in a combined excavation approximately 7 m (23 ft) deep. Approximately 5,683 bank cubic meters (BCM) (7,433 bank cubic yards [BCY]) of contaminated soil, rocks, and concrete was removed for disposal at the Environmental Restoration Disposal Facility (ERDF). Additional remediation was conducted between January 30, 2013 and February 4, 2013, to remove residual radiologically contaminated soil in the shallow zone of the site resulting in an additional 189 BCM (247 BCY) of contaminated soil removed for disposal to ERDF.

Verification sampling was conducted on October 10, and November 5 and 6, 2012. Replacement sampling at three locations was conducted on February 12, 2013. A summary of the cleanup evaluation for the soil sampling results against the applicable remedial action goals (RAGs) is presented in Table ES-1. The results of the verification sampling were used to make reclassification decisions for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2011).

The verification sampling results and modeling for the shallow zone of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites support a reclassification to Interim Closed Out. The current site conditions achieve the remedial action objectives (RAOs) and the corresponding RAGs established in the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (DOE-RL 2006b) and the *Interim Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington* (100-N Area ROD) (EPA 1999). These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The sample and modeling results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft]).

Table ES-1. Summary of Remedial Action Goals for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain dose rate of <15 mrem/yr above background over 1,000 years.	Maximum dose rates from sum-of-fractions evaluations for the shallow zone excavation using dose-equivalent lookup values are <15 mrem/yr. The maximum cumulative predicted dose rate for the combined waste sites is 6.42 mrem/yr.	Yes
Direct Exposure – Nonradionuclides	Attain individual COPC RAGs.	All individual COPC concentrations in the shallow zone 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 (1.6×10^{-3}) is <1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	The excess cancer risk for hexavalent chromium, the only nonradionuclide carcinogen detected above background level, is 1.8×10^{-7}, which is less than 1×10^{-6}.	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	The total excess cancer risk for hexavalent chromium, the only nonradionuclide carcinogen detected above background level, is 1.8×10^{-7} which is less than 1×10^{-5}.	
Groundwater/River Protection – Radionuclides	Attain single COPC groundwater and river RAGs.	Residual radionuclide concentrations in the shallow zone of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 remediation achieve the remedial action objectives for groundwater and river protection.	Yes
	Attain National Primary Drinking Water Regulations [a]: 4 mrem/yr (beta/gamma) dose standard to target receptor/organ.	Residual radionuclide concentrations encountered in the deep zone excavation are considered to be associated with the adjacent 116-N-1 waste site [b]. Specific institutional controls for deep zone contamination associated with the 116-N-1 site are addressed separately (WCH 2009).	
	Meet drinking water standards for nonuranium alpha emitters: the more stringent of 15 pCi/L MCL or 1/25th of the derived concentration guide for DOE Order 5400.5 [c].	No nonuranium alpha-emitting radionuclide COPCs were quantified above groundwater/river protection lookup values.	
	Meet total uranium standard of 30 µg/L (21.2 pCi/L) [d].	Uranium was quantified below background in samples associated with the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 remaining soils.	

Table ES-1. Summary of Remedial Action Goals for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and Columbia River cleanup requirements.	Residual concentrations of chromium, vanadium, and zinc exceed soil RAGs for groundwater and/or river protection. However, based on RESRAD modeling discussed in Appendix C of the 100-N Area RDR/RAWP (DOE-RL 2006b), it is predicted that these constituents will not reach groundwater (and thus the Columbia River) within 1,000 years [e].	Yes

[a] "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).

[b] Residual deep zone contamination observed at the combined UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites is attributed to deep zone contamination in soils underlying the 116-N-1 crib. This is based on the immediate spatial proximity of the 116-N-1 crib, observed radiological activity increasing with depth as remediation approached the 116-N-1 footprint, and comparability of deep zone sample results to those for the 116-N-1 site.

[c] *Radiation Protection of the Public and Environment* (DOE Order 5400.5).

[d] 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).

[e] Based on RESRAD modeling discussed in Appendix C of the 100-N Area RDR/RAWP (DOE-RL 2006b), residual concentrations of chromium, vanadium, and zinc are predicted to migrate less than 1.8 m (5.9 ft) vertically in 1,000 years (based on the lowest soil-partitioning coefficient of the contaminants [zinc] of 30 mL/g). The vadose zone underlying the soil beneath the excavation is approximately 14 m (46 ft) thick. Therefore, residual concentrations of these contaminants are predicted to be protective of groundwater and consequently are protective of 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 UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 unplanned release sites combined remediation is immediately adjacent to the former 116-N-1 waste site. During remediation of the unplanned release sites, increasing radiological activity was observed with depth approaching soils underlying the former 116-N-1 crib. Deep zone verification sample results for the UPR100-N-4, UPR-100-N-8, and UPR-100-N-31 combined remediation are also consistent with residual contamination documented in the *Cleanup Verification Package for the Soil Column of the 116-N-1 Crib and Trench* (WCH 2009). This suggests that the unplanned release sites remediation encountered residual 116-N-1 contamination left in place in the deep zone, and deep zone remediation of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites is considered complete. The liquid waste effluents associated with the UPR-100-N-31 and 116-N-1 waste sites are the same; contamination extends to the groundwater table in this area. Remediation and interim closure of the 116-N-1 site, including associated institutional controls, has been addressed separately in WCH (2009).

Soil cleanup levels were established in the 100-N Area ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the 100-N Area ROD, a comparison against ecological risk screening levels has been made for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites contaminants of potential concern and other constituents (Appendix A). Ecological screening levels from *Washington Administrative Code* 173-340 were exceeded for boron and vanadium. The U.S. Environmental Protection Agency ecological soil screening levels were exceeded for 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 the concentration of manganese is below the Hanford Site background value, it is believed that its presence does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for risk to ecological receptors as part of the final closeout decision for this site.

REMAINING SITES VERIFICATION PACKAGE FOR THE UPR-100-N-4, UPR-100-N-8, AND UPR-100-N-31 UNPLANNED RELEASE WASTE SITES

STATEMENT OF PROTECTIVENESS

The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 unplanned release waste sites cleanup verification sampling data, site evaluations, and supporting documentation demonstrate that these sites meet the objectives established in the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (100-N Area RDR/RAWP) (DOE-RL 2006b) and the *Interim Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington* (100-N Area ROD) (EPA 1999).

The verification sampling results and modeling for the shallow zone of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites support a reclassification to Interim Closed Out. The current site conditions achieve the remedial action objectives (RAOs) and the corresponding remedial action goals (RAGs) established in the 100-N Area RDR/RAWP (DOE-RL 2006b) and the 100-N Area ROD (EPA 1999). These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The sample and modeling results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft]).

The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 unplanned release sites combined remediation is immediately adjacent to the former 116-N-1 waste site. During remediation of the unplanned release sites, increasing radiological activity was observed with depth approaching soils underlying the former 116-N-1 crib. Deep zone verification sample results for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 combined remediation are also consistent with residual contamination documented in the *Cleanup Verification Package for the Soil Column of the 116-N-1 Crib and* (WCH 2009). This suggests that the unplanned release sites remediation encountered residual 116-N-1 contamination left in place in the deep zone, and deep zone remediation of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites is considered complete. The liquid waste effluents associated with the UPR-100-N-31 and 116-N-1 waste sites are the same; contamination extends to the groundwater table in this area. Remediation and interim closure of the 116-N-1 site, including associated institutional controls, has been addressed separately in WCH (2009).

Soil cleanup levels were established in the 100-N Area ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the 100-N Area ROD, a comparison against ecological risk screening levels has been made for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites contaminants of potential concern (COPCs) and other constituents (Appendix A). Ecological screening levels from *Washington Administrative Code* (WAC) 173-340 were exceeded for boron and vanadium. The U.S. Environmental Protection Agency (EPA) ecological soil screening levels were exceeded for 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 the concentration of manganese is below the Hanford Site background value, it is believed that its presence does not pose a risk to ecological receptors. All exceedances will be evaluated in the

context of additional lines of evidence for risk to ecological receptors as part of the final closeout decision for this site.

GENERAL SITE INFORMATION AND BACKGROUND

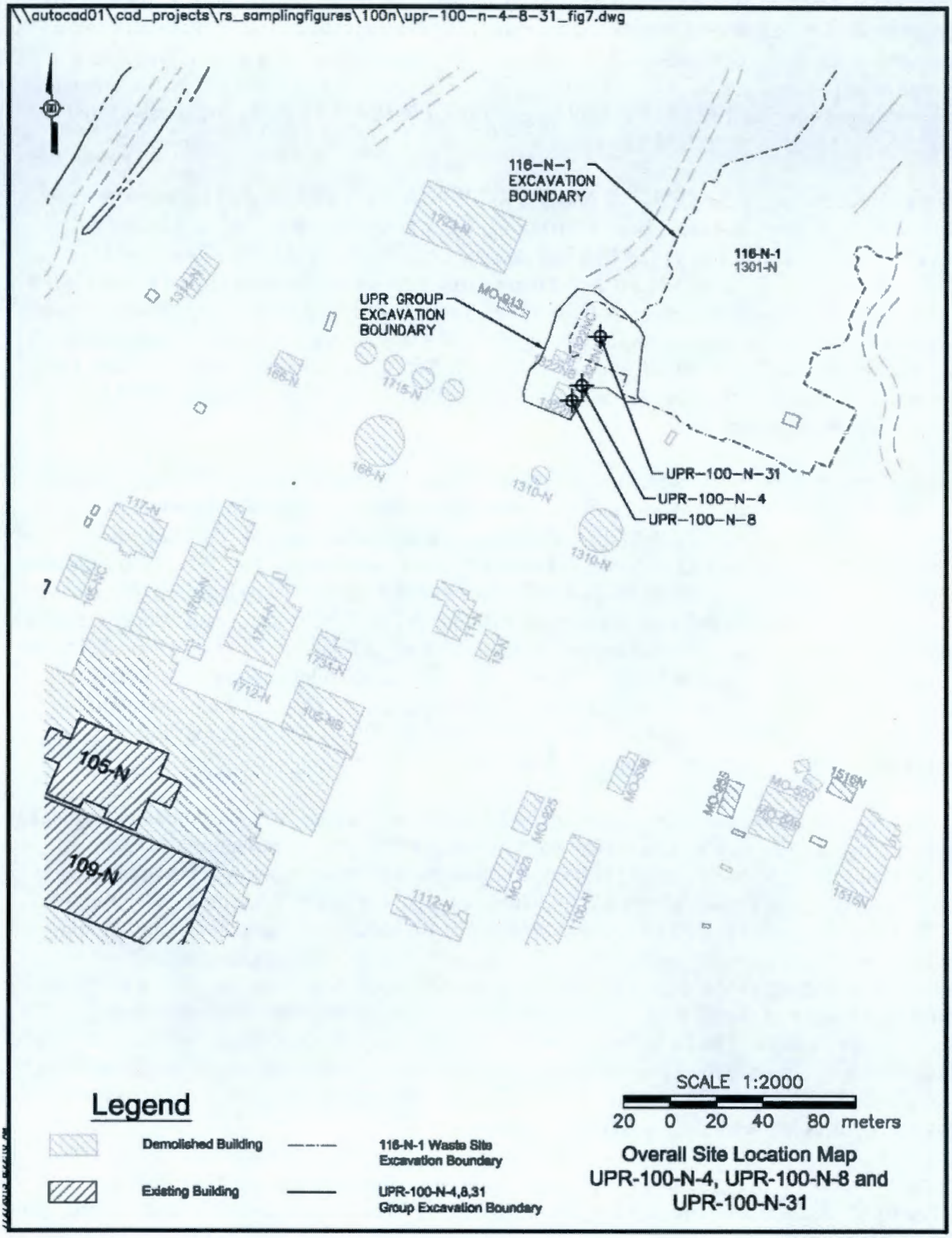
The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites are part of the 100-NR-1 Operable Unit. The UPR-100-N-4 and UPR-100-N-8 are located approximately 195 m (640 ft) northeast of the 105-N Reactor. The UPR-100-N-31 is located on the west side of the berm just west of the 1301-N Liquid Waste Disposal Facility (116-N-1 Crib and Trench). Figure 1 shows the location of the three unplanned release sites.

The UPR-100-N-4 waste site is described in the *100-N Area Technical Baseline Report* (WHC 1994) as a low-level liquid unplanned release waste site located near the 1322-A Sump. The report states that an unplanned release of low-level radioactively contaminated water occurred at 1322-N/NA Buildings on May 7, 1977. Approximately 760 L (200 gal) of low-level radioactive water leaked to the ground covering about 140 m^2 (1,500 ft^2). All contaminated soil was excavated, transported to the 200 Area Burial Grounds and replaced with clean fill material.

The UPR-100-N-8 waste site is described in the *100-N Area Technical Baseline Report* (WHC 1994) as a low-level radioactive liquid unplanned release waste site located in the area surrounding the 1322-A Sump in the 1322-N/NA Buildings. The report states that an unplanned release of low-level radioactively contaminated water occurred at 1322-N/NA Buildings on May 1, 1975. Contaminated water was observed to cover the floor and various pieces of equipment in the rear of the building. The leak was immediately stopped by shutting down the sample pumps. Subsequent contamination surveys showed that approximately 190 to 380 L (50 to 100 gal) of sample water had drained to the rear of the building and had run out the back door contaminating approximately 2.3 m (25 ft^2) of soil. Most of the contaminated soil was removed. The excavation was then backfilled with clean fill material.

The UPR-100-N-31 waste site is described in the *100-N Area Technical Baseline Report* (WHC 1994) as a low-level radioactive liquid waste site located on the west side of the berm just west of the 1301-N (116-N-1) Liquid Waste Disposal Facility. The report states that an unplanned release of radioactively contaminated effluent water occurred at this site on July 22, 1974. While sample lines were being installed in a 15-cm (6-in.) steel casing through the berm on the west side of the 1301-N (116-N-1) crib, the water level in the crib was raised 38 to 46 cm (15 to 18 in.) as a result of an emergency dump tank draw-down test being conducted. Due to the increased water level, approximately 8,785 L (1,000 gal) of effluent water flowed through the casing and was released to the soil. An area of approximately 188 m^2 (2,025 ft^2) was contaminated. The effluent water contained fission and activation products. The contaminated soil was removed and transported to the 200 Area for disposal. Clean fill material was used to restore the site.

Figure 1. The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Site Location Map.



REMEDIAL ACTION SUMMARY

The 1322N, 1322NA, 1322NB, and 1322NC above-ground buildings and slabs in the vicinity of the unplanned releases were removed during the 100-N deactivation, decommission, decontamination, and demolition (D4) activities. The removal included an excavation that measured approximately 3.7 m (12 ft) deep. The UPR-100-N-4 and UPR-100-N-8 waste sites are associated with the 1322-N/NA Buildings. The UPR-100-N-31 waste site is associated with the 116-N-1 (1301-N) Crib and Trench.

Further remediation of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste site soils was performed between December 13, 2011, and March 19, 2012, resulting in a combined excavation approximately 7 m (23 ft) deep. Because the locations of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 unplanned release sites are in close proximity to each other and no information was available to delineate the boundary of each release, the three sites were combined into one excavation. Additionally, since the waste sites are a result of unplanned releases of liquid effluent that originated from the 105-N Reactor and the COPCs are the same for each site, the three waste sites were combined in the work instruction for verification sampling without separate decision units.

Approximately 5,683 bank cubic meters (BCM) (7,433 bank cubic yards [BCY]) of additional contaminated soil, rocks, and concrete was removed for disposal at the Environmental Restoration Disposal Facility (ERDF). Additional contaminated soil was removed from locations SZ-6, SZ-8, and SZ-9 between January 30, 2013 and February 4, 2013, resulting in an additional 189 BCM (247 BCY) of contaminated soil removed for disposal at ERDF. Areas of stained soil remained in the deep zone (more than 4.6 m [15 ft] below ground surface [bgs]) following the completion of the remedial action activities. All material was direct loaded from the excavation for disposal at ERDF. There are no overburden piles associated with the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 unplanned release sites. No anomalies were encountered during the remediation. The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 post-excavation civil survey is shown in Figure 2.

The excavation for remediation of the combined unplanned release sites is immediately adjacent to the former 116-N-1 (1301-N) remediation site (Figure 3). During remediation of the unplanned release sites, increasing radiological activity was observed with depth approaching soils underlying the former 116-N-1 crib. Deep zone sample results from the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 remediation are also consistent with residual contamination in the 116-N-1 deep zone (WCH 2009). This suggests that the unplanned release sites remediation encountered residual 116-N-1 contamination left in place in the deep zone, and deep zone remediation of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites is considered complete. The liquid waste effluents associated with the UPR-100-N-31 and 116-N-1 waste sites are the same; contamination extends to the groundwater table in this area. Remediation and interim closure of the 116-N-1 site, including associated institutional controls, has been addressed separately in WCH (2009).

A site visit was performed on April 18, 2012, to observe the remediated UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites. Figure 4 is a post-remediation photograph of the sites looking west.

Figure 2. The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Post-Excavation Civil Survey.

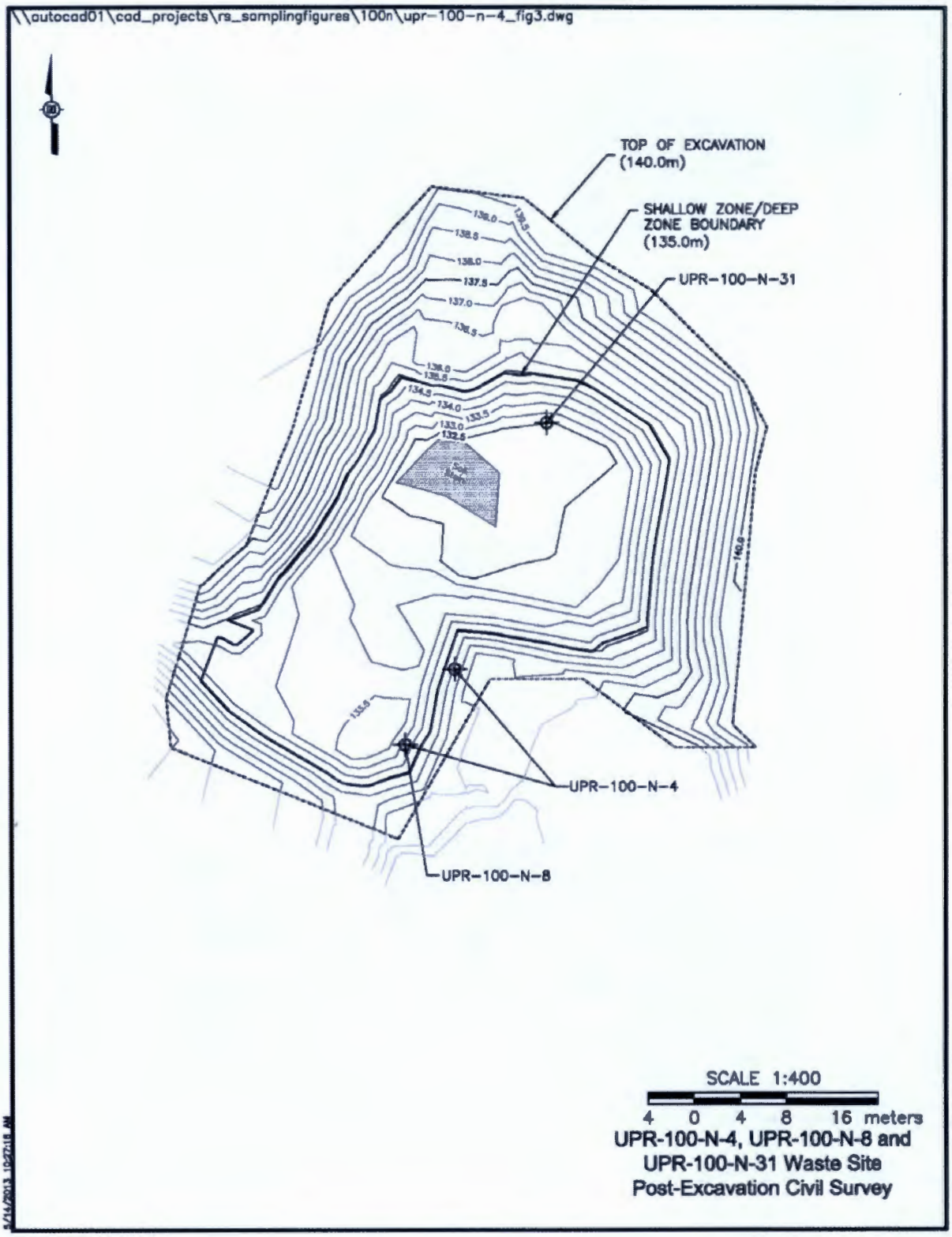


Figure 3. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Post-Excavation Civil Survey Overlain on the 116-N-1 Post-Excavation Civil Survey.

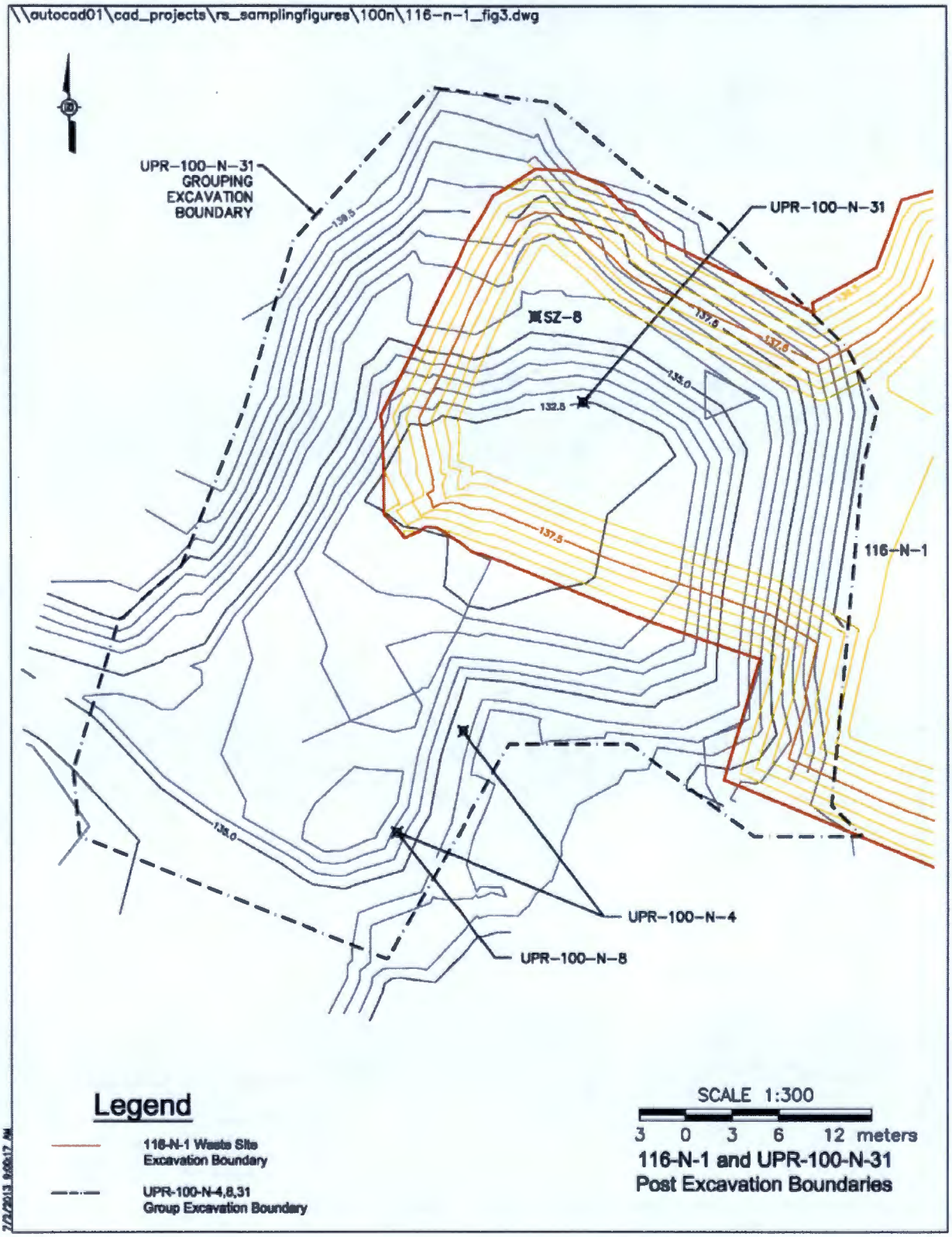


Figure 4. Post-Remediation Photograph of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites (Looking South).

VERIFICATION SAMPLING ACTIVITIES

Verification sampling was conducted at the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites on October 10 and November 5 and 6, 2012. Replacement sampling at three locations was conducted on February 12, 2013. Sampling was conducted to support a determination that residual contaminant concentrations in the soil meet cleanup criteria specified in the 100-N Area RDR/RAWP (DOE-RL 2006b) and 100-N Area ROD (EPA 1999).

The verification sample results are provided in Appendix B and indicate that the waste removal action achieved compliance with the RAOs and RAGs for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites. The following subsections provide additional discussion of the information used to develop the verification sampling design. The statistical results of verification sampling are also summarized to support interim closure of the site. A more detailed discussion of the verification sampling can be found in the *Work Instruction for Verification Sampling of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Unplanned Release Sites* (WCH 2012b).

Contaminants of Potential Concern

The COPCs for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites were determined based on available historical information and the in-process sampling results obtained from the waste site during remediation. The UPR-100-N-4 and UPR-100-N-8 waste sites are locations where unplanned releases occurred that originated from the 1322-NA Building where liquid effluent waste from the 105-N Reactor was treated and sampled. The UPR-100-N-31 unplanned release was a spill of reactor effluent from the 116-N-1 Crib and Trench as a result of a single overflow event. Because the effluent from each of these unplanned releases originated from the 105-N Reactor, the COPCs are the same and include those listed for the 116-N-1 waste site. The COPCs include americium-241, cesium-137, cobalt-60, europium-152, europium-154, europium-155, nickel-63, plutonium-239/240, strontium-90, tritium, chromium (total), hexavalent chromium, mercury, and nitrate. Carbon-14 was added as a COPC because it is a known byproduct of reactor operations. Plutonium-238, uranium-233/234, and uranium-238 were detected above a RAG in the in-process samples; therefore, they were included as site COPCs. Although not considered as COPCs, antimony, arsenic, barium, beryllium, boron, cadmium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc were included in the expanded list of inductively coupled plasma (ICP) metals.

The analytical methods that were performed to evaluate the site COPCs are provided in Table 1.

Table 1. Laboratory Analytical Methods.

Analytical Method	Contaminant of Potential Concern
ICP metals [a] – EPA Method 6010	Chromium
Mercury – EPA Method 7471	Mercury
Hexavalent chromium – EPA Method 7196	Hexavalent chromium
NO_2/NO_3 – EPA Method 353.2	Nitrate
GEA – Gamma spectroscopy	Americium-241, cesium-137, cobalt-60, europium-152, europium-154, europium-155
Isotopic plutonium – AEA	Plutonium-238, plutonium-239/240
Isotopic uranium – AEA	Uranium-233/234, uranium-238
Carbon-14 – Liquid scintillation	Carbon-14
Nickel-63 – Liquid scintillation	Nickel-63
Tritium – Liquid scintillation	Tritium
Total beta radiostrontium – Gas proportional counting	Strontium-90

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

AEA = alpha energy analysis
EPA = U.S. Environmental Protection Agency
GEA = gamma energy analysis
ICP = inductively coupled plasma
NO_2/NO_3 = nitrite/nitrate

Verification Sample Design

The combined UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites consisted of two decision units for verification sampling; specifically, the shallow zone and the deep zone. Twelve statistical verification soil samples, a duplicate sample, and a split sample were collected from each of the decision units. Additionally, four focused samples were collected from the excavation deep zone where staining was observed at the completion of remediation. All sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management*, to fulfill the requirements of the *100-N Area Sampling and Analysis Plan for CERCLA Waste Sites* (DOE-RL 2006a). All samples were grab samples collected at the predetermined coordinates. Additional information related to verification sampling can be found in the field sampling logbooks (WCH 2012a, 2013a). Figure 5 shows the waste site footprint, and the sampling locations. The verification sample summary is provided in Table 2.

Additional Remediation

After the initial verification samples were analyzed, it was determined that three locations within the shallow zone of the site exceeded direct exposure cleanup criteria for strontium-90 and/or cesium-137. Additional remediation at the failed sample locations was conducted, and replacement samples were collected and analyzed for the failing analytes only. Additional material was removed from the SZ-6, SZ-8, and SZ-9 locations in February 2013 and disposed at ERDF, and replacement samples were collected on February 12, 2013. The Hanford Environmental Information System (HEIS) sample numbers for the replacement samples are provided in Table 2.

The resulting analytical data from the replacement samples showed that the radionuclide concentrations at the SZ-6 and SZ-9 locations were below the lookup values. However, the radionuclide concentrations at the SZ-8 location were found to be higher than the original sample concentrations. Because the replacement sample collected from the SZ-8 location is below 4.6 m (15 ft), the location was considered to be part of the deep zone of the site; therefore, no further remediation was conducted. The SZ-8 sample was removed from the statistical data set and presented as a focused sample for the deep zone decision unit (WCH 2013b).

Verification Sample Results

All verification samples were analyzed using EPA-approved analytical methods. Evaluation of the verification data from the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 combined excavation was performed by direct comparison of the statistical or maximum sample results 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 UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 excavation decision units as specified by the 100-N Area RDR/RAWP (DOE-RL 2006b). The calculations are provided in Appendix B.

Figure 5. Verification Sample Locations for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Site Excavation.

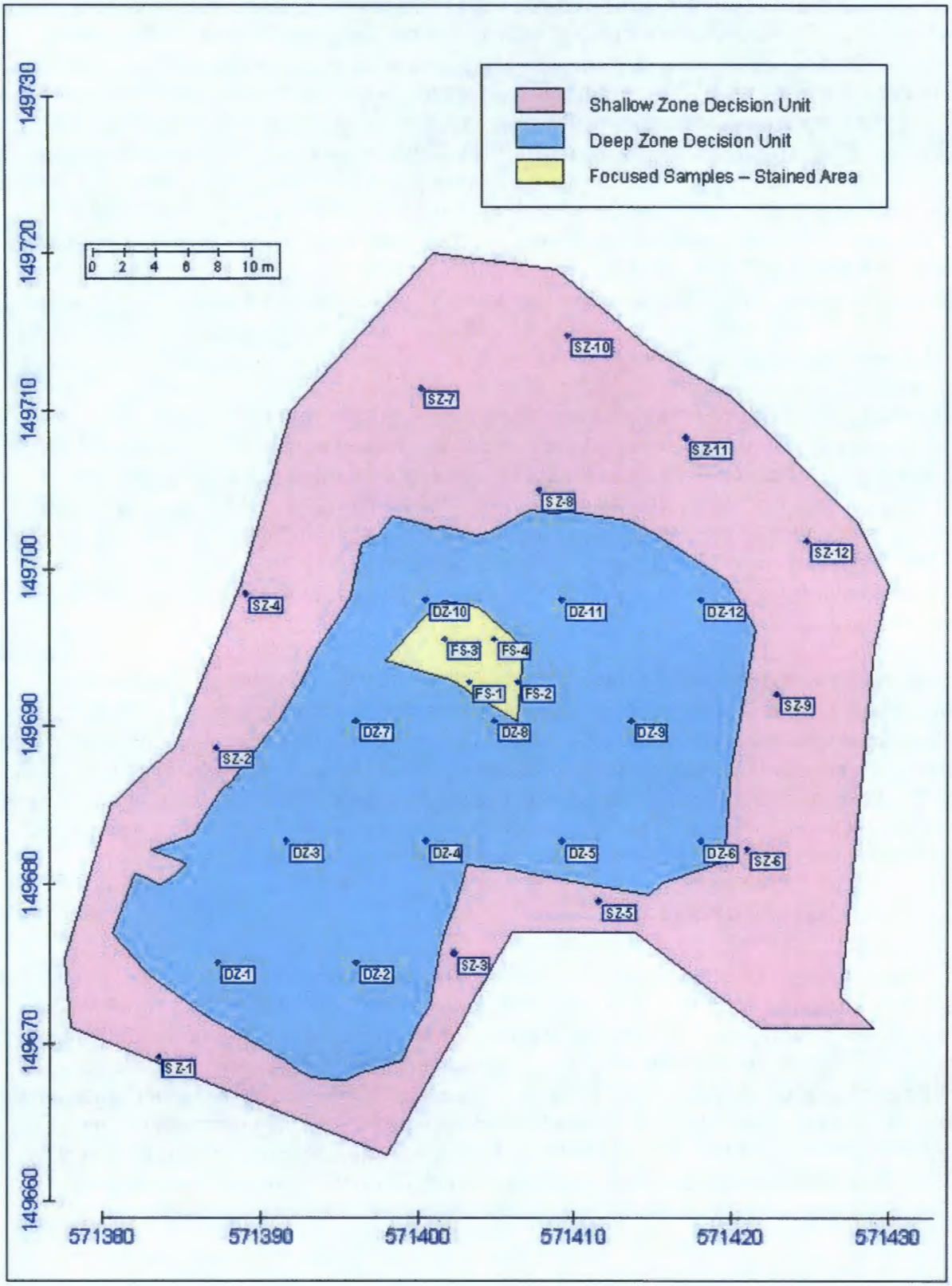


Table 2. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Sample Summary. (2 Pages)

Sample Location	HEIS Sample Number	Washington State Plane Coordinates		Sample Analysis
		Northing (m)	Easting (m)	
SZ-1	J1R513	149669.1	571383.5	ICP metals [a], mercury, hexavalent chromium, NO_2/NO_3, GEA, isotopic plutonium, isotopic uranium, carbon-14, nickel-63, tritium, strontium-90
SZ-2	J1R514	149688.6	571387.2	
SZ-3	J1R515	149675.7	571402.3	
Duplicate of SZ-3	J1R525	149675.7	571402.3	
Split of SZ-3	J1R541	149675.7	571402.3	
SZ-4	J1R516	149698.4	571389.1	
SZ-5	J1R517	149679.0	571411.7	
SZ-7	J1R519	149711.5	571400.3	
SZ-10	J1R522	149714.8	571409.7	
SZ-11	J1R523	149708.3	571417.2	
SZ-12	J1R524	149701.8	571424.7	
SZ-6	J1R518 [b]	149682.3	571421.1	ICP metals [a], mercury, hexavalent chromium, NO_2/NO_3, GEA, isotopic plutonium, isotopic uranium, carbon-14, nickel-63, tritium
SZ-6	J1RF74 [b]	149682.3	571421.1	Strontium-90
SZ-8	J1R520 [c]	149705.0	571407.8	ICP metals [a], mercury, hexavalent chromium, NO_2/NO_3, isotopic plutonium, isotopic uranium, carbon-14, nickel-63, tritium, strontium-90
SZ-8	J1RF75 [c]	149705.0	571407.8	GEA
SZ-9	J1R521 [d]	149692.0	571422.9	ICP metals [a], mercury, hexavalent chromium, NO_2/NO_3, isotopic plutonium, isotopic uranium, carbon-14, nickel-63, tritium
SZ-9	J1RF76 [d]	149692.0	571422.9	GEA, strontium-90
DZ-1	J1R2V0	149675.1	571387.3	ICP metals [a], mercury, hexavalent chromium, NO_2/NO_3, GEA, isotopic plutonium, isotopic uranium, carbon-14, nickel-63, tritium, strontium-90
Duplicate of DZ-1	J1R2W1	149675.1	571387.3	
Split of DZ-1	J1R2W0	149675.1	571387.3	
DZ-2	J1R2V1	149675.1	571396.1	
DZ-3	J1R2V2	149682.7	571391.7	
DZ-4	J1R2V3	149682.7	571400.5	
DZ-5	J1R2V4	149682.7	571409.3	
DZ-6	J1R2V5	149682.7	571418.1	
DZ-7	J1R2V6	149690.4	571396.1	
DZ-8	J1R2W6	149690.4	571404.9	
DZ-9	J1R2V7	149690.4	571413.7	ICP metals [a], mercury, hexavalent chromium, NO_2/NO_3, GEA, isotopic plutonium, isotopic uranium, carbon-14, nickel-63, tritium, strontium-90
DZ-10	J1R2V8	149698.0	571400.5	
DZ-11	J1R2V9	149698.0	571409.3	
DZ-12	J1R2W8	149698.0	571418.1	

Table 2. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Sample Summary. (2 Pages)

Sample Location	HEIS Sample Number	Washington State Plane Coordinates		Sample Analysis
		Northing (m)	Easting (m)	
FS-1	J1R2W5	149692.8	571403.3	ICP metals [a], mercury, hexavalent chromium, NO_2/NO_3, GEA, isotopic plutonium, isotopic uranium, carbon-14, nickel-63, tritium, strontium-90
FS-2	J1R2W4	149692.8	571406.5	
FS-3	J1R2W3	149695.6	571401.7	
FS-4	J1R2W7	149695.6	571404.9	
Equipment blank	J1R2W2	NA	NA	ICP metals [b], mercury

[a] Analysis for the expanded list of ICP metals included antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.
[b] Original sample collected at the SZ-6 location failed for strontium-90. Additional remediation was conducted and a replacement sample collected. Sample J1RF74 replaces J1R518 for strontium-90 analysis only.
[c] Original sample collected at the SZ-8 location failed for cesium-137. Additional remediation was conducted and a replacement sample collected. Sample J1RF75 replaces J1R520 for GEA analysis only.
[d] Original sample collected at the SZ-9 location failed for strontium-90 and cesium-137. Additional remediation was conducted and a replacement sample collected. Sample J1RF76 replaces J1R521 for strontium-90 and GEA analysis only.

GEA = gamma energy analysis
HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
NA = not applicable
NO_2/NO_3 = nitrate/nitrite

When a nonradionuclide COPC was detected in fewer than 50% of the verification samples collected for a decision unit, the maximum detected value was used for comparison to 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. The sample results for each focused sample were evaluated using the maximum detected concentration for each COPC and comparing the value directly to the RAG.

Comparisons of the results for each COPC from the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 excavation against the RAGs are summarized in Tables 3, 4, and 5. Contaminants that were not detected by laboratory analysis are excluded from the table. Calculated cleanup levels are not presented in the Cleanup Levels and Risk Calculations Database (Ecology 2012) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance for Superfund* (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 the table. The complete laboratory results for all constituents are stored in the Environmental Restoration (ENRE) project-specific database prior to archival in Hanford Environmental Information System (HEIS) and are presented in Attachment 1 of the 95% UCL calculations (Appendix B).

DATA EVALUATION

This section demonstrates that contaminant concentrations at the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites achieve the applicable RAGs developed to support unrestricted land use at the 100 Area as established in the 100-N Area ROD (EPA 1999) and documented in the 100-N Area RDR/RAWP (DOE-RL 2006b).

Table 3. Comparison of Contaminant Concentrations to Remedial Action Goals for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Excavation Shallow Zone Statistical Verification Samples.

COPC	Statistical or Maximum Result [a] (pCi/g)	Soil Lookup Values [b] (pCi/g)			Does the Result Exceed Lookup Values?	Does the Result Pass RESRAD Modeling?
		Direct Exposure Lookup Value	Soil Lookup Value for Groundwater Protection	Soil Lookup Value for River Protection		
Carbon-14	1.53	8.69	-- [c]	-- [c]	No	--
Cesium-137	0.875 (<BG)	6.2	1,465	1,465	No	--
Cobalt-60	0.149	1.4	13,900	13,900	No	--
Plutonium-239/240	0.173	33.9	-- [c]	-- [c]	No	--
Uranium-233/234	0.585 (<BG)	1.1 [d]	1.1 [d]	1.1 [d]	No	--
Uranium-238	0.517 (<BG)	1.1 [d]	1.1 [d]	1.1 [d]	No	--
COPC	**Statistical or Maximum Result [b] (mg/kg)**	**Remedial Action Goals [a] (mg/kg)**			**Does the Result Exceed RAGs?**	**Does the Result Pass RESRAD Modeling?**
		Direct Exposure	**Soil Cleanup Level for Groundwater Protection**	**Soil Cleanup Level for River Protection**		
Arsenic	3.0 (<BG)	20 [d]	20 [d]	20 [d]	No	--
Barium	59.4 (<BG)	16,000	200	400	No	--
Beryllium	0.261 (<BG)	10.4 [e]	1.51 [d]	1.51 [d]	No	--
Boron [f]	1.69	16,000	320	-- [g]	No	--
Chromium	10.7 (<BG)	120,000	18.5 [d]	18.5 [d]	No	--
Cobalt	8.65 (<BG)	1,600	32	-- [g]	No	--
Copper	17.9 (<BG)	2,960	59.2	22.0 [d]	No	--
Hexavalent chromium [f]	0.37	2.1	4.8	2	No	--
Lead	6.29 (<BG)	353	10.2 [d]	10.2 [d]	No	--
Manganese	329 (<BG)	11,200	512 [d]	-- [g]	No	--
Nickel	10.2 (<BG)	1,600	19.1 [d]	27.4	No	--
Vanadium	71.2 (<BG)	560	85.1 [d]	-- [g]	No	--
Zinc	52.9 (<BG)	24,000	480	67.8 [d]	No	--
Nitrogen in nitrite and nitrate [h]	3.72 (<BG)	128,000	1,000	2,000	No	--

[a] Maximum or 95% UCL, depending on data censorship, as described in the *UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations* (Appendix B).

[b] Look-up values and RAGs obtained from the 100-N Area RDR/RAWP (DOE-RL 2006b), unless noted otherwise.

[c] No value; because the distribution coefficient (K_d) 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(4)(d) (Ecology 1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Section 2.12.1 of the 100-N Area RDR/RAWP (DOE-RL 2006b).

[e] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3], Ecology 1996) using an airborne particulate mass-loading rate of 0.0001 g/m^3 (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).

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

[g] No parameters (bioconcentration factors or AWQC values) are available from the Ecology Cleanup Levels and Risk Calculations database or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).

[h] Remedial action goals obtained from the 100 Area RDR/RAWP (DOE-RL 2009).

-- = not applicable
AWQC = ambient water quality criteria
BG = background
COPC = contaminant of potential concern
Ecology = Washington State Department of Ecology
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*

Table 4. Comparison of Contaminant Concentrations to Remedial Action Goals for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Excavation Deep Zone Statistical Verification Samples. (2 Pages)

COPC	Statistical or Maximum Result [a] (pCi/g)	Soil Lookup Values [b] (pCi/g)		Does the Result Exceed Lookup Values?	Does the Result Pass RESRAD Modeling?
		Soil Lookup Value for Groundwater Protection	Soil Lookup Value for River Protection		
Americium-241	2.95	--[c]	--[c]	--	--
Carbon-14	2.89	--[c]	--[c]	--	--
Cesium-137	1,760	1,465	1,465	Yes	Yes[d]
Cobalt-60	15.0	13,900	13,900	No	--
Europium-154	1.13	--[c]	--[c]	--	--
Nickel-63	18.3	83	83	No	--
Plutonium-238	0.605	--[c]	--[c]	--	--
Plutonium-239/240	4.27	--[c]	--[c]	--	--
Total radiostrontium	341	27.6	27.6	Yes	Yes[d]
Tritium	2.55	12.6	12.6	No	--
Uranium-233/234	0.674 (<BG)	1.1[e]	1.1[e]	No	--
Uranium-238	0.672 (<BG)	1.1[e]	1.1[e]	No	--

COPC	Statistical or Maximum Result [b] (mg/kg)	Remedial Action Goals [a] (mg/kg)			Does the Result Exceed RAGs?	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Arsenic	1.95 (<BG)	20[e]	20[e]	20[e]	No	--
Barium	66.1 (<BG)	16,000	200	400	No	--
Beryllium	0.243 (<BG)	10.4[f]	1.51[e]	1.51[e]	No	--
Cadmium[g]	0.18 (<BG)	13.9[f]	0.81[e]	0.81[e]	No	--
Chromium	9.45 (<BG)	120,000	18.5[e]	18.5[e]	No	--
Cobalt	10.2 (<BG)	1,600	32	--[h]	No	--
Copper	16.0 (<BG)	2,960	59.2	22.0[e]	No	--
Hexavalent chromium[i]	0.61	2.1	4.8	2	No	--
Lead	3.08 (<BG)	353	10.2[e]	10.2[e]	No	--
Manganese	390 (<BG)	11,200	512[e]	--[h]	No	--
Mercury	0.0151 (<BG)	24	0.33[e]	0.33[e]	No	--
Molybdenum[i]	1.89	400	8	--[h]	No	--

Table 4. Comparison of Contaminant Concentrations to Remedial Action Goals for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Excavation Deep Zone Statistical Verification Samples. (2 Pages)

COPC	Statistical or Maximum Result [b] (mg/kg)	Remedial Action Goals [a] (mg/kg)			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		
Nickel	9.8 (<BG)	1,600	19.1 [c]	27.4	No	--
Vanadium	91.2	560	85.1 [c]	-- [h]	Yes	Yes [j]
Zinc	57.8 (<BG)	24,000	480	67.8 [c]	No	--
Nitrogen in nitrite and nitrate [k]	0.64 (<BG)	128,000	1,000	2,000	No	--

[a] Lookup values and RAGs obtained from the 100-N Area RDR/RAWP (DOE-RL 2006b), unless noted otherwise.

[b] Maximum or 95% UCL, depending on data censorship, as described in the *UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations* (Appendix B).

[c] No value; because the distribution coefficient (K_d) 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] The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 remediation encountered residual contamination that was left in-place in the deep zone with an approved waste site reclassification of Interim Closed Out for the 116-N-1 waste site (WCH 2009). The residual contamination is part of the 116-N-1 waste site and is not part of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites. RAG attainment and associated institutional controls for the 116-N-1 site are described in WCH (2009).

[e] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d) (Ecology 1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Section 2.12.1 of the 100-N Area RDR/RAWP (DOE-RL 2006b).

[f] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3], Ecology 1996) using an airborne particulate mass-loading rate of 0.0001 g/m^3 (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).

[g] Hanford Site-specific background not available. Value is Washington State background from *Natural Background Soil Metals Concentrations in Washington State* (Ecology 1994).

[h] No parameters (bioconcentration factors or AWQC values) are available from the Ecology Cleanup Levels and Risk Calculations database or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).

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

[j] Based on RESRAD modeling discussed in Appendix C of the 100-N Area RDR/RAWP (DOE-RL 2006b), the residual concentration of vanadium is not predicted to migrate vertically within 1,000 years (based on the soil-partitioning coefficient of 1,000 mL/g). The vadose zone beneath the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 combined excavation is approximately 14 m (46 ft) thick. Therefore, the residual concentration of this contaminant is predicted to be protective of groundwater and the Columbia River.

[k] Remedial action goals obtained from the 100 Area RDR/RAWP (DOE-RL 2009).

-- = not applicable
AWQC = ambient water quality criteria
BG = background
COPC = contaminant of potential concern
Ecology = Washington State Department of Ecology
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*

Table 5. Comparison of Contaminant Concentrations to Remedial Action Goals for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Excavation Deep Zone Focused Verification Samples. (2 Pages)

COPC	Maximum Result [a] (pCi/g)	Soil Lookup Values [b] (pCi/g)		Does the Result Exceed Lookup Values?	Does the Result Pass RESRAD Modeling?
		Soil Lookup Value for Groundwater Protection	Soil Lookup Value for River Protection		
Americium-241	12.5	--[c]	--[c]	--	--
Carbon-14	11.0	--[c]	--[c]	--	--
Cesium-137	35,600	1,465	1,465	Yes	Yes[d]
Cobalt-60	140	13,900	13,900	No	--
Europium-154	16.2	--[c]	--[c]	--	--
Nickel-63	95.5	83	83	Yes	Yes[d]
Plutonium-238	3.59	--[c]	--[c]	--	--
Plutonium-239/240	28.2	--[c]	--[c]	--	--
Total radiostrontium	1,100	27.6	27.6	Yes	Yes[d]
Tritium	5.43	12.6	12.6	No	--
Uranium-233/234	1.58	1.1[e]	1.1[e]	Yes	Yes[d]
Uranium-238	1.16	1.1[e]	1.1[e]	Yes	Yes[d]

COPC	Maximum Result [b] (mg/kg)	Remedial Action Goals [a] (mg/kg)			Does the Result Exceed RAGs?	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Arsenic	4.04 (<BG)	20[e]	20[e]	20[e]	No	--
Barium	86.0 (<BG)	16,000	200	400	No	--
Beryllium	0.254 (<BG)	10.4[f]	1.51[e]	1.51[e]	No	--
Cadmium[g]	0.192 (<BG)	13.9[f]	0.81[e]	0.81[e]	No	--
Chromium	23.4	120,000	18.5[e]	18.5[e]	Yes	Yes[h]
Cobalt	10.0 (<BG)	1,600	32	--[i]	No	--
Copper	17.7 (<BG)	2,960	59.2	22.0[e]	No	--
Hexavalent chromium[j]	1.64	2.1	4.8	2	No	--
Lead	5.17 (<BG)	353	10.2[e]	10.2[e]	No	--
Manganese	418 (<BG)	11,200	512[e]	--[i]	No	--
Mercury	0.0168 (<BG)	24	0.33[e]	0.33[e]	No	--
Molybdenum[j]	0.847	400	8	--[i]	No	--
Nickel	7.75 (<BG)	1,600	19.1[e]	27.4	No	--

Table 5. Comparison of Contaminant Concentrations to Remedial Action Goals for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Excavation Deep Zone Focused Verification Samples. (2 Pages)

COPC	Maximum Result [b] (mg/kg)	Remedial Action Goals [a] (mg/kg)			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		
Vanadium	101	560	85.1 [e]	-- [i]	Yes	Yes [h]
Zinc	71.1	24,000	480	67.8 [e]	Yes	Yes [h]
Nitrogen in nitrite and nitrate [k]	1.67 (<BG)	128,000	1,000	2,000	No	--

[a] Maximum result as described in the *UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations* (Appendix B).

[b] Lookup values and remedial action goals obtained from the 100-N Area RDR/RAWP (DOE-RL 2006b), unless noted otherwise.

[c] No value; because the distribution coefficient (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] The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 remediation encountered residual contamination that was left in-place in the deep zone with an approved waste site reclassification of interim closed out for 116-N-1 (WCH 2009). The residual contamination is part of the 116-N-1 waste site and is not part of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites. RAG attainment and associated institutional controls for the 116-N-1 site are described in WCH (2009). Uranium isotopes were not considered contaminants of concern for the 116-N-1 site. All focused sample results for uranium-238 and four of five focused sample results for uranium-233/234 are within the range of site background. One uranium-233/234 result slightly exceeds the range of background, but is not significant relative to the residual activities of other radionuclides and institutional controls applied to the 116-N-1 waste site.

[e] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d) (Ecology 1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Section 2.12.1 of the 100-N Area RDR/RAWP (DOE-RL 2006b).

[f] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3], Ecology 1996) using an airborne particulate mass-loading rate of 0.0001 g/m^3 (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).

[g] Hanford Site-specific background not available. Value is Washington State background from *Natural Background Soil Metals Concentrations in Washington State* (Ecology 1994).

[h] Based on RESRAD modeling discussed in Appendix C of the 100-N Area RDR/RAWP (DOE-RL 2006b), the residual concentrations of chromium, vanadium, and zinc are predicted to migrate less than 1.8 m (5.9 ft) vertically within 1,000 years (based on the lowest soil-partitioning coefficient of the contaminants [zinc] of 30 mL/g]). The vadose zone beneath the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 excavation is approximately 14 m (46 ft) thick. Therefore, the residual concentrations of these contaminants are predicted to be protective of groundwater and the Columbia River.

[i] No parameters (bioconcentration factors or AWQC values) are available from the Ecology Cleanup Levels and Risk Calculations database or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).

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

[k] Remedial action goals obtained from the 100 Area RDR/RAWP (DOE-RL 2009).

-- = not applicable
AWQC = ambient water quality criteria
BG = background
COPC = contaminant of potential concern
Ecology = Washington State Department of Ecology
RAG = remedial action goal
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RESRAD = RESidual RADioactivity (dose model)
UCL = upper confidence limit
WAC = *Washington Administrative Code*

Attainment of Nonradionuclide RAGS

Table 3 compares the shallow zone excavation cleanup verification sampling values to the applicable soil RAGs for direct exposure, protection of groundwater, and protection of the Columbia River. Evaluation of the results indicates that residual concentrations of all COPCs are below the direct exposure, groundwater, and/or river protection soil RAGs.

Tables 4 and 5 compare the deep zone excavation cleanup verification sampling and focused sample values to the applicable soil RAGs for protection of groundwater and protection of the Columbia River. Evaluation of the results indicates that all nonradiological COPCs were quantified below groundwater and/or river protection soil RAGs with the exception of total

chromium, vanadium, and zinc. However, given the lowest soil-partitioning coefficient of these contaminants (zinc) of 30 mL/g , none would be expected to migrate more than 1.8 m (5.9 ft) vertically in 1,000 years based on RESidual RADioactivity (RESRAD) modeling discussed in Appendix C of the 100-N Area RDR/RAWP (DOE-RL 2006b). The vadose zone beneath the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 combined excavations is approximately 14 m (46 ft) thick. Based on RESRAD modeling, constituents with a soil-partitioning coefficient of 4.6 mL/g or greater are not predicted to migrate through a vadose zone of this thickness and reach groundwater in 1,000 years. Therefore, residual concentrations of chromium, vanadium, and zinc are predicted to be protective of groundwater (and thus the Columbia River).

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 UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites combined excavation is included in the 95% UCL 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 vanadium, which fails two parts of the three-part test to be protective of groundwater and the Columbia River. However, based on RESRAD modeling discussed in Appendix C of the 100-N Area RDR/RAWP (DOE-RL 2006b), the residual concentration of vanadium is not predicted to migrate vertically within 1,000 years (based on the soil-partitioning coefficient [K_d] of 1,000 mL/g). The vadose zone beneath the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 combined excavations is approximately 14 m (46 ft) thick. Therefore, the residual concentration of vanadium is predicted to be protective of groundwater and the Columbia River.

An additional application of the three-part test is included for the statistical data sets that default to the maximum because less than half of the data set was detected. The results of this evaluation indicate that all COPC concentrations pass the three-part test in comparison against applicable RAGs

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 UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites, 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 1.6×10^{-3}. The individual carcinogenic risk value for hexavalent chromium, the only constituent that met the requirements for evaluation, is

1.8×10^{-7}, which is less than 1×10^{-6}, and the cumulative carcinogenic risk is less than 1×10^{-5}. The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites meet the requirements for the direct contact hazard quotient and excess carcinogenic risk as identified in the 100-N Area RDR/RAWP (DOE-RL 2006b).

Nonradionuclide Groundwater Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites included calculation of the hazard quotient and carcinogenic (excess cancer) risk values for groundwater protection for nonradionuclides. The requirements include an individual and cumulative hazard quotient of less than 1.0, an individual excess carcinogenic risk of less than 1×10^{-6}, and a cumulative excess carcinogenic risk of less than 1×10^{-5}. 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 soil-partitioning coefficients for these contaminants must be 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-N Area RDR/RAWP (DOE-RL 2006b). Based on this model and a vadose zone of approximately 14 m (46 ft) in thickness, a soil-partitioning coefficient (K_d) of 5.3 or greater is required to show no predicted migration to groundwater in 1,000 years. All individual hazard quotients for noncarcinogenic constituents are less than 1.0. The cumulative hazard quotient for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites is 8.2×10^{-2}, which is less than 1.0. No carcinogenic soil constituents met the criteria for groundwater protection evaluation at the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites; therefore, no calculations of excess carcinogenic risk were performed. Therefore, nonradionuclide risk requirements related to groundwater are met.

Attainment of Radionuclide RAGs

Evaluation of the radionuclide cleanup verification results (Table 3) indicates that all samples were below direct exposure lookup values in the shallow zone. Evaluation of direct exposure RAG attainment for radionuclides was performed using the single-radionuclide dose-equivalence lookup values to do sum-of-fractions evaluations. The model used to develop these dose-equivalence lookup values is presented in the 100-N Area RDR/RAWP (DOE-RL 2006b). Table 6 compares the radionuclide cleanup verification results from the shallow zone excavation soil samples 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 columns on the left side of the table are the COPCs and the 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. As demonstrated by the summation of the fractions for the shallow zone decision unit, the maximum cumulative dose values contributed by the residual radionuclide populations are predicted to be less than the RAG of 15 mrem/yr above background. The cumulative dose rate for the waste site shallow zone is predicted to be 6.42 mrem/yr.

Table 6. Attainment of Radionuclide Direct Exposure Remedial Action Goals.

COPC	95% UCL Statistical or Maximum Values[a] (pCi/g)	Activity Equivalent to 15 mrem/yr Dose[b] (pCi/g)	Fraction
	Excavation Shallow Zone		Excavation Shallow Zone
Carbon-14	1.53	8.69	0.176
Cesium-137	0.875	6.2	0.141
Cobalt-60	0.149	1.4	0.106
Plutonium-239/240	0.173	33.9	0.005
Uranium-233/234	0 (<BG)	0.57	0
Uranium-238	0 (<BG)	0.61	0
		Total	0.428
		Equivalent Dose (mrem/yr)	6.42

[a] Hanford Site background values for uranium-233/234 (1.1 pCi/g) and uranium-238 (1.1 pCi/g) (*Hanford Site Background: Part 2, Soil Background for Radionuclides* [DOE-RL 1996]) have been subtracted from 95% UCL values.

[a] Single radionuclide 15 mrem/yr dose-equivalence values and derivation methodology are presented in the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (DOE-RL 2006b).

BG = background
COPC= contaminant of potential concern
UCL = upper confidence limit

Elevated radionuclide contamination is present in a portion of the deep zone area of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 remediation. As previously described, this is considered part of the 116-N-1 site. RAG attainment and associated specific institutional controls for the 116-N-1 site have been addressed separately in WCH (2009).

DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the verification sampling approach (WCH 2012b), the field logbooks (WCH 2012a, 2013a), and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications.

The DQA for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites established that the data are of the right type, quality, and quantity to support site closeout decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. The cleanup verification sample analytical data are stored in the ENRE project-specific database for data evaluation prior to archival in the HEIS and are summarized in Appendix C.

SUMMARY FOR INTERIM CLOSURE

The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites have been evaluated in accordance with the 100-N Area ROD (EPA 1999) and the 100-N Area RDR/RAWP (DOE-RL 2006b). Verification sampling was performed, and the analytical results indicate that residual concentrations of nonradiological COPCs at the site meet the RAOs for direct exposure, groundwater protection, and river protection.

In accordance with this evaluation, the verification sampling and modeling results support a reclassification of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites to Interim Closed Out. The radionuclide and hexavalent chromium results of deep zone verification sampling from the combined unplanned release sites are consistent with residual deep contamination at the 116-N-1 crib; therefore, the deep zone of the UPR-100-N-4, UPR-100-N-8, UPR-100-N-31 unplanned release sites is reclassified as Interim Closed Out on the basis that soils associated with the unplanned releases have been removed and remediation has encountered a separate waste site. Institutional controls for deep zone contamination in the 116-N-1 site are addressed separately in WCH (2009).

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APPENDIX A

ECOLOGICAL RISK COMPARISON TABLE

Table A-1. Maximum Contaminant Concentrations that Exceed Ecological Screening Levels for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites [a].

Hazardous Substance		2001 WAC 173-340 Table 749-3			EPA Ecological Soil Screening Levels [b]				Maximum Result
		Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian [c]	Mammalian [c]	
	Background	Metals (mg/kg)							
Boron	NA	0.5	NA	NA	NA	NA	NA	NA	1.69
Manganese	512	1,100 [d]	NA	1,500	220	450	4,300	4,000	418 (<BG)
Vanadium	85.1	2	NA	NA	NA	NA	7.8	280	101
Zinc	67.8	86 [d]	200	360	160	120	46	79	71.1

NOTE: Shaded cells indicate screening values that are exceeded.

[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] 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.

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

APPENDIX B

CALCULATIONS

APPENDIX B

CALCULATION BRIEF

The calculations provided in this appendix are copies of originals that are kept in the active Washington Closure Hanford project files and are available upon request. When the project is completed, the file will be stored in a U.S. Department of Energy, Richland Operations Office, repository. These calculations has 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:

UPR-100-N-4, UPR-100-N-8, UPR-100-N-31 Cleanup Verification 95% UCL Calculations, 0100N-CA-V0192, Rev. 0, Washington Closure Hanford, Richland, Washington.

UPR-100-N-4, UPR-100-N-8, UPR-100-N-31 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, 0100N-CA-V0193, Rev. 0, Washington Closure Hanford, Richland, Washington.

UPR-100-N-4, UPR-100-N-8, UPR-100-N-31 Waste Sites Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater, 0100N-CA-V0203, Rev. 0, Washington Closure Hanford, Richland, Washington.

DISCLAIMER FOR CALCULATIONS

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

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 100-N Field Remediation **Job No. 14655**

Area: 100-N

Discipline: Environmental *Calculation No: 0100N-CA-V0192

Subject: UPR-100-N-4, UPR-100-N-8, UPR-100-N-31 Cleanup Verification 95% UCL Calculation

Computer Program: Excel Program No: Excel 2003

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 20 Attm. 1 = 14 Total = 35	N. K. Schiffern N.K. Schiffern	C. H. Dobie CH Dobie	J. D. Skoglie	D. F. Obenauer D.F. Obenauer	8/15/13

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	N. K. Schiffern NS	**Date**	03/26/13	**Calc. No.**	0100N-CA-V0192	**Rev. No.**	0
Project	100-N Field Remediation	**Job No.**	14655	**Checked**	C. H. Dobie CD	**Date**	03/26/13
Subject	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations					**Sheet No.**	1 of 20

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 5 - Calculation Sheet Summary
Sheet 6 to 14 - Calculation Sheet Verification Data - shallow zone and deep zone.
Sheet 15 to 18 - Ecology Software (MTCAStat) Results
Sheet 19 to 20 - Calculation Sheet Duplicate Analysis
Attachment 1 - UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites Verification Sampling Results (14 sheets)

Given/References:

1) Sample Results (Attachment 1).
2) DOE-RL, 2006a, 100-N Area Sampling and Analysis Plan for CERCLA Waste Sites, DOE/RL-2005-92, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) DOE-RL, 2006b, Remedial Design Report/Remedial Action Work Plan for the 100-N Area, DOE/RL-2005-93, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) Ecology, 1992, Statistical Guidance for Ecology Site Managers, Publication #92-54, Washington Department of Ecology, Olympia, Washington.
5) Ecology, 1993, Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-detection Limit or Below-PQL Values (Censored Data Sets), Publication #92-54, Washington Department of Ecology, Olympia, Washington.
6) Ecology, 2011, Cleanup Levels and Risk Calculations (CLARC) Database, Washington State Department of Ecology, Olympia, Washington, <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.
7) EPA, 1989, Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual, Part A; Interim Final, EPA/540/1-89/002, U.S. Environmental Protection Agency, Washington, D. C.
8) 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 2006b). 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 UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites. The data were entered into an EXCEL 2003 spreadsheet and calculations performed by using the built in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2006b) is documented by this calculation. Duplicate RPD results are used in evaluation of data quality within the RSVP for this site.

Methodology:

The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites underwent statistical sampling at two decision units for verification sampling consisting of a shallow zone decision unit and deep zone decision unit . Also taken were four focused samples from the deep zone excavation area. Sample Location SZ-8 was eliminated from the shallow zone decision unit, and is treated as a focused sample from the deep zone decision unit as discussed in the RSVP for this site.

Analytical results for all sampling locations are summarized in the tables provided on sheets 4 and 5. 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 N. K. Schiffern Date 03/25/13 Calc. No. 0100N-CA-V0192 Rev. No. 0
Project 100-N Field Remediation Job No. 14655 Checked C. H. Dobie Date 03/25/13
Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations Sheet No. 2 of 20

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 (2011) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance for Superfund* (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 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 2006b) 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 COC/COPC,
2) greater than 10% of the raw data exceed the most stringent cleanup limit for each COC/COPC,
3) the maximum value of the raw data set exceeds two times the most stringent cleanup limit for each COC/COPC.

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 2006a) 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	N. K. Schiffern NS	**Date**	03/25/13	**Calc. No.**	0100N-CA-V0192	**Rev. No.**	0
Project	100-N Field Remediation	**Job No.**	14655	**Checked**	C. H. Dobie CD	**Date**	03/25/13
Subject	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations					**Sheet No.**	3 of 20

Summary (continued)

QUALIFIER LIST

B = estimate
J = estimate
M = sample duplicate precision not met.
N = recovery exceeds upper and lower control limit.
R = rejected
U = undetected
X = serial dilution in the analytical batch indicates that physical and chemical interferences are present (metals).

ACRONYM LIST

-- = not applicable
DE = direct exposure
DZ = deep zone decision unit
GW = groundwater
MTCA = *Model Toxics Control Act*
NA = not applicable
P = >40 % difference for detected concentrations between the two GC columns; the lower value is reported.
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
SZ = shallow zone decision unit
TDL = target detection limit
UCL = upper confidence limit
WAC = Washington Administrative Code

Washington Closure Hanford **CALCULATION SHEET**

Originator	N. K. Schiffern NS	**Date**	05/09/13	**Calc. No.**	0100N-CA-V0192	**Rev. No.**	0
Project	100-N Field Remediatior	**Job No.**	14655	**Checked**	C. H. Dobie CD	**Date**	05/09/13
Subject	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations					**Sheet No.**	4 of 20

Summary (continued)

Results:
The results presented in the tables that follow include the summary of the results of the 95% UCL calculations for the shallow zone, deep zone, focused samples, 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 these sites.

Results Summary - UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites

Analyte	Shallow Zone		Deep Zone		Focused [a]	Unit
	95% UCL Result	Maximum Result	95% UCL Result	Maximum Result		
Americium-241	--	--	2.95	--	12.5	pCi/g
Carbon-14	1.53	--	2.89	--	11.0	pCi/g
Cesium-137	0.875	--	1760	--	35600	pCi/g
Cobalt-60	0.149	--	15.0	--	140	pCi/g
Europium-154	--	--	1.13	--	16.2	pCi/g
Nickel-63	--	--	18.3	--	95.5	pCi/g
Plutonium-238	--	--	0.605	--	3.59	pCi/g
Plutonium-239/240	0.173	--	4.27	--	28.2	pCi/g
Total radiostrontium	--	--	341	--	1100	pCi/g
Tritium	--	--	2.55	--	5.43	pCi/g
Uranium-233/234	0.585	--	0.674	--	1.58	pCi/g
Uranium-238	0.517	--	0.672	--	1.16	pCi/g
Arsenic	3.00	--	1.95	--	4.04	mg/kg
Barium	59.4	--	66.1	--	86.0	mg/kg
Beryllium	0.261	--	0.243	--	0.254	mg/kg
Boron	--	1.69	--	--	--	mg/kg
Cadmium	--	--	--	0.18	0.192	mg/kg
Chromium	10.7	--	9.45	--	23.4	mg/kg
Cobalt	8.65	--	10.2	--	10.0	mg/kg
Copper	17.9	--	16.0	--	17.7	mg/kg
Hexavalent Chromium	--	0.37	--	0.61	1.64	mg/kg
Lead	6.29	--	3.08	--	5.17	mg/kg
Manganese	329	--	390	--	418	mg/kg
Mercury	--	--	--	0.0151	0.0168	mg/kg
Molybdenum	--	--	1.89	--	0.847	mg/kg
Nickel	10.2	--	9.8	--	7.75	mg/kg
Vanadium	71.2	--	91.2	--	101	mg/kg
Zinc	52.9	--	57.8	--	71.1	mg/kg
Nitrogen in Nitrite and Nitrate	3.72	--	0.64	--	1.67	mg/kg
3-Part Test Evaluation:						
95% UCL or maximum[b] > Cleanup	NO	NO	YES	NO		
> 10% above Cleanup Limit?	NO	NO	YES	NO		
Any sample > 2x Cleanup Limit?	NO	NO	NO	NO		

[a] Focused sample result include SZ-8 data as discussed under the Methodology section and the RSVP for these sites.
[b] The 95% UCL result or maximum value, depending on data censorship, as described in the methodology section.

Washington Closure Hanford **CALCULATION SHEET**

Originator	N. K. Schiffern	**Date**	03/25/13	**Calc. No.**	0100N-CA-V019	**Rev. No.**	0
Project	100-N Field Remediation	**Job No.**	14655	**Checked**	C. H. Dobie	**Date**	03/25/13
Subject	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations					**Sheet No.**	5 of 20

Summary (continued)

Results:

The results presented in the tables that follow include the summary of the results of the 95% UCL calculations for the shallow zone, deep zone, focused samples, 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 these sites.

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

Analyte	Shallow Zone		Deep Zone	
	Duplicate	Split	Duplicate	Split
Potassium-40	7.5%	--	5.9%	--
Aluminum	1.9%	12.0%	4.6%	***62.3%***
Barium	0.4%	12.5%	9.2%	14.3%
Calcium	4.0%	7.3%	10.2%	***32.7%***
Chromium	12.7%	***33.0%***	--	--
Copper	15.7%	4.1%	5.6%	***93.4%***
Iron	4.2%	11.8%	4.0%	14.2%
Magnesium	19.3%	13.9%	5.9%	***41.1%***
Manganese	5.7%	10.9%	14.3%	***46.6%***
Silicon	***73.7%***	29.7%	1.6%	***118.5%***
Sodium	2.1%	7.7%	0.5%	0.5%
Vanadium	19.9%	19.9%	8.8%	***48.8%***
Zinc	13.6%	13.6%	1.2%	4.0%

[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 N. K. Schiffern NS
Project 100-N Field Remediation
Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations

Date 03/26/13
Job No. 14655

Calc. No. 0100N-CA-V0192
Checked C. H. Dobie CD

Rev. No. 0
Date 03/26/13
Sheet No. 6 of 20

1 **UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Statistical Calculations**
2 **Verification Data - Shallow Zone (SZ)**

3	Sample	Sample	Sample	Carbon-14			Cesium-137			Cobalt-60			Plutonium-239/240			Uranium-233/234			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
5	SZ-3	J1R515	11/5/2012	1.66		0.876	0.361		0.062	0.137		0.076	0.057	U	0.217	0.539		0.242	0.412		0.242
6	Duplicate of J1R515	J1R525	11/5/2012	1.15		0.842	0.180		0.060	0.113	U	0.113	0	U	0.245	0.444		0.179	0.561		0.179
7	SZ-1	J1R513	11/5/2012	0.667	U	0.871	0.455		0.046	0.064	U	0.064	0.043	U	0.332	0.414		0.176	0.483		0.176
8	SZ-2	J1R514	11/6/2012	0.674	U	0.850	0.068	U	0.068	0.072	U	0.072	0	U	0.166	0.338		0.216	0.338		0.216
9	SZ-4	J1R516	11/6/2012	1.32		0.898	0.447		0.084	0.107	U	0.107	0.056	U	0.214	0.299		0.254	0.332		0.254
10	SZ-5	J1R517	11/5/2012	1.02		0.872	0.158		0.068	0.061	U	0.061	0.059	U	0.225	0.491		0.179	0.444		0.179
11	SZ-6	J1R518	11/5/2012	1.13		0.839	0.235		0.069	0.053		0.048	0.042	U	0.318	0.446		0.163	0.489		0.163
12	SZ-7	J1R519	11/6/2012	0.865	U	0.870	2.07		0.090	0.378		0.081	0.096	U	0.183	0.585		0.224	0.673		0.224
13	SZ-9	J1R521	11/5/2012	0.909		0.882							0.569		0.290	0.561		0.179	0.468		0.179
14	Re-sample of J1R521	J1RF76	2/12/2013				0.178		0.0284	0.0320	U	0.0345									
15	SZ-10	J1R522	11/6/2012	2.98		1.39	0.063	U	0.063	0.058	U	0.058	0	U	0.414	0.824		0.225	0.441		0.225
16	SZ-11	J1R523	11/6/2012	1.08		0.866	0.607		0.069	0.096	U	0.096	0.044	U	0.335	0.618		0.338	0.574		0.338
17	SZ-12	J1R524	11/6/2012	1.33		0.905	1.55		0.064	0.238		0.066	0.092	U	0.353	0.575		0.367	0.431		0.367

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19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Carbon-14	Cesium-137	Cobalt-60	Plutonium-239/240	Uranium-233/234	Uranium-238
21	Area	Number	Date	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
22	SZ-3	J1R515/J1R525	11/5/2012	1.41	0.271	0.097	0.029	0.492	0.487
23	SZ-1	J1R513	11/5/2012	0.667	0.455	0.032	0.043	0.414	0.483
24	SZ-2	J1R514	11/6/2012	0.674	0.034	0.036	0	0.338	0.338
25	SZ-4	J1R516	11/6/2012	1.32	0.447	0.054	0.056	0.299	0.332
26	SZ-5	J1R517	11/5/2012	1.02	0.158	0.031	0.059	0.491	0.444
27	SZ-6	J1R518	11/5/2012	1.13	0.235	0.053	0.042	0.446	0.489
28	SZ-7	J1R519	11/6/2012	0.865	2.07	0.378	0.096	0.585	0.673
29	SZ-9	J1R521	11/5/2012	0.909			0.569	0.561	0.468
30	Re-sample of J1R521	J1RF76	2/12/2013		0.178	0.032			
31	SZ-10	J1R522	11/6/2012	2.98	0.032	0.029	0	0.824	0.441
32	SZ-11	J1R523	11/6/2012	1.08	0.607	0.048	0.044	0.618	0.574
33	SZ-12	J1R524	11/6/2012	1.33	1.55	0.238	0.092	0.575	0.431

34 **Statistical Computations**

35		Carbon-14	Cesium-137	Cobalt-60	Plutonium-239/240	Uranium-233/234	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.
37	N	11	11	11	11	11	11
38	% < Detection limit	27%	18%	64%	91%	0%	0%
39	Mean	1.22	0.549	0.093	0.094	0.513	0.469
40	Standard deviation	0.636	0.659	0.112	0.161	0.145	0.096
41	Z-statistic	1.64	1.64	1.64	1.64	1.64	1.64
42	95% UCL on mean	1.53	0.875	0.149	0.173	0.585	0.517
43	Maximum value	2.98	2.07	0.378	0.569	0.824	0.673

44 Qualifiers and acronyms are defined on page 3.

Washington Closure Hanford

CALCULATION SHEET

Originator N. K. Schiffern **Date** 03/25/13 **Calc. No.** 0100N-CA-V0192 **Rev. No.** 0

Project 100-N Field Remediation **Job No.** 14655 **Checked** C. H. Dobie **Date** 03/25/13

Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations **Sheet No.** 7 of 20

UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Statistical Calculations
Verification Data - Shallow Zone (SZ)

Sample Area	Sample Number	Sample Date	Arsenic mg/kg	Arsenic Q	Arsenic PQL	Barium mg/kg	Barium Q	Barium PQL	Beryllium mg/kg	Beryllium Q	Beryllium PQL	Chromium mg/kg	Chromium Q	Chromium PQL	Cobalt mg/kg	Cobalt Q	Cobalt PQL	Copper mg/kg	Copper Q	Copper PQL	Lead mg/kg	Lead Q	Lead PQL	Manganese mg/kg	Manganese Q	Manganese PQL
SZ-3	J1R515	11/5/2012	2.72		2.46	56.1		1.23	0.213	B	0.493	10.6		0.493	8.29		4.93	19.9		2.46	5.28		1.23	309		12.3
Duplicate of J1R515	J1R525	11/5/2012	2.58	B	2.78	55.9		1.39	0.229	B	0.555	9.33		0.555	7.55		5.55	17.0		2.78	4.22		1.39	292		13.9
SZ-1	J1R513	11/5/2012	3.38		3.01	48.8		1.51	0.290	B	0.602	9.45		0.602	9.06		6.02	19.2		3.01	4.91		1.51	351		15.1
SZ-2	J1R514	11/6/2012	2.08	B	2.88	59.0		1.44	0.217	B	0.577	9.49		0.577	7.90		5.77	15.2		2.88	5.08		1.44	316		14.4
SZ-4	J1R516	11/6/2012	2.09	B	2.85	61.6		1.42	0.198	B	0.570	13.0		0.570	7.37		5.70	19.6		2.85	12.7		1.42	290		14.2
SZ-5	J1R517	11/5/2012	1.82	B	2.95	44.9		1.47	0.175	B	0.589	4.96		0.589	8.64		5.89	15.7		2.95	2.82		1.47	301		14.7
SZ-6	J1R518	11/5/2012	2.41	B	2.78	61.9		1.39	0.238	B	0.557	12.4		0.557	6.73		5.57	14.1		2.78	3.41		1.39	289		13.9
SZ-7	J1R519	11/6/2012	2.22	B	2.71	63.9		1.36	0.242	B	0.543	9.55		0.543	8.85		5.43	16.1		2.71	4.00		1.36	333		13.6
SZ-9	J1R521	11/5/2012	2.89		2.86	51.9		1.43	0.259	B	0.572	7.12		0.572	7.68		5.72	15.7		2.86	4.17		1.43	288		14.3
SZ-10	J1R522	11/6/2012	3.64		2.87	52.6		1.44	0.242	B	0.575	10.5		0.575	7.10		5.75	16.6		2.87	4.10		1.44	310		14.4
SZ-11	J1R523	11/6/2012	2.84		2.50	54.7		1.25	0.264	B	0.500	9.56		0.500	8.41		5.00	17.2		2.50	4.38		1.25	323		12.5
SZ-12	J1R524	11/6/2012	2.95		2.85	58.4		1.43	0.279	B	0.571	7.99		0.571	9.67		5.71	17.8		2.85	4.47		1.43	363		14.3

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Arsenic mg/kg	Barium mg/kg	Beryllium mg/kg	Chromium mg/kg	Cobalt mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg
SZ-3	J1R515/J1R525	11/5/2012	2.65	56.0	0.221	9.97	7.92	18.5	4.75	301
SZ-1	J1R513	11/5/2012	3.38	48.8	0.290	9.45	9.06	19.2	4.91	351
SZ-2	J1R514	11/6/2012	2.08	59.0	0.217	9.49	7.90	15.2	5.08	316
SZ-4	J1R516	11/6/2012	2.09	61.6	0.198	13.0	7.37	19.6	12.7	290
SZ-5	J1R517	11/5/2012	1.82	44.9	0.175	4.96	8.64	15.7	2.82	301
SZ-6	J1R518	11/5/2012	2.41	61.9	0.238	12.4	6.73	14.1	3.41	289
SZ-7	J1R519	11/6/2012	2.22	63.9	0.242	9.55	8.85	16.1	4.00	333
SZ-9	J1R521	11/5/2012	2.89	51.9	0.259	7.12	7.68	15.7	4.17	288
SZ-10	J1R522	11/6/2012	3.64	52.6	0.242	10.5	7.10	16.6	4.10	310
SZ-11	J1R523	11/6/2012	2.84	54.7	0.264	9.56	8.41	17.2	4.38	323
SZ-12	J1R524	11/6/2012	2.95	58.4	0.279	7.99	9.67	17.8	4.47	363

Statistical Computations

	Arsenic	Barium	Beryllium	Chromium	Cobalt	Copper	Lead	Manganese
95% UCL based on	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), 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.
N	11	11	11	11	11	11	11	11
% < Detection limit	0%	0%	0%	0%	0%	0%	0%	0%
Mean	2.63	55.8	0.239	9.45	8.12	16.9	4.98	315
Standard deviation	0.571	5.90	0.0344	2.25	0.894	1.74	2.64	25.4
95% UCL on mean	3.00	59.4	0.261	10.7	8.65	17.9	6.29	329
Maximum value	3.64	63.9	0.290	13.0	9.67	19.9	12.7	363
Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)	20 DE, GW & River Protection	200 GW Protection	1.51 GW & River Protection	18.5 GW & River Protection	32 GW Protection	22.0 River Protection	10.2 GW & River Protection	512 GW Protection
WAC 173-340 3-PART TEST								
95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA	NA	NO	NA
> 10% above Cleanup Limit?	NA	NA	NA	NA	NA	NA	NO	NA
Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA	NA	NO	NA
WAC 173-340 Compliance?	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 (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.	Because all values are below background (512 mg/kg) the WAC 173-340 3-part test is not required.

Qualifiers and acronyms are defined on page 3.

Washington Closure Hanford

CALCULATION SHEET

Originator N. K. Schiffern **Date** 03/25/13 **Calc. No.** 0100N-CA-V0192 **Rev. No.** 0

Project 100-N Field Remediation **Job No.** 14655 **Checked** C. H. Dobie **Date** 03/25/13

Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations **Sheet No.** 8 of 20

UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Statistical Calculations

Verification Data - Shallow Zone (SZ)

1	Sample	Sample	Sample	Nickel			Vanadium			Zinc			Nitrogen in Nitrite and Nitrate		
2	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
3	SZ-3	J1R515	11/5/2012	12.9		9.86	64.2		6.16	47.1		24.6	0.17	B	0.10
4	Duplicate of J1R515	J1R525	11/5/2012	9.23	B	11.1	68.6		6.94	46.9		27.8	0.39	B	0.10
5	SZ-1	J1R513	11/5/2012	10.4	B	12.0	72.4		7.53	52.1		30.1	0.79		0.10
6	SZ-2	J1R514	11/6/2012	8.52	B	11.5	66.1		7.21	46.0		28.8	2.49		0.10
7	SZ-4	J1R516	11/6/2012	9.16	B	11.4	61.9		7.12	68.4		28.5	1.81		0.10
8	SZ-5	J1R517	11/5/2012	6.44	B	11.8	70.8		7.36	46.4		29.5	0.47		0.09
9	SZ-6	J1R518	11/5/2012	10.8	B	11.1	58.7		6.96	41.1		27.8	0.90		0.10
10	SZ-7	J1R519	11/6/2012	8.60	B	10.9	73.2		6.79	51.4		27.1	1.21		0.10
11	SZ-9	J1R521	11/5/2012	8.54	B	11.4	63.8		7.15	44.6		28.6	1.23		0.10
12	SZ-10	J1R522	11/6/2012	9.85	B	11.5	58.9		7.19	40.8		28.7	0.30	B	0.10
13	SZ-11	J1R523	11/6/2012	10.9		10.0	63.2		6.25	48.2		25.0	0.41	B	0.10
14	SZ-12	J1R524	11/6/2012	9.65	B	11.4	82.7		7.13	54.0		28.5	6.81		0.10

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16 **Statistical Computation Input Data**

17	Sample	Sample	Sample	Nickel			Vanadium			Zinc			Nitrogen in Nitrite and Nitrate		
18	Area	Number	Date	mg/kg			mg/kg			mg/kg			mg/kg		
19	SZ-3	J1R515/J1R525	11/5/2012	11.1			66.4			47.0			0.28		
20	SZ-1	J1R513	11/5/2012	10.4			72.4			52.1			0.79		
21	SZ-2	J1R514	11/6/2012	8.52			66.1			46.0			2.49		
22	SZ-4	J1R516	11/6/2012	9.16			61.9			68.4			1.81		
23	SZ-5	J1R517	11/5/2012	6.44			70.8			46.4			0.47		
24	SZ-6	J1R518	11/5/2012	10.8			58.7			41.1			0.90		
25	SZ-7	J1R519	11/6/2012	8.60			73.2			51.4			1.21		
26	SZ-9	J1R521	11/5/2012	8.54			63.8			44.6			1.23		
27	SZ-10	J1R522	11/6/2012	9.85			58.9			40.8			0.30		
28	SZ-11	J1R523	11/6/2012	10.9			63.2			48.2			0.41		
29	SZ-12	J1R524	11/6/2012	9.65			82.7			54.0			6.81		

30 **Statistical Computations**

31		Nickel			Vanadium			Zinc			Nitrogen in Nitrite and Nitrate		
32	95% UCL based on	Large data set (n ≥ 10), use MTCAStat normal 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.		
33	N	11			11			11			11		
34	% < Detection limit	0%			0%			0%			0%		
35	Mean	9.45			67.1			49.1			1.52		
36	Standard deviation	1.39			7.17			7.66			1.88		
37	95% UCL on mean	10.2			71.2			52.9			3.72		
38	Maximum value	12.9			82.7			68.4			6.81		
39	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg) unless stated otherwise noted**	19.1	GW Protection		85.1	GW Protection		67.8	River Protection		1000	GW Protection	
40	**WAC 173-340 3-PART TEST**												
41	95% UCL > Cleanup Limit?	NA			NA			NO			NA		
42	> 10% above Cleanup Limit?	NA			NA			NO			NA		
43	Any sample > 2X Cleanup Limit?	NA			NA			NO			NA		
44	**WAC 173-340 Compliance?**	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.			The data set meets the 3-part test criteria when compared to the most stringent RAG.			Because all values are below background (11.8 mg/kg) the WAC 173-340 3-part test is not required.		

45 Qualifiers and acronyms are defined on page 3.

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CALCULATION SHEET

Washington Closure Hanford

Originator	N. K. Schiffern	**Date**	03/25/13	**Calc. No.**	0100N-CA-V0192
Project	100-N Field Remediation	**Job No.**	14655	**Checked**	C. H. Dobie
Subject	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations				

Rev. No. 0
Date 03/25/13
Sheet No. 9 of 20

1 **UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Maximum Calculations**
2 **Verification Data - Shallow Zone (SZ)**

3	Sample	Sample	Sample	Boron			Hexavalent Chromium		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL
5	SZ-3	J1R515	11/5/2012	4.93	U	4.93	0.21	U	0.21
6	Duplicate of J1R515	J1R525	11/5/2012	5.55	U	5.55	0.21	U	0.21
7	SZ-1	J1R513	11/5/2012	1.69	B	6.02	0.21	U	0.21
8	SZ-2	J1R514	11/6/2012	5.77	U	5.77	0.21	U	0.21
9	SZ-4	J1R516	11/6/2012	5.70	U	5.70	0.37	B	0.21
10	SZ-5	J1R517	11/5/2012	5.89	U	5.89	0.21	U	0.21
11	SZ-6	J1R518	11/5/2012	5.57	U	5.57	0.21	U	0.21
12	SZ-7	J1R519	11/6/2012	5.43	U	5.43	0.21	U	0.21
13	SZ-9	J1R521	11/5/2012	5.72	U	5.72	0.21	U	0.21
14	SZ-10	J1R522	11/6/2012	5.75	U	5.75	0.21	U	0.21
15	SZ-11	J1R523	11/6/2012	5.00	U	5.00	0.21	U	0.21
16	SZ-12	J1R524	11/6/2012	5.71	U	5.71	0.21	U	0.21

17 **Statistical Computation Input Data**

18		Boron			Hexavalent Chromium		
19	% < Detection limit	91%			91%		
20	Maximum value	1.69			0.37		
21	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	320	GW Protection		2	River Protection	
22	**3-PART TEST**						
23	Maximum > Cleanup Limit?	NO			NO		
24	> 10% above Cleanup Limit?	NO			NO		
25	Any sample > 2X Cleanup Limit?	NO			NO		
26	**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.		

27 Qualifiers and acronyms are defined on page 3.
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CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern NS
Project 100-N Field Remediation
Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations

Date 03/26/13
Job No. 14655

Calc. No. 0100N-CA-V0192
Checked C. H. Dobie CD

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Sheet No. 10 of 20

1 **UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Statistical Calculations**
2 **Verification Data - Deep Zone (DZ)**

3 Sample Area	Sample Number	Sample Date	Americium-241			Cesium-137			Carbon-14			Cobalt-60			Europium-154			Nickel-63			Plutonium-238			Plutonium-239/240		
4			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	pCi/g	Q	MDA
5 DZ-1	J1R2V0	10/10/2012	0.081	U	0.081	0.076		0.020	0.579	UJ	0.801	0.028	U	0.028	0.055	U	0.055	1.14	U	3.00	0.005	U	0.045	0.003	U	0.028
6 Duplicate of J1R2V0	J1R2W1	10/10/2012	0.139	U	0.139	0.184		0.024	3.33	J	1.14	0.025	U	0.025	0.072	U	0.072	2.11	U	3.17	0.026	U	0.050	0.011	U	0.036
7 DZ-2	J1R2V1	10/10/2012	0.040	U	0.040	0.421		0.032	0.940	J	0.798	0.066		0.041	0.099	U	0.099	1.07	U	3.03	-0.003	U	0.036	0.036		0.025
8 DZ-3	J1R2V2	10/10/2012	0.102	U	0.102	0.200		0.030	0.908	J	0.806	0.063	U	0.063	0.099	U	0.099	2.29	U	2.96	0.021	U	0.054	0.025	U	0.027
9 DZ-4	J1R2V3	10/10/2012	0.336	U	0.336	0.220		0.044	1.34	J	0.823	0.046	U	0.046	0.135	U	0.135	4.29		3.04	0.004	U	0.049	0.040		0.028
10 DZ-5	J1R2V4	10/10/2012	0.037	U	0.037	0.093		0.022	0.567	UJ	0.800	0.020	U	0.020	0.064	U	0.064	0.442	U	2.96	-0.003	U	0.045	0	U	0.034
11 DZ-6	J1R2V5	10/10/2012	0.162	U	0.162	0.651		0.034	1.14	J	0.819	0.049	U	0.049	0.090	U	0.090	1.40	U	2.96	0.009	U	0.046	0.021	U	0.033
12 DZ-7	J1R2V6	10/10/2012	0.663		0.400	127		0.112	3.56	J	0.930	5.37		0.049	0.323		0.121	9.47		2.84	0.244		0.043	1.88		0.020
13 DZ-8	J1R2W6	10/10/2012	19.7	U	19.7	3760		5.39	6.34		0.930	44.7		1.44	4.41	U	4.41	64.0		3.01	0.955		0.046	7.97		0.029
14 DZ-9	J1R2V7	10/10/2012	0.163	U	0.163	4.17		0.069	1.14	J	0.818	0.067	U	0.067	0.162	U	0.162	0.559	U	2.94	0.009	U	0.053	0.012	U	0.032
15 DZ-10	J1R2V8	10/10/2012	0.053	U	0.053	11.6		0.052	1.12	J	0.805	0.337		0.032	0.103	U	0.103	1.92	U	3.14	0.043	U	0.073	0.186		0.037
16 DZ-11	J1R2V9	10/10/2012	2.44	U	2.44	115		0.660	2.36		0.863	2.30		0.561	1.36	U	1.36	2.36	U	3.22	0.092		0.046	0.529		0.024
17 DZ-12	J1R2W8	10/10/2012	5.60		3.92	6000		6.56	3.67		0.952	37.2		1.08	3.56		2.52	25.1		3.07	2.17		0.057	14.6		0.036

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19 **Statistical Computation Input Data**

20 Sample Area	Sample Number	Sample Date	Americium-241			Cesium-137			Carbon-14			Cobalt-60			Europium-154			Nickel-63			Plutonium-238			Plutonium-239/240		
21			pCi/g			pCi/g			pCi/g			pCi/g			pCi/g			pCi/g			pCi/g			pCi/g		
22 DZ-1	J1R2V0/J1R2W1	10/10/2012	0.055			0.130			1.95			0.013			0.032			1.63			0.016			0.007		
23 DZ-2	J1R2V1	10/10/2012	0.020			0.421			0.940			0.066			0.050			1.07			-0.003			0.036		
24 DZ-3	J1R2V2	10/10/2012	0.051			0.200			0.908			0.032			0.050			2.29			0.021			0.025		
25 DZ-4	J1R2V3	10/10/2012	0.168			0.220			1.34			0.023			0.068			4.29			0.004			0.040		
26 DZ-5	J1R2V4	10/10/2012	0.019			0.093			0.567			0.010			0.032			0.442			-0.003			0		
27 DZ-6	J1R2V5	10/10/2012	0.081			0.651			1.14			0.025			0.045			1.40			0.009			0.021		
28 DZ-7	J1R2V6	10/10/2012	0.663			127			3.56			5.37			0.323			9.47			0.244			1.88		
29 DZ-8	J1R2W6	10/10/2012	9.85			3760			6.34			44.7			2.21			64.0			0.955			7.97		
30 DZ-9	J1R2V7	10/10/2012	0.082			4.17			1.14			0.034			0.081			0.559			0.009			0.012		
31 DZ-10	J1R2V8	10/10/2012	0.027			11.6			1.12			0.337			0.052			1.92			0.043			0.186		
32 DZ-11	J1R2V9	10/10/2012	1.22			115			2.36			2.30			0.680			2.36			0.092			0.529		
33 DZ-12	J1R2W8	10/10/2012	5.60			6000			3.67			37.2			3.56			25.1			2.17			14.6		

34 **Statistical Computations**

35	Americium-241			Cesium-137			Carbon-14			Cobalt-60			Europium-154			Nickel-63			Plutonium-238			Plutonium-239/240		
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.			Radionuclide data set. Use nonparametric z-statistic.		
37 N	12			12			12			12			12			12			12			12		
38 % < Detection limit	83%			0%			8%			50%			83%			67%			67%			42%		
39 Mean	1.49			835			2.09			7.51			0.598			9.54			0.296			2.11		
40 Standard deviation	3.07			1949			1.68			15.8			1.12			18.5			0.649			4.54		
41 Z-statistic	1.64			1.64			1.64			1.64			1.64			1.64			1.64			1.64		
42 95% UCL on mean	2.95			1761			2.89			15.0			1.13			18.3			0.605			4.27		
43 Maximum value	5.60			6000			6.34			44.7			3.56			64.0			2.17			14.6		

44 Qualifiers and acronyms are defined on page 3.

CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern NS
Project 100-N Field Remediation
Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations

Date 03/26/13
Job No. 14655

Calc. No. 0100N-CA-V0192
Checked C. H. Dobie CD

Rev. No. 0
Date 03/26/13
Sheet No. 11 of 20

1 **UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Statistical Calculations**
2 **Verification Data - Deep Zone (DZ)**

3	Sample	Sample	Sample	Total radiostrontium			Tritium			Uranium-233/234			Uranium-238		
4	Area	Number	Date	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
5	DZ-1	J1R2V0	10/10/2012	0.231		0.199	1.52	UJ	3.29	0.534		0.227	0.564		0.227
6	Duplicate of J1R2V0	J1R2W1	10/10/2012	0.052	U	0.290	3.36	J	2.66	0.418		0.246	0.322		0.246
7	DZ-2	J1R2V1	10/10/2012	0.206	U	0.267	0.226	UJ	3.30	0.523		0.200	0.706		0.200
8	DZ-3	J1R2V2	10/10/2012	0.018	U	0.281	1.16	UJ	3.37	0.937		0.199	0.963		0.199
9	DZ-4	J1R2V3	10/10/2012	0.466		0.223	0.771	UJ	3.46	0.507		0.228	0.657		0.228
10	DZ-5	J1R2V4	10/10/2012	0.192	U	0.231	1.28	UJ	3.41	0.682		0.227	0.475		0.227
11	DZ-6	J1R2V5	10/10/2012	0.068	U	0.283	1.38	UJ	4.24	0.788		0.215	0.535		0.215
12	DZ-7	J1R2V6	10/10/2012	11.5		0.214	7.24	J	2.63	0.492		0.188	0.713		0.188
13	DZ-8	J1R2W6	10/10/2012	796		0.368	2.30	U	3.42	0.513		0.178	0.490		0.178
14	DZ-9	J1R2V7	10/10/2012	0.733		0.252	0.231	UJ	3.38	0.562		0.205	0.562		0.205
15	DZ-10	J1R2V8	10/10/2012	1.30		0.241	0.055	UJ	3.19	0.470		0.189	0.494		0.189
16	DZ-11	J1R2V9	10/10/2012	931		0.359	1.90	UJ	3.37	0.619		0.182	0.523		0.182
17	DZ-12	J1R2W8	10/10/2012	403		0.332	0.502	U	3.61	0.693		0.183	0.669		0.183

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19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Total radiostrontium			Tritium			Uranium-233/234			Uranium-238		
21	Area	Number	Date	pCi/g			pCi/g			pCi/g			pCi/g		
22	DZ-1	J1R2V0/J1R2W1	10/10/2012	0.142			2.44			0.476			0.443		
23	DZ-2	J1R2V1	10/10/2012	0.206			0.226			0.523			0.706		
24	DZ-3	J1R2V2	10/10/2012	0.018			1.16			0.937			0.963		
25	DZ-4	J1R2V3	10/10/2012	0.466			0.771			0.507			0.657		
26	DZ-5	J1R2V4	10/10/2012	0.192			1.28			0.682			0.475		
27	DZ-6	J1R2V5	10/10/2012	0.068			1.38			0.788			0.535		
28	DZ-7	J1R2V6	10/10/2012	11.5			7.24			0.492			0.713		
29	DZ-8	J1R2W6	10/10/2012	796			2.30			0.513			0.490		
30	DZ-9	J1R2V7	10/10/2012	0.733			0.231			0.562			0.562		
31	DZ-10	J1R2V8	10/10/2012	1.30			0.055			0.470			0.494		
32	DZ-11	J1R2V9	10/10/2012	931			1.90			0.619			0.523		
33	DZ-12	J1R2W8	10/10/2012	403			0.502			0.693			0.669		

34 **Statistical Computations**

35		Total radiostrontium			Tritium			Uranium-233/234			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.		
37	N	12			12			12			12		
38	% < Detection limit	33%			83%			0%			0%		
39	Mean	179			1.62			0.605			0.603		
40	Standard deviation	341			1.94			0.145			0.147		
41	Z-statistic	1.64			1.64			1.64			1.64		
42	95% UCL on mean	341			2.55			0.674			0.672		
43	Maximum value	931			7.24			0.937			0.963		

44 Qualifiers and acronyms are defined on page 3.

CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern **Date** 03/25/13 **Calc. No.** 0100N-CA-V0192 **Rev. No.** 0
Project 100-N Field Remediation **Job No.** 14655 **Checked** C. H. Dobie **Date** 03/25/13
Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations **Sheet No.** 12 of 20

1 **UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Statistical Calculations**
2 **Verification Data - Deep Zone (DZ)**

3	Sample	Sample	Sample	Arsenic			Barium			Beryllium			Chromium			Cobalt			Copper			Lead			Manganese		
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	DZ-1	J1R2V0	10/10/2012	1.75	B	2.90	62.8		1.45	0.239	B	0.581	5.13		0.581	9.99		5.81	13.8		2.90	2.66		1.45	426		14.5
6	Duplicate of J1R2V0	J1R2W1	10/10/2012	1.74	B	2.70	57.3		1.35	0.205	B	0.540	4.89		0.540	9.67		5.40	14.6		2.70	2.45		1.35	369		13.5
7	DZ-2	J1R2V1	10/10/2012	1.80	B	2.10	56.0		1.05	0.203	B	0.420	5.54		0.420	8.64		4.20	13.3		2.10	2.44		1.05	331		10.5
8	DZ-3	J1R2V2	10/10/2012	2.54	B	2.56	55.3		1.28	0.252	B	0.511	13.4		0.511	8.10		5.11	12.4		2.56	3.62		1.28	344		12.8
9	DZ-4	J1R2V3	10/10/2012	1.56	B	2.56	39.7		1.28	0.232	B	0.512	4.51		0.512	9.67		5.12	14.5		2.56	2.20		1.28	389		12.8
10	DZ-5	J1R2V4	10/10/2012	1.43	B	2.66	62.5		1.33	0.225	B	0.532	8.60		0.532	10.2		5.32	14.5		2.66	2.18		1.33	358		13.3
11	DZ-6	J1R2V5	10/10/2012	2.52	B	2.58	56.2		1.29	0.260	B	0.515	9.23		0.515	8.77		5.15	16.2		2.58	3.65		1.29	340		12.9
12	DZ-7	J1R2V6	10/10/2012	1.74	B	2.56	67.1		1.28	0.241	B	0.513	5.72		0.513	10.6		5.13	16.4		2.56	3.03		1.28	430		12.8
13	DZ-8	J1R2W6	10/10/2012	1.53	B	2.61	83.4		1.30	0.223	B	0.521	11.5		0.521	10.7		5.21	15.5		2.61	3.42		1.30	361		13.0
14	DZ-9	J1R2V7	10/10/2012	1.66	B	2.44	50.7		1.22	0.237	B	0.488	7.44		0.488	9.90		4.88	15.2		2.44	2.52		1.22	436		12.2
15	DZ-10	J1R2V8	10/10/2012	1.64	B	2.32	50.7		1.16	0.224	B	0.464	6.81		0.464	8.07		4.64	16.1		2.32	2.63		1.16	292		11.6
16	DZ-11	J1R2V9	10/10/2012	1.63	B	2.44	75.3		1.22	0.231	B	0.489	4.64		0.489	10.7		4.89	17.1		2.44	2.54		1.22	380		12.2
17	DZ-12	J1R2W8	10/10/2012	1.40	B	2.91	53.2		1.45	0.257	B	0.582	8.78		0.582	10.5		5.82	16.4		2.91	2.63		1.45	344		14.5

18
19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Arsenic	Barium	Beryllium	Chromium	Cobalt	Copper	Lead	Manganese
21	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
22	DZ-1	J1R2V0/J1R2W1	10/10/2012	1.75	60.1	0.222	5.01	9.83	14.2	2.56	398
23	DZ-2	J1R2V1	10/10/2012	1.80	56.0	0.203	5.54	8.64	13.3	2.44	331
24	DZ-3	J1R2V2	10/10/2012	2.54	55.3	0.252	13.4	8.10	12.4	3.62	344
25	DZ-4	J1R2V3	10/10/2012	1.56	39.7	0.232	4.51	9.67	14.5	2.20	389
26	DZ-5	J1R2V4	10/10/2012	1.43	62.5	0.225	8.60	10.2	14.5	2.18	358
27	DZ-6	J1R2V5	10/10/2012	2.52	56.2	0.260	9.23	8.77	16.2	3.65	340
28	DZ-7	J1R2V6	10/10/2012	1.74	67.1	0.241	5.72	10.6	16.4	3.03	430
29	DZ-8	J1R2W6	10/10/2012	1.53	83.4	0.223	11.5	10.7	15.5	3.42	361
30	DZ-9	J1R2V7	10/10/2012	1.66	50.7	0.237	7.44	9.90	15.2	2.52	436
31	DZ-10	J1R2V8	10/10/2012	1.64	50.7	0.224	6.81	8.07	16.1	2.63	292
32	DZ-11	J1R2V9	10/10/2012	1.63	75.3	0.231	4.64	10.7	17.1	2.54	380
33	DZ-12	J1R2W8	10/10/2012	1.40	53.2	0.257	8.78	10.5	16.4	2.63	344

34 **Statistical Computations**

35		Arsenic	Barium	Beryllium	Chromium	Cobalt	Copper	Lead	Manganese
36	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), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat normal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.
37	N	12	12	12	12	12	12	12	12
38	% < Detection limit	0%	0%	0%	0%	0%	0%	0%	0%
39	Mean	1.77	59.2	0.234	7.60	9.64	15.2	2.78	367
40	Standard deviation	0.377	11.7	0.0165	2.82	0.996	1.41	0.519	41.7
41	95% UCL on mean	1.95	66.1	0.243	9.45	10.2	16.0	3.08	390
42	Maximum value	2.54	83.4	0.260	13.4	10.7	17.1	3.65	436
43	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	20 DE, GW & River Protection	200 GW Protection	1.51 GW & River Protection	18.5 GW & River Protection	32 GW Protection	22.0 River Protection	10.2 GW & River Protection	512 GW Protection
44	**WAC 173-340 3-PART TEST**								
45	95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
46	> 10% above Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
47	Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
48	**WAC 173-340 Compliance?**	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 (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.	Because all values are below background (512 mg/kg) the WAC 173-340 3-part test is not required.

49 Qualifiers and acronyms are defined on page 3.

CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern **Date** 03/25/13 **Calc. No.** 0100N-CA-V0192 **Rev. No.** 0
Project 100-N Field Remediation **Job No.** 14655 **Checked** C. H. Dobie **Date** 03/25/13
Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations **Sheet No.** 13 of 20

1 **UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Statistical Calculations**
2 **Verification Data - Deep Zone (DZ)**

3	Sample	Sample	Sample	Molybdenum			Nickel			Vanadium			Zinc			Nitrogen in Nitrite and Nitrate		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
5	DZ-1	J1R2V0	10/10/2012	5.81	U	5.81	7.40	B	11.6	88.5		7.26	51.3		29.0	0.10	U	0.10
6	Duplicate of J1R2V0	J1R2W1	10/10/2012	5.40	U	5.40	6.86	B	10.8	81.0		6.75	50.7		27.0	0.16	B	0.10
7	DZ-2	J1R2V1	10/10/2012	0.654	B	4.20	7.65	B	8.40	85.7		5.25	48.7		21.0	0.19	B	0.10
8	DZ-3	J1R2V2	10/10/2012	5.11	U	5.11	10.4		10.2	77.7		6.39	43.6		25.6	0.54		0.10
9	DZ-4	J1R2V3	10/10/2012	0.711	B	5.12	6.80	B	10.2	90.2		6.40	53.4		25.6	0.22	B	0.10
10	DZ-5	J1R2V4	10/10/2012	0.609	B	5.32	14.0		10.6	96.5		6.64	55.8		26.6	0.29	B	0.10
11	DZ-6	J1R2V5	10/10/2012	0.532	B	5.15	10.5		10.3	75.8		6.44	49.6		25.8	0.63		0.10
12	DZ-7	J1R2V6	10/10/2012	0.528	B	5.13	8.11	B	10.3	90.1		6.41	57.2		25.6	0.55		0.10
13	DZ-8	J1R2W6	10/10/2012	5.21	U	5.21	6.29	B	10.4	100		6.52	74.0		26.1	0.17	B	0.10
14	DZ-9	J1R2V7	10/10/2012	0.494	B	4.88	8.17	B	9.75	93.3		6.10	53.2		24.4	1.04		0.10
15	DZ-10	J1R2V8	10/10/2012	4.64	U	4.64	8.18	B	9.29	71.6		5.81	45.8		23.2	0.25	B	0.09
16	DZ-11	J1R2V9	10/10/2012	4.89	U	4.89	6.07	B	9.78	77.8		6.11	53.6		24.4	0.22	B	0.10
17	DZ-12	J1R2W8	10/10/2012	0.753	B	5.82	9.27	B	11.6	91.0		7.27	58.3		29.1	0.49	B	0.10

18
19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Molybdenum	Nickel	Vanadium	Zinc	Nitrogen in Nitrite and Nitrate
21	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
22	DZ-1	J1R2V0/J1R2W1	10/10/2012	2.80	7.13	84.8	51.0	0.11
23	DZ-2	J1R2V1	10/10/2012	0.654	7.65	85.7	48.7	0.19
24	DZ-3	J1R2V2	10/10/2012	2.56	10.4	77.7	43.6	0.54
25	DZ-4	J1R2V3	10/10/2012	0.711	6.80	90.2	53.4	0.22
26	DZ-5	J1R2V4	10/10/2012	0.609	14.0	96.5	55.8	0.29
27	DZ-6	J1R2V5	10/10/2012	0.532	10.5	75.8	49.6	0.63
28	DZ-7	J1R2V6	10/10/2012	0.528	8.11	90.1	57.2	0.55
29	DZ-8	J1R2W6	10/10/2012	2.61	6.29	100	74.0	0.17
30	DZ-9	J1R2V7	10/10/2012	0.494	8.17	93.3	53.2	1.04
31	DZ-10	J1R2V8	10/10/2012	2.32	8.18	71.6	45.8	0.25
32	DZ-11	J1R2V9	10/10/2012	2.45	6.07	77.8	53.6	0.22
33	DZ-12	J1R2W8	10/10/2012	0.753	9.27	91.0	58.3	0.49

34 **Statistical Computations**

35		Molybdenum	Nickel	Vanadium	Zinc	Nitrogen in Nitrite and Nitrate
36	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), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.
37	N	12	12	12	12	12
38	% < Detection limit	42%	0%	0%	0%	0%
39	Mean	1.42	8.55	86.2	53.7	0.39
40	Standard deviation	1.00	2.24	8.88	7.77	0.27
41	95% UCL on mean	1.89	9.80	91.2	57.8	0.64
42	Maximum value	0.753	14.0	100	74.0	1.04
43	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg) unless stated otherwise noted**	8 GW Protection	19.1 GW Protection	85.1 GW Protection	67.8 River Protection	1000 GW Protection
44	**WAC 173-340 3-PART TEST**					
45	95% UCL > Cleanup Limit?	NO	NA	YES	NO	NA
46	> 10% above Cleanup Limit?	NO	NA	YES	NO	NA
47	Any sample > 2X Cleanup Limit?	NO	NA	NO	NO	NA
48	**WAC 173-340 Compliance?**	The data set meets the 3-part test criteria when compared to the most stringent RAG.	Because all values are below background (19.1 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.	The data set meets the 3-part test criteria when compared to the most stringent RAG.	Because all values are below background (11.8 mg/kg) the WAC 173-340 3-part test is not required.

49 Qualifiers and acronyms are defined on page 3.
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CALCULATION SHEET

Washington Closure Hanford

Originator	N. K. Schiffern	**Date**	03/25/13	**Calc. No.**	0100N-CA-V0192
Project	100-N Field Remediation	**Job No.**	14655	**Checked**	C. H. Dobie
Subject	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations				

Rev. No.	0
Date	03/25/13
Sheet No.	14 of 20

1 **UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Maximum Calculations**

2 **Verification Data - Deep Zone (DZ)**

3	Sample	Sample	Sample	Cadmium			Hexavalent Chromium			Mercury		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
5	DZ-1	J1R2V0	10/10/2012	0.58	U	0.58	0.20	U	0.20	0.0232	U	0.0232
6	Duplicate of J1R2V0	J1R2W1	10/10/2012	0.54	U	0.54	0.20	U	0.20	0.0232	U	0.0232
7	DZ-2	J1R2V1	10/10/2012	0.42	U	0.42	0.20	U	0.20	0.0267	U	0.0267
8	DZ-3	J1R2V2	10/10/2012	0.51	U	0.51	0.20	U	0.20	0.0292	U	0.0292
9	DZ-4	J1R2V3	10/10/2012	0.51	U	0.51	0.20	U	0.20	0.0283	U	0.0283
10	DZ-5	J1R2V4	10/10/2012	0.53	U	0.53	0.20	U	0.20	0.0284	U	0.0284
11	DZ-6	J1R2V5	10/10/2012	0.52	U	0.52	0.20	U	0.20	0.0261	U	0.0261
12	DZ-7	J1R2V6	10/10/2012	0.51	U	0.51	0.20	U	0.20	0.0252	U	0.0252
13	DZ-8	J1R2W6	10/10/2012	0.18	B	0.52	0.61		0.20	0.0151	B	0.0283
14	DZ-9	J1R2V7	10/10/2012	0.49	U	0.49	0.20	U	0.20	0.0245	U	0.0245
15	DZ-10	J1R2V8	10/10/2012	0.46	U	0.46	0.20	U	0.20	0.0252	U	0.0252
16	DZ-11	J1R2V9	10/10/2012	0.49	U	0.49	0.20	U	0.20	0.0253	U	0.0253
17	DZ-12	J1R2W8	10/10/2012	0.58	U	0.58	0.33	B	0.20	0.0239	U	0.0239

18 **Statistical Computation Input Data**

19		Cadmium	Hexavalent Chromium	Mercury
20	% < Detection limit	92%	83%	92%
21	Maximum value	0.18	0.61	0.0151
22	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	0.81 GW & River Protection	2 River Protection	0.33 GW & River Protection
23	**3-PART TEST**			
24	Maximum > Cleanup Limit?	NA	NO	NA
25	> 10% above Cleanup Limit?	NA	NO	NA
26	Any sample > 2X Cleanup Limit?	NA	NO	NA
27	**3-Part Test Compliance?**	Because all values are below background (0.81 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.	Because all values are below background (0.33 mg/kg) the WAC 173-340 3-part test is not required.

28 Qualifiers and acronyms are defined on page 3.

CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern	**Date** 03/25/13	**Calc. No.** 0100N-CA-V0192	**Rev. No.** 0
Project 100-N Field Remediation	**Job No.** 14655	**Checked** C. H. Dobie	**Date** 03/25/13
Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations			**Sheet No.** 15 of 20

Ecology Software (MTCAStat) Results, Shallow Zone (SZ)

Arsenic 95% UCL Calculation

DATA	ID
2.65	J1R515/J1R525
3.38	J1R513
2.08	J1R514
2.09	J1R516
1.82	J1R517
2.41	J1R518
2.22	J1R519
2.89	J1R521
3.64	J1R522
2.84	J1R523
2.95	J1R524

Number of samples		Uncensored values	
Uncensored	11	Mean	2.63
Censored		Lognormal mean	2.64
Detection limit or PQL		Std. devn.	0.571
Method detection limit		Median	2.65
TOTAL	11	Min.	1.82
		Max.	3.64

Lognormal distribution? r-squared is: 0.978
Normal distribution? r-squared is: 0.969
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 3.00

Barium 95% UCL Calculation

DATA	ID
56.0	J1R515/J1R525
48.8	J1R513
59.0	J1R514
61.6	J1R516
44.9	J1R517
61.9	J1R518
63.9	J1R519
51.9	J1R521
52.6	J1R522
54.7	J1R523
58.4	J1R524

Number of samples		Uncensored values	
Uncensored	11	Mean	55.8
Censored		Lognormal mean	55.8
Detection limit or PQL		Std. devn.	5.90
Method detection limit		Median	56.0
TOTAL	11	Min.	44.9
		Max.	63.9

Lognormal distribution? r-squared is: 0.963
Normal distribution? r-squared is: 0.976
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 59.4

Beryllium 95% UCL Calculation

DATA	ID
0.221	J1R515/J1R525
0.290	J1R513
0.217	J1R514
0.198	J1R516
0.175	J1R517
0.238	J1R518
0.242	J1R519
0.259	J1R521
0.242	J1R522
0.264	J1R523
0.279	J1R524

Number of samples		Uncensored values	
Uncensored	11	Mean	0.239
Censored		Lognormal mean	0.239
Detection limit or PQL		Std. devn.	0.0344
Method detection limit		Median	0.242
TOTAL	11	Min.	0.175
		Max.	0.290

Lognormal distribution? r-squared is: 0.962
Normal distribution? r-squared is: 0.982
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.261

Chromium 95% UCL Calculation

DATA	ID
9.97	J1R515/J1R525
9.45	J1R513
9.49	J1R514
13.0	J1R516
4.96	J1R517
12.4	J1R518
9.55	J1R519
7.12	J1R521
10.5	J1R522
9.56	J1R523
7.99	J1R524

Number of samples		Uncensored values	
Uncensored	11	Mean	9.45
Censored		Lognormal mean	9.51
Detection limit or PQL		Std. devn.	2.25
Method detection limit		Median	9.55
TOTAL	11	Min.	4.96
		Max.	13.0

Lognormal distribution? r-squared is: 0.879
Normal distribution? r-squared is: 0.934
Recommendations:
Use normal distribution.

UCL (t-statistic) is 10.7

Cobalt 95% UCL Calculation

DATA	ID
7.92	J1R515/J1R525
9.06	J1R513
7.90	J1R514
7.37	J1R516
8.64	J1R517
6.73	J1R518
8.85	J1R519
7.68	J1R521
7.10	J1R522
8.41	J1R523
9.67	J1R524

Number of samples		Uncensored values	
Uncensored	11	Mean	8.12
Censored		Lognormal mean	8.13
Detection limit or PQL		Std. devn.	0.894
Method detection limit		Median	7.92
TOTAL	11	Min.	6.73
		Max.	9.67

Lognormal distribution? r-squared is: 0.991
Normal distribution? r-squared is: 0.990
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 8.65

Copper 95% UCL Calculation

DATA	ID
18.5	J1R515/J1R525
19.2	J1R513
15.2	J1R514
19.6	J1R516
15.7	J1R517
14.1	J1R518
16.1	J1R519
15.7	J1R521
16.6	J1R522
17.2	J1R523
17.8	J1R524

Number of samples		Uncensored values	
Uncensored	11	Mean	16.9
Censored		Lognormal mean	16.9
Detection limit or PQL		Std. devn.	1.74
Method detection limit		Median	16.6
TOTAL	11	Min.	14.1
		Max.	19.6

Lognormal distribution? r-squared is: 0.980
Normal distribution? r-squared is: 0.977
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 17.9

Lead 95% UCL Calculation

DATA	ID
4.75	J1R515/J1R525
4.91	J1R513
5.08	J1R514
12.7	J1R516
2.82	J1R517
3.41	J1R518
4.00	J1R519
4.17	J1R521
4.10	J1R522
4.38	J1R523
4.47	J1R524

Number of samples		Uncensored values	
Uncensored	11	Mean	4.98
Censored		Lognormal mean	4.94
Detection limit or PQL		Std. devn.	2.64
Method detection limit		Median	4.38
TOTAL	11	Min.	2.82
		Max.	12.7

Lognormal distribution? r-squared is: 0.736
Normal distribution? r-squared is: 0.553
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (Z-statistics) is 6.29

Manganese 95% UCL Calculation

DATA	ID
301	J1R515/J1R525
351	J1R513
316	J1R514
290	J1R516
301	J1R517
289	J1R518
333	J1R519
288	J1R521
310	J1R522
323	J1R523
363	J1R524

Number of samples		Uncensored values	
Uncensored	11	Mean	315
Censored		Lognormal mean	315
Detection limit or PQL		Std. devn.	25.4
Method detection limit		Median	310
TOTAL	11	Min.	288
		Max.	363

Lognormal distribution? r-squared is: 0.933
Normal distribution? r-squared is: 0.923
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 329

Nickel 95% UCL Calculation

DATA	ID
11.1	J1R515/J1R525
10.4	J1R513
8.52	J1R514
9.16	J1R516
6.44	J1R517
10.8	J1R518
8.6	J1R519
8.54	J1R521
9.85	J1R522
10.9	J1R523
9.65	J1R524

Number of samples		Uncensored values	
Uncensored	11	Mean	9.45
Censored		Lognormal mean	9.46
Detection limit or PQL		Std. devn.	1.39
Method detection limit		Median	9.65
TOTAL	11	Min.	6.44
		Max.	11.1

Lognormal distribution? r-squared is: 0.874
Normal distribution? r-squared is: 0.917
Recommendations:
Use normal distribution.

UCL (t-statistic) is 10.2

Qualifiers and acronyms are defined on page 3.

CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern NS
Project 100-N Field Remediation
Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations

Date 03/25/13
Job No. 14655

Calc. No. 0100N-CA-V0192
Checked C. H. Dobie CHD

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Date 03/25/13
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Ecology Software (MTCAStat) Results, Shallow Zone (SZ)

	DATA	ID	Vanadium 95% UCL Calculation			
1	DATA	ID				
2	66.4	J1R515/J1R525				
3	72.4	J1R513				
4	66.1	J1R514	Number of samples		Uncensored values	
5	61.9	J1R516	Uncensored	11	Mean	67.1
6	70.8	J1R517	Censored		Lognormal mean	67.1
7	58.7	J1R518	Detection limit or PQL		Std. devn.	7.17
8	73.2	J1R519	Method detection limit		Median	66.1
9	63.8	J1R521	TOTAL	11	Min.	58.7
10	58.9	J1R522			Max.	82.7
11	63.2	J1R523				
12	82.7	J1R524				
13						
14						
15			Lognormal distribution?		Normal distribution?	
16			r-squared is: 0.946		r-squared is: 0.925	
17			Recommendations:			
18			Use lognormal distribution.			
19						
20			UCL (Land's method) is		71.2	

	DATA	ID	Zinc 95% UCL Calculation			
	DATA	ID				
	47.0	J1R515/J1R525				
	52.1	J1R513				
	46.0	J1R514	Number of samples		Uncensored values	
	68.4	J1R516	Uncensored	11	Mean	49.1
	46.4	J1R517	Censored		Lognormal mean	49.1
	41.1	J1R518	Detection limit or PQL		Std. devn.	7.66
	51.4	J1R519	Method detection limit		Median	47.0
	44.6	J1R521	TOTAL	11	Min.	40.8
	40.8	J1R522			Max.	68.4
	48.2	J1R523				
	54.0	J1R524				
			Lognormal distribution?		Normal distribution?	
			r-squared is: 0.890		r-squared is: 0.834	
			Recommendations:			
			Reject BOTH lognormal and normal distributions.			
			UCL (Z-statistics) is		52.9	

	DATA	ID	Nitrogen in Nitrate and Nitrite 95% UCL Calculation			
	DATA	ID				
	0.28	J1R515/J1R525				
	0.79	J1R513				
	2.49	J1R514	Number of samples		Uncensored values	
	1.81	J1R516	Uncensored	11	Mean	1.52
	0.47	J1R517	Censored		Lognormal mean	1.51
	0.90	J1R518	Detection limit or PQL		Std. devn.	1.88
	1.21	J1R519	Method detection limit		Median	0.90
	1.23	J1R521	TOTAL	11	Min.	0.28
	0.30	J1R522			Max.	6.81
	0.41	J1R523				
	6.81	J1R524				
			Lognormal distribution?		Normal distribution?	
			r-squared is: 0.955		r-squared is: 0.637	
			Recommendations:			
			Use lognormal distribution.			
			UCL (Land's method) is		3.72	

CALCULATION SHEET

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Originator N. K. Schiffern **Date** 03/25/13 **Calc. No.** 0100N-CA-V0192 **Rev. No.** 0

Project 100-N Field Remediation **Job No.** 14655 **Checked** C. H. Dobie **Date** 03/25/13

Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations **Sheet No.** 17 of 20

Ecology Software (MTCAStat) Results, Deep Zone (DZ)

Arsenic 95% UCL Calculation

DATA	ID
1.75	J1R2V0/J1R2W1
1.80	J1R2V1
2.54	J1R2V2
1.56	J1R2V3
1.43	J1R2V4
2.52	J1R2V5
1.74	J1R2V6
1.53	J1R2W6
1.66	J1R2V7
1.64	J1R2V8
1.63	J1R2V9
1.40	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	1.77
Censored		Lognormal mean	1.77
Detection limit or PQL		Std. devn.	0.377
Method detection limit		Median	1.65
TOTAL	12	Min.	1.40
		Max.	2.54

Lognormal distribution? r-squared is: 0.823
Normal distribution? r-squared is: 0.763
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (Z-statistics) is 1.95

Barium 95% UCL Calculation

DATA	ID
60.1	J1R2V0/J1R2W1
56.0	J1R2V1
55.3	J1R2V2
39.7	J1R2V3
62.5	J1R2V4
56.2	J1R2V5
67.1	J1R2V6
83.4	J1R2W6
50.7	J1R2V7
50.7	J1R2V8
75.3	J1R2V9
53.2	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	59.2
Censored		Lognormal mean	59.3
Detection limit or PQL		Std. devn.	11.7
Method detection limit		Median	56.1
TOTAL	12	Min.	39.7
		Max.	83.4

Lognormal distribution? r-squared is: 0.954
Normal distribution? r-squared is: 0.937
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 66.1

Beryllium 95% UCL Calculation

DATA	ID
0.222	J1R2V0/J1R2W1
0.203	J1R2V1
0.252	J1R2V2
0.232	J1R2V3
0.225	J1R2V4
0.260	J1R2V5
0.241	J1R2V6
0.223	J1R2W6
0.237	J1R2V7
0.224	J1R2V8
0.231	J1R2V9
0.257	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	0.234
Censored		Lognormal mean	0.234
Detection limit or PQL		Std. devn.	0.0165
Method detection limit		Median	0.232
TOTAL	12	Min.	0.203
		Max.	0.260

Lognormal distribution? r-squared is: 0.950
Normal distribution? r-squared is: 0.952
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.243

Chromium 95% UCL Calculation

DATA	ID
5.01	J1R2V0/J1R2W1
5.54	J1R2V1
13.4	J1R2V2
4.51	J1R2V3
8.60	J1R2V4
9.23	J1R2V5
5.72	J1R2V6
11.5	J1R2W6
7.44	J1R2V7
6.81	J1R2V8
4.64	J1R2V9
8.78	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	7.60
Censored		Lognormal mean	7.63
Detection limit or PQL		Std. devn.	2.82
Method detection limit		Median	7.13
TOTAL	12	Min.	4.51
		Max.	13.4

Lognormal distribution? r-squared is: 0.964
Normal distribution? r-squared is: 0.923
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 9.45

Cobalt 95% UCL Calculation

DATA	ID
9.83	J1R2V0/J1R2W1
8.64	J1R2V1
8.10	J1R2V2
9.67	J1R2V3
10.2	J1R2V4
8.77	J1R2V5
10.6	J1R2V6
10.7	J1R2W6
9.90	J1R2V7
8.07	J1R2V8
10.7	J1R2V9
10.5	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	9.64
Censored		Lognormal mean	9.65
Detection limit or PQL		Std. devn.	1.00
Method detection limit		Median	9.87
TOTAL	12	Min.	8.07
		Max.	10.7

Lognormal distribution? r-squared is: 0.889
Normal distribution? r-squared is: 0.900
Recommendations:
Use normal distribution.

UCL (t-statistic) is 10.2

Copper 95% UCL Calculation

DATA	ID
14.2	J1R2V0/J1R2W1
13.3	J1R2V1
12.4	J1R2V2
14.5	J1R2V3
14.5	J1R2V4
16.2	J1R2V5
16.4	J1R2V6
15.5	J1R2W6
15.2	J1R2V7
16.1	J1R2V8
17.1	J1R2V9
16.4	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	15.2
Censored		Lognormal mean	15.2
Detection limit or PQL		Std. devn.	1.41
Method detection limit		Median	15.4
TOTAL	12	Min.	12.4
		Max.	17.1

Lognormal distribution? r-squared is: 0.939
Normal distribution? r-squared is: 0.953
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 16.0

Lead 95% UCL Calculation

DATA	ID
2.56	J1R2V0/J1R2W1
2.44	J1R2V1
3.62	J1R2V2
2.20	J1R2V3
2.18	J1R2V4
3.65	J1R2V5
3.03	J1R2V6
3.42	J1R2W6
2.52	J1R2V7
2.63	J1R2V8
2.54	J1R2V9
2.63	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	2.78
Censored		Lognormal mean	2.79
Detection limit or PQL		Std. devn.	0.519
Method detection limit		Median	2.59
TOTAL	12	Min.	2.18
		Max.	3.65

Lognormal distribution? r-squared is: 0.904
Normal distribution? r-squared is: 0.878
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 3.08

Manganese 95% UCL Calculation

DATA	ID
398	J1R2V0/J1R2W1
331	J1R2V1
344	J1R2V2
389	J1R2V3
358	J1R2V4
340	J1R2V5
430	J1R2V6
361	J1R2W6
436	J1R2V7
292	J1R2V8
380	J1R2V9
344	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	367
Censored		Lognormal mean	367
Detection limit or PQL		Std. devn.	41.7
Method detection limit		Median	360
TOTAL	12	Min.	292
		Max.	436

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

UCL (Land's method) is 390

Molybdenum 95% UCL Calculation

DATA	ID
2.80	J1R2V0/J1R2W1
0.654	J1R2V1
2.555	J1R2V2
0.711	J1R2V3
0.609	J1R2V4
0.532	J1R2V5
0.528	J1R2V6
2.605	J1R2W6
0.494	J1R2V7
2.32	J1R2V8
2.45	J1R2V9
0.753	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	1.42
Censored		Lognormal mean	1.46
Detection limit or PQL		Std. devn.	1.00
Method detection limit		Median	0.732
TOTAL	12	Min.	0.494
		Max.	2.80

Lognormal distribution? r-squared is: 0.804
Normal distribution? r-squared is: 0.772
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (Z-statistics) is 1.89

Qualifiers and acronyms are defined on page 3.

CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern	**Date** 03/25/13	**Calc. No.** 0100N-CA-V0192	**Rev. No.** 0
Project 100-N Field Remediation	**Job No.** 14655	**Checked** C. H. Dobie	**Date** 03/25/13
Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations			**Sheet No.** 18 of 20

Ecology Software (MTCAStat) Results, Deep Zone (DZ)

Nickel 95% UCL Calculation

DATA	ID
7.13	J1R2V0/J1R2W1
7.65	J1R2V1
10.4	J1R2V2
6.80	J1R2V3
14.0	J1R2V4
10.5	J1R2V5
8.11	J1R2V6
6.29	J1R2W6
8.17	J1R2V7
8.18	J1R2V8
6.07	J1R2V9
9.27	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	8.55
Censored		Lognormal mean	8.56
Detection limit or PQL		Std. devn.	2.24
Method detection limit		Median	8.14
TOTAL	12	Min.	6.07
		Max.	14.0

Lognormal distribution? r-squared is: 0.944
Normal distribution? r-squared is: 0.876
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 9.80

Vanadium 95% UCL Calculation

DATA	ID
84.8	J1R2V0/J1R2W1
85.7	J1R2V1
77.7	J1R2V2
90.2	J1R2V3
96.5	J1R2V4
75.8	J1R2V5
90.1	J1R2V6
100	J1R2W6
93.3	J1R2V7
71.6	J1R2V8
77.8	J1R2V9
91.0	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	86.2
Censored		Lognormal mean	86.2
Detection limit or PQL		Std. devn.	8.88
Method detection limit		Median	87.9
TOTAL	12	Min.	71.6
		Max.	100

Lognormal distribution? r-squared is: 0.962
Normal distribution? r-squared is: 0.968
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 91.2

Zinc 95% UCL Calculation

DATA	ID
51.0	J1R2V0/J1R2W1
48.7	J1R2V1
43.6	J1R2V2
53.4	J1R2V3
55.8	J1R2V4
49.6	J1R2V5
57.2	J1R2V6
74.0	J1R2W6
53.2	J1R2V7
45.8	J1R2V8
53.6	J1R2V9
58.3	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	53.7
Censored		Lognormal mean	53.7
Detection limit or PQL		Std. devn.	7.77
Method detection limit		Median	53.3
TOTAL	12	Min.	43.6
		Max.	74.0

Lognormal distribution? r-squared is: 0.903
Normal distribution? r-squared is: 0.847
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 57.8

Nitrogen in Nitrate and Nitrite 95% UCL Calculation

DATA	ID
0.11	J1R2V0/J1R2W1
0.19	J1R2V1
0.54	J1R2V2
0.22	J1R2V3
0.29	J1R2V4
0.63	J1R2V5
0.55	J1R2V6
0.17	J1R2W6
1.04	J1R2V7
0.25	J1R2V8
0.22	J1R2V9
0.49	J1R2W8

Number of samples		Uncensored values	
Uncensored	12	Mean	0.39
Censored		Lognormal mean	0.40
Detection limit or PQL		Std. devn.	0.27
Method detection limit		Median	0.27
TOTAL	12	Min.	0.11
		Max.	1.04

Lognormal distribution? r-squared is: 0.962
Normal distribution? r-squared is: 0.852
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.64

Qualifiers and acronyms are defined on page 3.

CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern **Date** 03/25/13 **Calc. No.** 0100N-CA-V0192 **Rev. No.** 0
Project 100-N Field Remediation **Job No.** 14655 **Checked** C. H. Dobie **Date** 03/25/13
Subject UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations **Sheet No.** 19 of 20

Duplicate/Split Analysis - Shallow Zone (SZ)

Sampling Area	Sample Number	Sample Date	Cesium-137			Carbon-14			Cobaltt-60			Potassium-40			Radium-226			Uranium-233/234			Uranium-238			Aluminum			Arsenic		
			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	mg/kg	Q	PQL	mg/kg	Q	PQL
SZ-3	J1R515	11/5/2012	0.361		0.062	1.66		0.876	0.137		0.076	9.57		0.684	0.381		0.115	0.539		0.242	0.412		0.242	6780		12.3	2.72		2.46
Duplicate of J1R515	J1R525	11/5/2012	0.180		0.060	1.15		0.842	0.113	U	0.113	8.88		1.01	0.387		0.129	0.444		0.179	0.561		0.179	6650		13.9	2.58	B	2.78
Split of J1R515	J1R541	11/5/2012	0.127		0.0278	0.330	U	0.550	0.0958		0.0213				0.477		0.0401	0.162		0.0548	0.150		0.060	6010	X	1.5	2.4		0.62

Analysis:

TDL			0.05			1			0.05			0.5			0.1			1			1			5			10		
Duplicate Analysis	Both > PQL?		Yes (continue)			Yes (continue)						Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			No-Stop (acceptable)		
	Both >5xTDL?		No-Stop (acceptable)			No-Stop (acceptable)						Yes (calc RPD)			No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)			Yes (calc RPD)					
	RPD											7.5%												1.9%					
	Difference > 2 TDL?		Yes - assess further			No - acceptable						Not applicable			No - acceptable			No - acceptable			No - acceptable			Not applicable			No - acceptable		
Split Analysis	Both > PQL?		Yes (continue)						Yes (continue)						Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)		
	Both >5xTDL?		No-Stop (acceptable)						No-Stop (acceptable)						No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)			Yes (calc RPD)					
	RPD																							12.0%					
	Difference > 2 TDL?		Yes - assess further						No - acceptable						No - acceptable			No - acceptable			No - acceptable			Not applicable			No - acceptable		

Duplicate/Split Analysis - Shallow Zone (SZ)

Sampling Area	Sample Number	Sample Date	Barium			Beryllium			Calcium			Chromium			Cobalt			Copper			Iron			Lead			Magnesium		
			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
SZ-3	J1R515	11/5/2012	56.1		1.23	0.213	B	0.493	7090		246	10.6		0.493	8.29		4.93	19.9		2.46	24200		49.3	5.28		1.23	5160		185
Duplicate of J1R515	J1R525	11/5/2012	55.9		1.39	0.229	B	0.555	6810		278	9.33		0.555	7.55		5.55	17.0		2.78	23200		55.5	4.22		1.39	4250		208
Split of J1R515	J1R541	11/5/2012	49.5	X	0.072	0.27		0.031	6590	X	13.3	7.6	X	0.055	7.2	X	0.094	19.1		0.200	21500	X	3.6	3.7		0.25	4490	X	3.5

Analysis:

TDL			2			0.2			100			1			2			1			5			5			75		
Duplicate Analysis	Both > PQL?		Yes (continue)			No-Stop (acceptable)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)		
	Both >5xTDL?		Yes (calc RPD)						Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)			Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)			Yes (calc RPD)		
	RPD		0.4%						4.0%			12.7%						15.7%			4.2%						19.3%		
	Difference > 2 TDL?		Not applicable			No - acceptable			Not applicable			Not applicable			No - acceptable			Not applicable			Not applicable			No - acceptable			Not applicable		
Split Analysis	Both > PQL?		Yes (continue)			No-Stop (acceptable)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)		
	Both >5xTDL?		Yes (calc RPD)						Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)			Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)			Yes (calc RPD)		
	RPD		12.5%						7.3%			33.0%						4.1%			11.8%						13.9%		
	Difference > 2 TDL?		Not applicable			No - acceptable			Not applicable			Not applicable			No - acceptable			Not applicable			Not applicable			No - acceptable			Not applicable		

Duplicate/Split Analysis - Shallow Zone (SZ)

Sampling Area	HEIS Number	Sample Date	Manganese			Nickel			Potassium			Silicon			Sodium			Vanadium			Zinc			Nitrogen in Nitrite and 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	mg/kg	Q	PQL
SZ-3	J1R515	11/5/2012	309		12.3	12.9		9.86	991		986	360		4.93	337		123	64.2		6.16	47.1		24.6	0.17	B	0.10
Duplicate of J1R515	J1R525	11/5/2012	292		13.9	9.23	B	11.1	986	B	1110	780		11.1	330		139	68.6		6.94	46.9		27.8	0.39	B	0.10
Split of J1R515	J1R541	11/5/2012	277	X	0.094	10.6	X	0.12	875		38.7	267		5.3	312		55.7	52.6		0.089	41.1	X	0.38	0.38	B	0.32

Analysis:

TDL			5			4			400			2			50			2.5			1			0.75					
Duplicate Analysis	Both > PQL?		Yes (continue)			No-Stop (acceptable)			No-Stop (acceptable)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)					
	Both >5xTDL?		Yes (calc RPD)									Yes (calc RPD)			Yes (calc RPD)			Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)					
	RPD		5.7%									73.7%			2.1%			19.9%			13.6%								
	Difference > 2 TDL?		Not applicable			No - acceptable			No - acceptable			Not applicable			Not applicable			Not applicable			Not applicable			No - acceptable					
Split Analysis	Both > PQL?		Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)					
	Both >5xTDL?		Yes (calc RPD)									Yes (calc RPD)			Yes (calc RPD)			Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)					
	RPD		10.9%									29.7%			7.7%			19.9%			13.6%								
	Difference > 2 TDL?		Not applicable			No - acceptable			No - acceptable			Not applicable			Not applicable			Not applicable			Not applicable			No - acceptable					

Qualifiers and acronyms are defined on page 3.

CALCULATION SHEET

Washington Closure Hanford

Originator	N. K. Schiffern	Date	03/26/13
Project	100-N Field Remediation	Job No.	14655
Subject	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Cleanup Verification 95% UCL Calculations		

Calc. No.	0100N-CA-V0192	Rev. No.	0
Checked	C. H. Dobie	Date	03/26/13
		Sheet No.	20 of 20

Duplicate/Split Analysis - Deep Zone (DZ)

Sampling Area	Sample Number	Sample Date	Cesium-137 pCi/g	Q	MDA	Potassium-40 pCi/g	Q	MDA	Radium-226 pCi/g	Q	MDA	Radium-228 pCi/g	Q	MDA	Thorium-228 pCi/g	Q	MDA	Thorium-232 pCi/g	Q	MDA	Total radiostrontium pCi/g	Q	MDA	Uranium-233/234 pCi/g	Q	MDA	Uranium-238 pCi/g	Q	MDA
DZ-1	J1R2V0	10/10/2012	0.076		0.020	9.52		0.167	0.312		0.034	0.523		0.082	0.470		0.025	0.523		0.082	0.231		0.199	0.534		0.227	0.564		0.227
Duplicate of J1R2V0	J1R2W1	10/10/2012	0.184		0.024	10.1		0.186	0.361		0.037	0.544		0.090	0.527		0.030	0.544		0.090	0.052	U	0.290	0.418		0.246	0.322		0.246
Split of J1R2V0	J1R2W0	10/10/2012	0.0950		0.0245				0.386		0.0483										0.209		0.153	0.109		0.0531	0.085		0.061

Analysis:

		Cesium-137	Potassium-40	Radium-226	Radium-228	Thorium-228	Thorium-232	Total radiostrontium	Uranium-233/234	Uranium-238
TDL		0.05	0.5	0.1	0.2	1	1	1	1	1
Duplicate Analysis	Both > PQL?	Yes (continue)	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)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)		No-Stop (acceptable)	No-Stop (acceptable)
	RPD		5.9%							
	Difference > 2 TDL?	Yes - assess further	Not applicable	No - acceptable	No - acceptable	No - acceptable	No - acceptable		No - acceptable	No - acceptable
Split Analysis	Both > PQL?	Yes (continue)		Yes (continue)				Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)		No-Stop (acceptable)				No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD									
	Difference > 2 TDL?	No - acceptable		No - acceptable				No - acceptable	No - acceptable	No - acceptable

Duplicate/Split Analysis - Deep Zone (DZ)

Sampling Area	Sample Number	Sample Date	Aluminum mg/kg	Q	PQL	Arsenic mg/kg	Q	PQL	Barium mg/kg	Q	PQL	Beryllium mg/kg	Q	PQL	Calcium mg/kg	Q	PQL	Chromium mg/kg	Q	PQL	Cobalt mg/kg	Q	PQL	Copper mg/kg	Q	PQL	Iron mg/kg	Q	PQL
DZ-1	J1R2V0	10/10/2012	5560	J	14.5	1.75	B	2.90	62.8		1.45	0.239	B	0.581	7220	J	290	5.13		0.581	9.99		5.81	13.8		2.90	30900		58.1
Duplicate of J1R2V0	J1R2W1	10/10/2012	5310	J	13.5	1.74	B	2.70	57.3		1.35	0.205	B	0.540	6520	J	270	4.89		0.540	9.67		5.40	14.6		2.70	29700		54.0
Split of J1R2V0	J1R2W0	10/10/2012	2920		7.0	0.59	U	0.59	54.4		0.34	0.50	B	0.15	5190		63.3	1.5	M	0.052	9.0		0.09	38.0	MN	0.19	26800		17.1

Analysis:

		Aluminum	Arsenic	Barium	Beryllium	Calcium	Chromium	Cobalt	Copper	Iron
TDL		5	10	2	0.2	100	1	2	1	5
Duplicate Analysis	Both > PQL?	Yes (continue)	No-Stop (acceptable)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)		Yes (calc RPD)		Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD	4.6%		9.2%		10.2%			5.6%	4.0%
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	No - acceptable	Not applicable	No - acceptable	No - acceptable	Not applicable	Not applicable
Split Analysis	Both > PQL?	Yes (continue)		Yes (continue)	No-Stop (acceptable)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)		Yes (calc RPD)		Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD	*62.3%*		14.3%		*32.7%*			*93.4%*	14.2%
	Difference > 2 TDL?	Not applicable		Not applicable	No - acceptable	Not applicable	Yes - assess further	No - acceptable	Not applicable	Not applicable

Duplicate/Split Analysis - Deep Zone (DZ)

Sampling Area	HEIS Number	Sample Date	Lead mg/kg	Q	PQL	Magnesium mg/kg	Q	PQL	Manganese mg/kg	Q	PQL	Nickel mg/kg	Q	PQL	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
DZ-1	J1R2V0	10/10/2012	2.66		1.45	5070		218	426		14.5	7.40	B	11.6	684	B	1160	422		5.81	432		145	88.5		7.26	51.3		29.0
Duplicate of J1R2V0	J1R2W1	10/10/2012	2.45		1.35	4780		202	369		13.5	6.86	B	10.8	670	B	1080	429		5.40	430		135	81.0		6.75	50.7		27.0
Split of J1R2V0	J1R2W0	10/10/2012	4.0	M	0.24	3340		3.3	265		0.09	4.3	M	0.11	421	B	184	108		25.4	434	B	265	53.8		0.084	49.3	N	0.36

Analysis:

		Lead	Magnesium	Manganese	Nickel	Potassium	Silicon	Sodium	Vanadium	Zinc
TDL		5	75	5	4	400	2	50	2.5	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)			Yes (calc RPD)	Yes (calc RPD)	Yes (calc RPD)	Yes (calc RPD)
	RPD		5.9%	14.3%			1.6%	0.5%	8.8%	1.2%
	Difference > 2 TDL?	No - acceptable	Not applicable	Not applicable	No - acceptable	No - acceptable	Not applicable	Not applicable	Not applicable	Not applicable
Split Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)			Yes (calc RPD)	Yes (calc RPD)	Yes (calc RPD)	Yes (calc RPD)
	RPD		*41.1%*	*46.6%*			*118.5%*	0.5%	*48.8%*	4.0%
	Difference > 2 TDL?	No - acceptable	Not applicable	Not applicable	No - acceptable	No - acceptable	Not applicable	Not applicable	Not applicable	Not applicable

Qualifiers and acronyms are defined on page 3.

Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Radionuclides

Sample Location	HEIS Number	Sample Date	Americium-241			Cesium-137			Carbon-14			Cobalt-60		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
SZ-3	J1R515	11/5/2012	0.140	U	0.140	0.361		0.062	1.66		0.876	0.137		0.076
Duplicate of J1R515	J1R525	11/5/2012	0.078	U	0.078	0.180		0.060	1.15		0.842	0.113	U	0.113
SZ-1	J1R513	11/5/2012	0.171	U	0.171	0.455		0.046	0.667	U	0.871	0.064	U	0.064
SZ-2	J1R514	11/6/2012	0.074	U	0.074	0.068	U	0.068	0.674	U	0.850	0.072	U	0.072
SZ-4	J1R516	11/6/2012	0.072	U	0.072	0.447		0.084	1.32		0.898	0.107	U	0.107
SZ-5	J1R517	11/5/2012	0.122	U	0.122	0.158		0.068	1.02		0.872	0.061	U	0.061
SZ-6	J1R518	11/5/2012	0.081	U	0.081	0.235		0.069	1.13		0.839	0.053		0.048
SZ-7	J1R519	11/6/2012	0.156	U	0.156	2.07		0.090	0.865	U	0.870	0.378		0.081
SZ-9	J1R521	11/5/2012	0.292	U	0.292	30.0		0.081	0.909		0.882	0.711		0.063
Re-sample of J1R521 [a]	J1RF76	2/12/2013	0.00302	U	0.0431	0.178		0.0284				0.0320	U	0.0345
SZ-10	J1R522	11/6/2012	0.254	U	0.254	0.063	U	0.063	2.98		1.39	0.058	U	0.058
SZ-11	J1R523	11/6/2012	0.078	U	0.078	0.607		0.069	1.08		0.866	0.096	U	0.096
SZ-12	J1R524	11/6/2012	0.140	U	0.140	1.55		0.064	1.33		0.905	0.238		0.066
Split of J1R515	J1R541	11/5/2012	0.00367	U	0.0387	0.127		0.0278	0.330	U	0.550	0.0958		0.0213
DZ-1	J1R2V0	10/10/2012	0.081	U	0.081	0.076		0.020	0.579	UJ	0.801	0.028	U	0.028
Duplicate of J1R2V0	J1R2W1	10/10/2012	0.139	U	0.139	0.184		0.024	3.33	J	1.14	0.025	U	0.025
DZ-2	J1R2V1	10/10/2012	0.040	U	0.040	0.421		0.032	0.940	J	0.798	0.066		0.041
DZ-3	J1R2V2	10/10/2012	0.102	U	0.102	0.200		0.030	0.908	J	0.806	0.063	U	0.063
DZ-4	J1R2V3	10/10/2012	0.336	U	0.336	0.220		0.044	1.34	J	0.823	0.046	U	0.046
DZ-5	J1R2V4	10/10/2012	0.037	U	0.037	0.093		0.022	0.567	UJ	0.800	0.020	U	0.020
DZ-6	J1R2V5	10/10/2012	0.162	U	0.162	0.651		0.034	1.14	J	0.819	0.049	U	0.049
DZ-7	J1R2V6	10/10/2012	0.663		0.400	127		0.112	3.56	J	0.930	5.37		0.049
DZ-8	J1R2W6	10/10/2012	19.7	U	19.7	3760		5.39	6.34		0.930	44.7		1.44
DZ-9	J1R2V7	10/10/2012	0.163	U	0.163	4.17		0.069	1.14	J	0.818	0.067	U	0.067
DZ-10	J1R2V8	10/10/2012	0.053	U	0.053	11.6		0.052	1.12	J	0.805	0.337		0.032
DZ-11	J1R2V9	10/10/2012	2.44	U	2.44	115		0.660	2.36		0.863	2.30		0.561
DZ-12	J1R2W8	10/10/2012	5.60		3.92	6000		6.56	3.67		0.952	37.2		1.08
Split of J1R2V0	J1R2W0	10/10/2012	-0.0247	U	0.166	0.0950		0.0245	-0.260	U	0.650	0.00361	U	0.0304
FS-1	J1R2W5	10/10/2012	23.8	U	23.8	16000		8.69	4.51		1.01	65.0		1.19
FS-2	J1R2W4	10/10/2012	3.88	U	3.88	7040		6.61	11.0		0.950	9.07		1.08
FS-3	J1R2W3	10/10/2012	10.3		8.73	35600		8.56	9.42		0.980	140		1.10
FS-4	J1R2W7	10/10/2012	7.30		3.29	4500		2.67	7.01		0.959	9.82		0.700
SZ-8 [b]	J1R520	11/6/2012	0.720	U	0.720	21.5		0.183	0.931		0.853	0.491		0.095
Re-sample of J1R520 [b]	J1RF75	2/12/2013	12.5		3.12	1760		0.592				73.5		0.234

Grey cells indicate not applicable or data will not be used.

[a] Sample Locations SZ-6 and SZ-9 underwent additional remediation and were re-sampled

[b] Sample Location SZ-8 was eliminated from the shallow zone decision unit, and is treated as a focused sample from the deep zone decision unit as discussed in the RSVP for this site.

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

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

B = blank contamination (inorganic constituents)
DZ = deep zone
HEIS = Hanford Environmental Information System
J = estimate
M = sample duplicate precision not met.
N= recovery exceeds upper and lower control limit.
PQL = practical quantitation limit
Q = qualifier
RAG = remedial action goal
SZ = shallow zone
U = undetected
X (metals) = serial dilution in the analytical batch indicates that physical and chemical interferences are present (metals).

Attachment	1	Sheet No.	1 of 14
Originator	N. K. Schiffern	Date	3/26/13
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Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Radionuclides

Sample Location	HEIS Number	Sample Date	Europium-152			Europium-154			Europium-155			Nickel-63		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
SZ-3	J1R515	11/5/2012	0.181	U	0.181	0.202	U	0.202	0.134	U	0.134	-1.89	U	3.26
Duplicate of J1R515	J1R525	11/5/2012	0.188	U	0.188	0.203	U	0.203	0.136	U	0.136	-2.93	U	3.44
SZ-1	J1R513	11/5/2012	0.151	U	0.151	0.168	U	0.168	0.151	U	0.151	-0.934	U	3.43
SZ-2	J1R514	11/6/2012	0.192	U	0.192	0.201	U	0.201	0.144	U	0.144	-1.76	U	3.30
SZ-4	J1R516	11/6/2012	0.164	U	0.164	0.191	U	0.191	0.131	U	0.131	-1.29	U	3.21
SZ-5	J1R517	11/5/2012	0.149	U	0.149	0.183	U	0.183	0.113	U	0.113	-1.97	U	3.27
SZ-6	J1R518	11/5/2012	0.179	U	0.179	0.226	U	0.226	0.150	U	0.150	-1.90	U	3.28
SZ-7	J1R519	11/6/2012	0.201	U	0.201	0.197	U	0.197	0.139	U	0.139	-3.04	U	3.78
SZ-9	J1R521	11/5/2012	0.390	U	0.390	0.203	U	0.203	0.322	U	0.322	0.302	U	3.65
Re-sample of J1R521 [a]	J1RF76	2/12/2013	-0.0234	U	0.0623	-0.00617	U	0.0783	-0.00781	U	0.0623			
SZ-10	J1R522	11/6/2012	0.157	U	0.157	0.179	U	0.179	0.163	U	0.163	-2.02	U	3.22
SZ-11	J1R523	11/6/2012	0.174	U	0.174	0.213	U	0.213	0.138	U	0.138	-0.083	U	3.50
SZ-12	J1R524	11/6/2012	0.187	U	0.187	0.226	U	0.226	0.143	U	0.143	-2.47	U	3.48
Split of J1R515	J1R541	11/5/2012	0.0191	U	0.0618	0.00177	U	0.0803	0.0274	U	0.058	-3.61	U	15.4
DZ-1	J1R2V0	10/10/2012	0.048	U	0.048	0.055	U	0.055	0.067	U	0.067	1.14	U	3.00
Duplicate of J1R2V0	J1R2W1	10/10/2012	0.060	U	0.060	0.072	U	0.072	0.078	U	0.078	2.11	U	3.17
DZ-2	J1R2V1	10/10/2012	0.085	U	0.085	0.099	U	0.099	0.072	U	0.072	1.07	U	3.03
DZ-3	J1R2V2	10/10/2012	0.073	U	0.073	0.099	U	0.099	0.095	U	0.095	2.29	U	2.96
DZ-4	J1R2V3	10/10/2012	0.108	U	0.108	0.135	U	0.135	0.132	U	0.132	4.29		3.04
DZ-5	J1R2V4	10/10/2012	0.056	U	0.056	0.064	U	0.064	0.057	U	0.057	0.442	U	2.96
DZ-6	J1R2V5	10/10/2012	0.073	U	0.073	0.090	U	0.090	0.089	U	0.089	1.40	U	2.96
DZ-7	J1R2V6	10/10/2012	0.379	U	0.379	0.323		0.121	0.337	U	0.337	9.47		2.84
DZ-8	J1R2W6	10/10/2012	17.3	U	17.3	4.41	U	4.41	10.5	U	10.5	64.0		3.01
DZ-9	J1R2V7	10/10/2012	0.198	U	0.198	0.162	U	0.162	0.173	U	0.173	0.559	U	2.94
DZ-10	J1R2V8	10/10/2012	0.174	U	0.174	0.103	U	0.103	0.106	U	0.106	1.92	U	3.14
DZ-11	J1R2V9	10/10/2012	2.14	U	2.14	1.36	U	1.36	2.20	U	2.20	2.36	U	3.22
DZ-12	J1R2W8	10/10/2012	17.3	U	17.3	3.56		2.52	7.67	U	7.67	25.1		3.07
Split of J1R2V0	J1R2W0	10/10/2012	-0.0255	U	0.0611	0.00790	U	0.0829	0.0437	U	0.0685	3.36	U	14.3
FS-1	J1R2W5	10/10/2012	25.4	U	25.4	7.31		2.58	15.5	U	15.5	28.6		3.15
FS-2	J1R2W4	10/10/2012	17.1	U	17.1	2.27	U	2.27	7.54	U	7.54	7.23		3.12
FS-3	J1R2W3	10/10/2012	36.2	U	36.2	16.2		4.13	17.9	U	17.9	95.5		3.04
FS-4	J1R2W7	10/10/2012	12.0	U	12.0	1.72		1.15	6.02	U	6.02	26.4		3.21
SZ-8 [b]	J1R520	11/6/2012	0.556	U	0.556	0.294	U	0.294	0.423	U	0.423	1.16	U	3.37
Re-sample of J1R520 [b]	J1RF75	2/12/2013	0.193	U	2.00	5.19		0.659	0.917	U	1.36			

Attachment	1	Sheet No.	2 of 14
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Checked	C. H. Dobie	Date	3/25/13
Calc. No.	0100N-CA-V0192	Rev. No.	0

Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Radionuclides

Sample Location	HEIS Number	Sample Date	Potassium-40			Plutonium-238			Plutonium-239/240			Radium-226		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
SZ-3	J1R515	11/5/2012	9.57		0.684	-0.028	U	0.217	0.057	U	0.217	0.381		0.115
Duplicate of J1R515	J1R525	11/5/2012	8.88		1.01	0.064	U	0.245	0	U	0.245	0.387		0.129
SZ-1	J1R513	11/5/2012	10.6		0.355	0.043	U	0.332	0.043	U	0.332	0.379		0.117
SZ-2	J1R514	11/6/2012	8.73		0.838	-0.022	U	0.166	0	U	0.166	0.256		0.151
SZ-4	J1R516	11/6/2012	9.82		0.733	0	U	0.214	0.056	U	0.214	0.298		0.123
SZ-5	J1R517	11/5/2012	7.99		0.632	0	U	0.225	0.059	U	0.225	0.274		0.110
SZ-6	J1R518	11/5/2012	10.6		0.794	0.042	U	0.318	0.042	U	0.318	0.292		0.137
SZ-7	J1R519	11/6/2012	9.96		0.064	0	U	0.183	0.096	U	0.183	0.323		0.122
SZ-9	J1R521	11/5/2012	9.77		0.414	0.114	U	0.290	0.569		0.290	0.210	U	0.226
Re-sample of J1R521 [a]	J1RF76	2/12/2013	13.0		0.228							0.388		0.0468
SZ-10	J1R522	11/6/2012	10.8		0.609	0	U	0.414	0	U	0.414	0.505		0.116
SZ-11	J1R523	11/6/2012	10.5		0.709	0.044	U	0.335	0.044	U	0.335	0.429		0.137
SZ-12	J1R524	11/6/2012	9.16		0.595	0	U	0.353	0.092	U	0.353	0.429		0.120
Split of J1R515	J1R541	11/5/2012				0.0121	U	0.0948	0.0781	U	0.112	0.477		0.0401
DZ-1	J1R2V0	10/10/2012	9.52		0.167	0.005	U	0.045	0.003	U	0.028	0.312		0.034
Duplicate of J1R2V0	J1R2W1	10/10/2012	10.1		0.186	0.026	U	0.050	0.011	U	0.036	0.361		0.037
DZ-2	J1R2V1	10/10/2012	10.8		0.352	-0.003	U	0.036	0.036		0.025	0.437		0.056
DZ-3	J1R2V2	10/10/2012	11.4		0.236	0.021	U	0.054	0.025	U	0.027	0.527		0.054
DZ-4	J1R2V3	10/10/2012	8.87		0.364	0.004	U	0.049	0.040		0.028	0.316		0.072
DZ-5	J1R2V4	10/10/2012	9.30		0.164	-0.003	U	0.045	0	U	0.034	0.304		0.036
DZ-6	J1R2V5	10/10/2012	12.2		0.213	0.009	U	0.046	0.021	U	0.033	0.435		0.063
DZ-7	J1R2V6	10/10/2012	10.6		0.324	0.244		0.043	1.88		0.020	0.381		0.172
DZ-8	J1R2W6	10/10/2012	17.1	U	17.1	0.955		0.046	7.97		0.029	8.26	U	8.26
DZ-9	J1R2V7	10/10/2012	8.59		0.437	0.009	U	0.053	0.012	U	0.032	0.318		0.086
DZ-10	J1R2V8	10/10/2012	12.7		0.330	0.043	U	0.073	0.186		0.037	0.399		0.071
DZ-11	J1R2V9	10/10/2012	13.4		3.14	0.092		0.046	0.529		0.024	1.14	U	1.14
DZ-12	J1R2W8	10/10/2012	13.0		4.95	2.17		0.057	14.6		0.036	5.36	U	5.36
Split of J1R2V0	J1R2W0	10/10/2012				0.0111	U	0.0796	0.0289	U	0.0665	0.386		0.0483
FS-1	J1R2W5	10/10/2012	8.88		5.83	1.77		0.051	13.8		0.029	10.5	U	10.5
FS-2	J1R2W4	10/10/2012	13.6		4.20	0.699		0.057	4.36		0.033	5.26	U	5.26
FS-3	J1R2W3	10/10/2012	19.4	U	19.4	3.59		0.052	28.2		0.030	11.5	U	11.5
FS-4	J1R2W7	10/10/2012	10.3		4.03	1.28		0.050	10.1		0.028	3.85	U	3.85
SZ-8 [b]	J1R520	11/6/2012	7.46		0.897	0.278		0.266	0.451		0.265	0.416		0.252
Re-sample of J1R520 [b]	J1RF75	2/12/2013	10.2		1.82							0.576	U	1.08

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Checked	C. H. Dobie	Date	3/25/13
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Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Radionuclides

Sample Location	HEIS Number	Sample Date	Radium-228			Thorium-228			Thorium-232			Total beta radiostrontium		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
SZ-3	J1R515	11/5/2012										0.124	U	0.340
Duplicate of J1R515	J1R525	11/5/2012										0.041	U	0.326
SZ-1	J1R513	11/5/2012										0.008	U	0.434
SZ-2	J1R514	11/6/2012										-0.040	U	0.332
SZ-4	J1R516	11/6/2012										-0.050	U	0.341
SZ-5	J1R517	11/5/2012										-0.015	U	0.291
SZ-6	J1R518	11/5/2012										4.67		0.260
Re-sample of J1R518 [a]	J1RF74	2/12/2013										0.108	U	0.114
SZ-7	J1R519	11/6/2012										0.080	U	0.298
SZ-9	J1R521	11/5/2012										11.8		0.266
Re-sample of J1R521 [a]	J1RF76	2/12/2013										0.0285	U	0.118
SZ-10	J1R522	11/6/2012										-0.080	U	0.322
SZ-11	J1R523	11/6/2012										0.062	U	0.296
SZ-12	J1R524	11/6/2012										0.094	U	0.322
Split of J1R515	J1R541	11/5/2012										0.210		0.171
DZ-1	J1R2V0	10/10/2012	0.523		0.082	0.470		0.025	0.523		0.082	0.231		0.199
Duplicate of J1R2V0	J1R2W1	10/10/2012	0.544		0.090	0.527		0.030	0.544		0.090	0.052	U	0.290
DZ-2	J1R2V1	10/10/2012	0.488		0.136	0.641		0.041	0.488		0.136	0.206	U	0.267
DZ-3	J1R2V2	10/10/2012	0.880		0.116	0.727		0.032	0.880		0.116	0.018	U	0.281
DZ-4	J1R2V3	10/10/2012	0.423		0.160	0.578		0.065	0.423		0.160	0.466		0.223
DZ-5	J1R2V4	10/10/2012	0.437		0.090	0.454		0.025	0.437		0.090	0.192	U	0.231
DZ-6	J1R2V5	10/10/2012	0.741		0.104	0.624		0.039	0.741		0.104	0.068	U	0.283
DZ-7	J1R2V6	10/10/2012	0.629		0.234	0.481		0.212	0.629		0.234	11.5		0.214
DZ-8	J1R2W6	10/10/2012	7.56	U	7.56	6.72	U	6.72	7.56	U	7.56	796		0.368
DZ-9	J1R2V7	10/10/2012	0.511		0.211	0.446		0.097	0.511		0.211	0.733		0.252
DZ-10	J1R2V8	10/10/2012	0.693		0.147	0.744		0.078	0.693		0.147	1.30		0.241
DZ-11	J1R2V9	10/10/2012	1.93	U	1.93	1.16	U	1.16	1.93	U	1.93	931		0.359
DZ-12	J1R2W8	10/10/2012	5.34	U	5.34	6.31	U	6.31	5.34	U	5.34	403		0.332
Split of J1R2V0	J1R2W0	10/10/2012										0.209		0.153
FS-1	J1R2W5	10/10/2012	6.08	U	6.08	10.9	U	10.9	6.08	U	6.08	390		0.330
FS-2	J1R2W4	10/10/2012	3.74	U	3.74	6.28	U	6.28	3.74	U	3.74	271		0.336
FS-3	J1R2W3	10/10/2012	8.70	U	8.70	14.1	U	14.1	8.70	U	8.70	1100		0.388
FS-4	J1R2W7	10/10/2012	2.60	U	2.60	4.71	U	4.71	2.60	U	2.60	422		0.382
SZ-8 [b]	J1R520	11/6/2012										2.56		0.188

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Checked	C. H. Dobie	Date	3/25/13
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Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Radionuclides

Sample Location	HEIS Number	Sample Date	Tritium			Uranium-233/234			Uranium-234			Uranium-235		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
SZ-3	J1R515	11/5/2012	-0.330	U	3.50	0.539		0.242				0	U	0.293
Duplicate of J1R515	J1R525	11/5/2012	0.056	U	3.55	0.444		0.179				0.085	U	0.216
SZ-1	J1R513	11/5/2012	0.116	U	3.68	0.414		0.176				0	U	0.213
SZ-2	J1R514	11/6/2012	0.385	U	3.51	0.338		0.216				0.034	U	0.261
SZ-4	J1R516	11/6/2012	2.80	U	4.06	0.299		0.254				0	U	0.308
SZ-5	J1R517	11/5/2012	-0.124	U	3.94	0.491		0.179				0	U	0.216
SZ-6	J1R518	11/5/2012	1.61	U	3.42	0.446		0.163				0.077	U	0.197
SZ-7	J1R519	11/6/2012	1.12	U	3.77	0.585		0.224				0	U	0.271
SZ-9	J1R521	11/5/2012	0.765	U	3.76	0.561		0.179				0.028	U	0.216
SZ-10	J1R522	11/6/2012	-0.841	U	2.82	0.824		0.225				0	U	0.272
SZ-11	J1R523	11/6/2012	0.400	U	3.65	0.618		0.338				0.053	U	0.409
SZ-12	J1R524	11/6/2012	1.80	U	3.70	0.575		0.367				0.058	U	0.444
Split of J1R515	J1R541	11/5/2012	0.0439	U	0.0449				0.162		0.0548	0.0110	U	0.0400
DZ-1	J1R2V0	10/10/2012	1.52	UJ	3.29	0.534		0.227				0.036	UJ	0.275
Duplicate of J1R2V0	J1R2W1	10/10/2012	3.36	J	2.66	0.418		0.246				0	UJ	0.298
DZ-2	J1R2V1	10/10/2012	0.226	UJ	3.30	0.523		0.200				0	UJ	0.242
DZ-3	J1R2V2	10/10/2012	1.16	UJ	3.37	0.937		0.199				0.032	UJ	0.241
DZ-4	J1R2V3	10/10/2012	0.771	UJ	3.46	0.507		0.228				0.036	UJ	0.276
DZ-5	J1R2V4	10/10/2012	1.28	UJ	3.41	0.682		0.227				0.072	UJ	0.275
DZ-6	J1R2V5	10/10/2012	1.38	UJ	4.24	0.788		0.215				0.034	UJ	0.261
DZ-7	J1R2V6	10/10/2012	7.24	J	2.63	0.492		0.188				0.030	UJ	0.228
DZ-8	J1R2W6	10/10/2012	2.30	U	3.42	0.513		0.178				0.085	U	0.216
DZ-9	J1R2V7	10/10/2012	0.231	UJ	3.38	0.562		0.205				0.032	UJ	0.248
DZ-10	J1R2V8	10/10/2012	0.055	UJ	3.19	0.470		0.189				0	UJ	0.229
DZ-11	J1R2V9	10/10/2012	1.90	UJ	3.37	0.619		0.182				0	UJ	0.220
DZ-12	J1R2W8	10/10/2012	0.502	U	3.61	0.693		0.183				0.145	U	0.221
Split of J1R2V0	J1R2W0	10/10/2012	0.022	U	0.047				0.109		0.0531	-0.000888	U	0.0446
FS-1	J1R2W5	10/10/2012	3.53	U	3.62	0.560		0.195				0.031	U	0.236
FS-2	J1R2W4	10/10/2012	2.21	U	3.63	1.58		0.199				0.220	U	0.240
FS-3	J1R2W3	10/10/2012	5.43		3.64	1.25		0.228				0.145	U	0.276
FS-4	J1R2W7	10/10/2012	1.86	U	3.59	1.08		0.189				0.149	U	0.228
SZ-8 [b]	J1R520	11/6/2012	0.606	U	3.86	0.685		0.194				0	U	0.235

Attachment	1	Sheet No.	5 of 14
Originator	N. K. Schiffern	Date	3/25/13
Checked	C. H. Dobie	Date	3/25/13
Calc. No.	0100N-CA-V0192	Rev. No.	0

Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Radionuclides

Sample Location	HEIS Number	Sample Date	Uranium-238		
			pCi/g	Q	MDA
SZ-3	J1R515	11/5/2012	0.412		0.242
Duplicate of J1R515	J1R525	11/5/2012	0.561		0.179
SZ-1	J1R513	11/5/2012	0.483		0.176
SZ-2	J1R514	11/6/2012	0.338		0.216
SZ-4	J1R516	11/6/2012	0.332		0.254
SZ-5	J1R517	11/5/2012	0.444		0.179
SZ-6	J1R518	11/5/2012	0.489		0.163
SZ-7	J1R519	11/6/2012	0.673		0.224
SZ-9	J1R521	11/5/2012	0.468		0.179
SZ-10	J1R522	11/6/2012	0.441		0.225
SZ-11	J1R523	11/6/2012	0.574		0.338
SZ-12	J1R524	11/6/2012	0.431		0.367
Split of J1R515	J1R541	11/5/2012	0.150		0.0604
DZ-1	J1R2V0	10/10/2012	0.564		0.227
Duplicate of J1R2V0	J1R2W1	10/10/2012	0.322		0.246
DZ-2	J1R2V1	10/10/2012	0.706		0.200
DZ-3	J1R2V2	10/10/2012	0.963		0.199
DZ-4	J1R2V3	10/10/2012	0.657		0.228
DZ-5	J1R2V4	10/10/2012	0.475		0.227
DZ-6	J1R2V5	10/10/2012	0.535		0.215
DZ-7	J1R2V6	10/10/2012	0.713		0.188
DZ-8	J1R2W6	10/10/2012	0.490		0.178
DZ-9	J1R2V7	10/10/2012	0.562		0.205
DZ-10	J1R2V8	10/10/2012	0.494		0.189
DZ-11	J1R2V9	10/10/2012	0.523		0.182
DZ-12	J1R2W8	10/10/2012	0.669		0.183
Split of J1R2V0	J1R2W0	10/10/2012	0.0847		0.061
FS-1	J1R2W5	10/10/2012	0.611		0.195
FS-2	J1R2W4	10/10/2012	1.06		0.199
FS-3	J1R2W3	10/10/2012	0.956		0.228
FS-4	J1R2W7	10/10/2012	1.16		0.189
SZ-8 [b]	J1R520	11/6/2012	0.634		0.194

Attachment	1	Sheet No.	6 of 14
Originator	N. K. Schiffern	Date	3/25/13
Checked	C. H. Dobie	Date	3/25/13
Calc. No.	0100N-CA-V0192	Rev. No.	0

Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Metals.

Sample Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
SZ-3	J1R515	11/5/2012	6780		12.3	1.48	U	1.48	2.72		2.46	56.1		1.23	0.213	B	0.493
Duplicate of J1R515	J1R525	11/5/2012	6650		13.9	1.67	U	1.67	2.58	B	2.78	55.9		1.39	0.229	B	0.555
SZ-1	J1R513	11/5/2012	7680		15.1	1.81	U	1.81	3.38		3.01	48.8		1.51	0.290	B	0.602
SZ-2	J1R514	11/6/2012	6010		14.4	1.73	U	1.73	2.08	B	2.88	59.0		1.44	0.217	B	0.577
SZ-4	J1R516	11/6/2012	6540		14.2	1.71	U	1.71	2.09	B	2.85	61.6		1.42	0.198	B	0.570
SZ-5	J1R517	11/5/2012	4740		14.7	1.77	U	1.77	1.82	B	2.95	44.9		1.47	0.175	B	0.589
SZ-6	J1R518	11/5/2012	7670		13.9	1.67	U	1.67	2.41	B	2.78	61.9		1.39	0.238	B	0.557
SZ-7	J1R519	11/6/2012	6920		13.6	1.63	U	1.63	2.22	B	2.71	63.9		1.36	0.242	B	0.543
SZ-9	J1R521	11/5/2012	7050		14.3	1.72	U	1.72	2.89		2.86	51.9		1.43	0.259	B	0.572
SZ-10	J1R522	11/6/2012	7440		14.4	1.72	U	1.72	3.64		2.87	52.6		1.44	0.242	B	0.575
SZ-11	J1R523	11/6/2012	7400		12.5	1.50	U	1.50	2.84		2.50	54.7		1.25	0.264	B	0.500
SZ-12	J1R524	11/6/2012	7470		14.3	1.71	U	1.71	2.95		2.85	58.4		1.43	0.279	B	0.571
Split of J1R515	J1R541	11/5/2012	6010	X	1.5	0.36	U	0.36	2.4		0.62	49.5	X	0.072	0.27		0.031
DZ-1	J1R2V0	10/10/2012	5560	J	14.5	1.74	UJ	1.74	1.75	B	2.90	62.8		1.45	0.239	B	0.581
Duplicate of J1R2V0	J1R2W1	10/10/2012	5310	J	13.5	1.62	UJ	1.62	1.74	B	2.70	57.3		1.35	0.205	B	0.540
DZ-2	J1R2V1	10/10/2012	4900	J	10.5	1.26	UJ	1.26	1.80	B	2.10	56.0		1.05	0.203	B	0.420
DZ-3	J1R2V2	10/10/2012	6530	J	12.8	1.53	UJ	1.53	2.54	B	2.56	55.3		1.28	0.252	B	0.511
DZ-4	J1R2V3	10/10/2012	4810	J	12.8	1.54	UJ	1.54	1.56	B	2.56	39.7		1.28	0.232	B	0.512
DZ-5	J1R2V4	10/10/2012	4780	J	13.3	1.59	UJ	1.59	1.43	B	2.66	62.5		1.33	0.225	B	0.532
DZ-6	J1R2V5	10/10/2012	6780	J	12.9	1.55	UJ	1.55	2.52	B	2.58	56.2		1.29	0.26	B	0.515
DZ-7	J1R2V6	10/10/2012	5890	J	12.8	1.54	UJ	1.54	1.74	B	2.56	67.1		1.28	0.241	B	0.513
DZ-8	J1R2W6	10/10/2012	5110		13.0	1.56	U	1.56	1.53	B	2.61	83.4		1.30	0.223	B	0.521
DZ-9	J1R2V7	10/10/2012	5430	J	12.2	1.46	UJ	1.46	1.66	B	2.44	50.7		1.22	0.237	B	0.488
DZ-10	J1R2V8	10/10/2012	5550	J	11.6	1.39	UJ	1.39	1.64	B	2.32	50.7		1.16	0.224	B	0.464
DZ-11	J1R2V9	10/10/2012	4720	J	12.2	1.47	UJ	1.47	1.63	B	2.44	75.3		1.22	0.231	B	0.489
DZ-12	J1R2W8	10/10/2012	4680		14.5	1.75	U	1.75	1.40	B	2.91	53.2		1.45	0.257	B	0.582
Split of J1R2V0	J1R2W0	10/10/2012	2920		7.0	0.34	U	0.34	0.59	U	0.59	54.4		0.34	0.50	B	0.15
FS-1	J1R2W5	10/10/2012	5440		13.0	1.57	U	1.57	1.66	B	2.61	74.4		1.30	0.208	B	0.522
FS-2	J1R2W4	10/10/2012	4880		9.98	1.20	U	1.20	1.38	B	2.00	35.2		0.998	0.127	B	0.399
FS-3	J1R2W3	10/10/2012	5830		12.8	1.54	U	1.54	1.55	B	2.57	86.0		1.28	0.205	B	0.513
FS-4	J1R2W7	10/10/2012	5000		12.4	1.49	U	1.49	1.44	B	2.48	40.4		1.24	0.192	B	0.495
SZ-8 [b]	J1R520	11/6/2012	6740		15.2	1.83	U	1.83	4.04		3.05	53.1		1.52	0.254	B	0.609
Equipment Blank	J1R2W2	10/10/2012	246	J	3.29	0.395	UJ	0.395	0.286	B	0.658	2.45		0.329	0.040	B	0.132

Attachment	1	Sheet No.	7 of 14
Originator	N. K. Schiffern	Date	3/25/13
Checked	C. H. Dobie	Date	3/25/13
Calc. No.	0100N-CA-V0192	Rev. No.	0

Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Metals.

Sample Location	HEIS Number	Sample Date	Boron			Cadmium			Calcium			Chromium			Cobalt		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
SZ-3	J1R515	11/5/2012	4.93	U	4.93	0.493	U	0.493	7090		246	10.6		0.493	8.29		4.93
Duplicate of J1R515	J1R525	11/5/2012	5.55	U	5.55	0.555	U	0.555	6810		278	9.33		0.555	7.55		5.55
SZ-1	J1R513	11/5/2012	1.69	B	6.02	0.602	U	0.602	17300		301	9.45		0.602	9.06		6.02
SZ-2	J1R514	11/6/2012	5.77	U	5.77	0.577	U	0.577	4820		288	9.49		0.577	7.90		5.77
SZ-4	J1R516	11/6/2012	5.70	U	5.70	0.570	U	0.570	6240		285	13.0		0.570	7.37		5.70
SZ-5	J1R517	11/5/2012	5.89	U	5.89	0.589	U	0.589	6820		295	4.96		0.589	8.64		5.89
SZ-6	J1R518	11/5/2012	5.57	U	5.57	0.557	U	0.557	8780		278	12.4		0.557	6.73		5.57
SZ-7	J1R519	11/6/2012	5.43	U	5.43	0.543	U	0.543	6890		271	9.55		0.543	8.85		5.43
SZ-9	J1R521	11/5/2012	5.72	U	5.72	0.572	U	0.572	14300		286	7.12		0.572	7.68		5.72
SZ-10	J1R522	11/6/2012	5.75	U	5.75	0.575	U	0.575	8630		287	10.5		0.575	7.10		5.75
SZ-11	J1R523	11/6/2012	5.00	U	5.00	0.500	U	0.500	8000		250	9.56		0.500	8.41		5.00
SZ-12	J1R524	11/6/2012	5.71	U	5.71	0.571	U	0.571	8030		285	7.99		0.571	9.67		5.71
Split of J1R515	J1R541	11/5/2012	0.93	U	0.93	0.15	B	0.039	6590	X	13.3	7.6	X	0.055	7.2	X	0.094
DZ-1	J1R2V0	10/10/2012	5.81	U	5.81	0.581	U	0.581	7220	J	290	5.13		0.581	9.99		5.81
Duplicate of J1R2V0	J1R2W1	10/10/2012	5.40	U	5.40	0.540	U	0.540	6520	J	270	4.89		0.540	9.67		5.40
DZ-2	J1R2V1	10/10/2012	4.20	U	4.20	0.420	U	0.420	6080	J	210	5.54		0.420	8.64		4.20
DZ-3	J1R2V2	10/10/2012	5.11	U	5.11	0.511	U	0.511	5400	J	256	13.4		0.511	8.10		5.11
DZ-4	J1R2V3	10/10/2012	5.12	U	5.12	0.512	U	0.512	6690	J	256	4.51		0.512	9.67		5.12
DZ-5	J1R2V4	10/10/2012	5.32	U	5.32	0.532	U	0.532	6510	J	266	8.60		0.532	10.2		5.32
DZ-6	J1R2V5	10/10/2012	5.15	U	5.15	0.515	U	0.515	7600	J	258	9.23		0.515	8.77		5.15
DZ-7	J1R2V6	10/10/2012	5.13	U	5.13	0.513	U	0.513	6640	J	256	5.72		0.513	10.6		5.13
DZ-8	J1R2W6	10/10/2012	5.21	U	5.21	0.182	B	0.521	5650		261	11.5		0.521	10.7		5.21
DZ-9	J1R2V7	10/10/2012	4.88	U	4.88	0.488	U	0.488	7350	J	244	7.44		0.488	9.90		4.88
DZ-10	J1R2V8	10/10/2012	4.64	U	4.64	0.464	U	0.464	5490	J	232	6.81		0.464	8.07		4.64
DZ-11	J1R2V9	10/10/2012	4.89	U	4.89	0.489	U	0.489	6380	J	244	4.64		0.489	10.7		4.89
DZ-12	J1R2W8	10/10/2012	5.82	U	5.82	0.582	U	0.582	6420		291	8.78		0.582	10.5		5.82
Split of J1R2V0	J1R2W0	10/10/2012	0.88	U	0.88	0.075	B	0.037	5190		63.3	1.5	M	0.052	9.0		0.09
FS-1	J1R2W5	10/10/2012	5.22	U	5.22	0.522	U	0.522	5340		261	17.0		0.522	10.0		5.22
FS-2	J1R2W4	10/10/2012	3.99	U	3.99	0.399	U	0.399	5400		200	6.75		0.399	9.64		3.99
FS-3	J1R2W3	10/10/2012	5.13	U	5.13	0.192	B	0.513	6260		257	23.4		0.513	9.79		5.13
FS-4	J1R2W7	10/10/2012	4.95	U	4.95	0.495	U	0.495	6170		248	4.65		0.495	9.45		4.95
SZ-8 [b]	J1R520	11/6/2012	6.09	U	6.09	0.609	U	0.609	5110		305	5.74		0.609	8.46		6.09
Equipment Blank	J1R2W2	10/10/2012	1.32	U	1.32	0.132	U	0.132	36.8	BJ	65.8	0.165		0.132	1.32	U	1.32

Attachment	1	Sheet No.	8 of 14
Originator	N. K. Schiffern	Date	3/25/13
Checked	C. H. Dobie	Date	3/25/13
Calc. No.	0100N-CA-V0192	Rev. No.	0

Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Metals.

Sample Location	HEIS Number	Sample Date	Copper			Hexavalent Chromium			Iron			Lead			Magnesium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
SZ-3	J1R515	11/5/2012	19.9		2.46	0.21	U	0.21	24200		49.3	5.28		1.23	5160		185
Duplicate of J1R515	J1R525	11/5/2012	17.0		2.78	0.21	U	0.21	23200		55.5	4.22		1.39	4250		208
SZ-1	J1R513	11/5/2012	19.2		3.01	0.21	U	0.21	26500		60.2	4.91		1.51	5850		226
SZ-2	J1R514	11/6/2012	15.2		2.88	0.21	U	0.21	24600		57.7	5.08		1.44	3950		216
SZ-4	J1R516	11/6/2012	19.6		2.85	0.37	B	0.21	21500		57.0	12.7		1.42	3730		214
SZ-5	J1R517	11/5/2012	15.7		2.95	0.21	U	0.21	25100		58.9	2.82		1.47	3530		221
SZ-6	J1R518	11/5/2012	14.1		2.78	0.21	U	0.21	21500		55.7	3.41		1.39	4460		209
SZ-7	J1R519	11/6/2012	16.1		2.71	0.21	U	0.21	26200		54.3	4.00		1.36	4470		204
SZ-9	J1R521	11/5/2012	15.7		2.86	0.21	U	0.21	23600		57.2	4.17		1.43	4700		215
SZ-10	J1R522	11/6/2012	16.6		2.87	0.21	U	0.21	22100		57.5	4.10		1.44	4760		216
SZ-11	J1R523	11/6/2012	17.2		2.50	0.21	U	0.21	25200		50.0	4.38		1.25	4970		187
SZ-12	J1R524	11/6/2012	17.8		2.85	0.21	U	0.21	28600		57.1	4.47		1.43	5360		214
Split of J1R515	J1R541	11/5/2012	19.1		0.20	0.210		0.155	21500	X	3.6	3.7		0.25	4490	X	3.5
DZ-1	J1R2V0	10/10/2012	13.8		2.90	0.20	U	0.20	30900		58.1	2.66		1.45	5070		218
Duplicate of J1R2V0	J1R2W1	10/10/2012	14.6		2.70	0.20	U	0.20	29700		54.0	2.45		1.35	4780		202
DZ-2	J1R2V1	10/10/2012	13.3		2.10	0.20	U	0.20	28300		42.0	2.44		1.05	4720		157
DZ-3	J1R2V2	10/10/2012	12.4		2.56	0.20	U	0.20	26700		51.1	3.62		1.28	4490		192
DZ-4	J1R2V3	10/10/2012	14.5		2.56	0.20	U	0.20	31300		51.2	2.20		1.28	4830		192
DZ-5	J1R2V4	10/10/2012	14.5		2.66	0.20	U	0.20	31900		53.2	2.18		1.33	5470		199
DZ-6	J1R2V5	10/10/2012	16.2		2.58	0.20	U	0.20	27000		51.5	3.65		1.29	4970		193
DZ-7	J1R2V6	10/10/2012	16.4		2.56	0.20	U	0.20	31000		51.3	3.03		1.28	4830		192
DZ-8	J1R2W6	10/10/2012	15.5		2.61	0.61		0.20	31500		52.1	3.42		1.30	4070		195
DZ-9	J1R2V7	10/10/2012	15.2		2.44	0.20	U	0.20	30800		48.8	2.52		1.22	4790		183
DZ-10	J1R2V8	10/10/2012	16.1		2.32	0.20	U	0.20	26200		46.4	2.63		1.16	4470		174
DZ-11	J1R2V9	10/10/2012	17.1		2.44	0.20	U	0.20	32000		48.9	2.54		1.22	4800		183
DZ-12	J1R2W8	10/10/2012	16.4		2.91	0.33	B	0.20	31700		58.2	2.63		1.45	4570		218
Split of J1R2V0	J1R2W0	10/10/2012	38.0	MN	0.19	0.155	U	0.155	26800		17.1	4.0	M	0.24	3340		3.3
FS-1	J1R2W5	10/10/2012	15.2		2.61	0.85		0.20	29600		52.2	3.05		1.30	4450		196
FS-2	J1R2W4	10/10/2012	14.4		2.00	0.20	U	0.20	30800		39.9	2.14		0.998	4680		150
FS-3	J1R2W3	10/10/2012	17.7		2.57	1.64		0.20	32600		51.3	2.68		1.28	4060		193
FS-4	J1R2W7	10/10/2012	14.6		2.48	0.20	U	0.20	32200		49.5	2.53		1.24	4540		186
SZ-8 [b]	J1R520	11/6/2012	16.0		3.05	0.21	U	0.21	25600		60.9	5.17		1.52	4510		228
Equipment Blank	J1R2W2	10/10/2012	0.658	U	0.658				696		13.2	0.738		0.329	26.2	B	49.4

Attachment	1	Sheet No.	9 of 14
Originator	N. K. Schiffern	Date	3/25/13
Checked	C. H. Dobie	Date	3/25/13
Calc. No.	0100N-CA-V0192	Rev. No.	0

Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Metals.

Sample Location	HEIS Number	Sample Date	Manganese			Mercury			Molybdenum			Nickel			Potassium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
SZ-3	J1R515	11/5/2012	309		12.3	0.0239	U	0.0239	4.93	U	4.93	12.9		9.86	991		986
Duplicate of J1R515	J1R525	11/5/2012	292		13.9	0.0283	U	0.0283	5.55	U	5.55	9.23	B	11.1	986	B	1110
SZ-1	J1R513	11/5/2012	351		15.1	0.0282	U	0.0282	6.02	U	6.02	10.4	B	12.0	1170	B	1200
SZ-2	J1R514	11/6/2012	316		14.4	0.0252	U	0.0252	5.77	U	5.77	8.52	B	11.5	1000	B	1150
SZ-4	J1R516	11/6/2012	290		14.2	0.0285	U	0.0285	5.70	U	5.70	9.16	B	11.4	1010	B	1140
SZ-5	J1R517	11/5/2012	301		14.7	0.0275	U	0.0275	5.89	U	5.89	6.44	B	11.8	812	B	1180
SZ-6	J1R518	11/5/2012	289		13.9	0.0240	U	0.0240	5.57	U	5.57	10.8	B	11.1	1230		1110
SZ-7	J1R519	11/6/2012	333		13.6	0.0262	U	0.0262	5.43	U	5.43	8.60	B	10.9	1070	B	1090
SZ-9	J1R521	11/5/2012	288		14.3	0.0260	U	0.0260	5.72	U	5.72	8.54	B	11.4	990	B	1140
SZ-10	J1R522	11/6/2012	310		14.4	0.0274	U	0.0274	5.75	U	5.75	9.85	B	11.5	1110	B	1150
SZ-11	J1R523	11/6/2012	323		12.5	0.0255	U	0.0255	5.00	U	5.00	10.9		10.0	1170		1000
SZ-12	J1R524	11/6/2012	363		14.3	0.0294	U	0.0294	5.71	U	5.71	9.65	B	11.4	1180		1140
Split of J1R515	J1R541	11/5/2012	277	X	0.094	0.0053	U	0.0053	0.44	B	0.25	10.6	X	0.12	875		38.7
DZ-1	J1R2V0	10/10/2012	426		14.5	0.0232	U	0.0232	5.81	U	5.81	7.40	B	11.6	684	B	1160
Duplicate of J1R2V0	J1R2W1	10/10/2012	369		13.5	0.0232	U	0.0232	5.40	U	5.40	6.86	B	10.8	670	B	1080
DZ-2	J1R2V1	10/10/2012	331		10.5	0.0267	U	0.0267	0.654	B	4.20	7.65	B	8.40	642	B	840
DZ-3	J1R2V2	10/10/2012	344		12.8	0.0292	U	0.0292	5.11	U	5.11	10.4		10.2	1060		1020
DZ-4	J1R2V3	10/10/2012	389		12.8	0.0283	U	0.0283	0.711	B	5.12	6.80	B	10.2	589	B	1020
DZ-5	J1R2V4	10/10/2012	358		13.3	0.0284	U	0.0284	0.609	B	5.32	14.0		10.6	537	B	1060
DZ-6	J1R2V5	10/10/2012	340		12.9	0.0261	U	0.0261	0.532	B	5.15	10.5		10.3	977	B	1030
DZ-7	J1R2V6	10/10/2012	430		12.8	0.0252	U	0.0252	0.528	B	5.13	8.11	B	10.3	884	B	1030
DZ-8	J1R2W6	10/10/2012	361		13.0	0.0151	B	0.0283	5.21	U	5.21	6.29	B	10.4	378	B	1040
DZ-9	J1R2V7	10/10/2012	436		12.2	0.0245	U	0.0245	0.494	B	4.88	8.17	B	9.75	726	B	975
DZ-10	J1R2V8	10/10/2012	292		11.6	0.0252	U	0.0252	4.64	U	4.64	8.18	B	9.29	757	B	929
DZ-11	J1R2V9	10/10/2012	380		12.2	0.0253	U	0.0253	4.89	U	4.89	6.07	B	9.78	420	B	978
DZ-12	J1R2W8	10/10/2012	344		14.5	0.0239	U	0.0239	0.753	B	5.82	9.27	B	11.6	442	B	1160
Split of J1R2V0	J1R2W0	10/10/2012	265		0.09	0.0049	UN	0.0049	0.32	B	0.23	4.3	M	0.11	421	B	184
FS-1	J1R2W5	10/10/2012	418		13.0	0.0168	B	0.0293	5.22	U	5.22	7.48	B	10.4	625	B	1040
FS-2	J1R2W4	10/10/2012	333		9.98	0.0240	U	0.0240	0.658	B	3.99	7.75	B	7.98	360	B	798
FS-3	J1R2W3	10/10/2012	320		12.8	0.0267	U	0.0267	5.13	U	5.13	5.78	B	10.3	366	B	1030
FS-4	J1R2W7	10/10/2012	334		12.4	0.0263	U	0.0263	0.847	B	4.95	7.11	B	9.9	399	B	990
SZ-8 [b]	J1R520	11/6/2012	324		15.2	0.0264	U	0.0264	6.09	U	6.09	7.69	B	12.2	921	B	1220
Equipment Blank	J1R2W2	10/10/2012	23.9		3.29	0.0250	U	0.0250	1.32	U	1.32	2.63	U	2.63	50.7	B	263

Attachment	1	Sheet No.	10 of 14
Originator	N. K. Schiffern	Date	3/25/13
Checked	C. H. Dobie	Date	3/25/13
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Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Metals.

Sample Location	HEIS Number	Sample Date	Selenium			Silicon			Silver			Sodium			Vanadium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
SZ-3	J1R515	11/5/2012	0.739	U	0.739	360		4.93	0.493	U	0.493	337		123	64.2		6.16
Duplicate of J1R515	J1R525	11/5/2012	0.833	U	0.833	780		11.1	0.555	U	0.555	330		139	68.6		6.94
SZ-1	J1R513	11/5/2012	0.903	U	0.903	563		6.02	0.602	U	0.602	379		151	72.4		7.53
SZ-2	J1R514	11/6/2012	0.865	U	0.865	331		5.77	0.577	U	0.577	314		144	66.1		7.21
SZ-4	J1R516	11/6/2012	0.854	U	0.854	425		5.70	0.570	U	0.570	459		142	61.9		7.12
SZ-5	J1R517	11/5/2012	0.884	U	0.884	291		5.89	0.589	U	0.589	365		147	70.8		7.36
SZ-6	J1R518	11/5/2012	0.835	U	0.835	518		5.57	0.557	U	0.557	313		139	58.7		6.96
SZ-7	J1R519	11/6/2012	0.814	U	0.814	453		5.43	0.543	U	0.543	406		136	73.2		6.79
SZ-9	J1R521	11/5/2012	0.858	U	0.858	648		11.4	0.572	U	0.572	441		143	63.8		7.15
SZ-10	J1R522	11/6/2012	0.862	U	0.862	802		11.5	0.575	U	0.575	317		144	58.9		7.19
SZ-11	J1R523	11/6/2012	0.750	U	0.750	686		10.0	0.500	U	0.500	355		125	63.2		6.25
SZ-12	J1R524	11/6/2012	0.856	U	0.856	759		11.4	0.571	U	0.571	416		143	82.7		7.13
Split of J1R515	J1R541	11/5/2012	0.81	U	0.81	267		5.3	0.15	U	0.15	312		55.7	52.6		0.089
DZ-1	J1R2V0	10/10/2012	0.871	U	0.871	422		5.81	0.581	U	0.581	432		145	88.5		7.26
Duplicate of J1R2V0	J1R2W1	10/10/2012	0.809	U	0.809	429		5.40	0.540	U	0.540	430		135	81.0		6.75
DZ-2	J1R2V1	10/10/2012	0.630	U	0.630	379		4.20	0.420	U	0.420	386		105	85.7		5.25
DZ-3	J1R2V2	10/10/2012	0.767	U	0.767	565		5.11	0.511	U	0.511	276		128	77.7		6.39
DZ-4	J1R2V3	10/10/2012	0.768	U	0.768	403		5.12	0.512	U	0.512	443		128	90.2		6.40
DZ-5	J1R2V4	10/10/2012	0.797	U	0.797	385		5.32	0.532	U	0.532	491		133	96.5		6.64
DZ-6	J1R2V5	10/10/2012	0.773	U	0.773	572		5.15	0.515	U	0.515	373		129	75.8		6.44
DZ-7	J1R2V6	10/10/2012	0.769	U	0.769	518		5.13	0.513	U	0.513	393		128	90.1		6.41
DZ-8	J1R2W6	10/10/2012	0.782	U	0.782	366		5.21	0.521	U	0.521	397		130	100		6.52
DZ-9	J1R2V7	10/10/2012	0.731	U	0.731	453		4.88	0.488	U	0.488	390		122	93.3		6.10
DZ-10	J1R2V8	10/10/2012	0.697	U	0.697	398		4.64	0.464	U	0.464	332		116	71.6		5.81
DZ-11	J1R2V9	10/10/2012	0.733	U	0.733	336		4.89	0.489	U	0.489	447		122	77.8		6.11
DZ-12	J1R2W8	10/10/2012	0.873	U	0.873	473		5.82	0.582	U	0.582	399		145	91.0		7.27
Split of J1R2V0	J1R2W0	10/10/2012	0.77	U	0.77	108		25.4	0.14	UN	0.14	434	B	265	53.8		0.084
FS-1	J1R2W5	10/10/2012	0.783	U	0.783	438		5.22	0.522	U	0.522	382		130	84.3		6.52
FS-2	J1R2W4	10/10/2012	0.599	U	0.599	293		3.99	0.399	U	0.399	429		99.8	101		4.99
FS-3	J1R2W3	10/10/2012	0.770	U	0.770	315		5.13	0.513	U	0.513	523		128	90.3		6.42
FS-4	J1R2W7	10/10/2012	0.743	U	0.743	534		4.95	0.495	U	0.495	477		124	95.0		6.19
SZ-8 [b]	J1R520	11/6/2012	0.914	U	0.914	672		12.2	0.609	U	0.609	467		152	69.4		7.61
Equipment Blank	J1R2W2	10/10/2012	0.197	U	0.197	114		1.32	0.132	U	0.132	32.9	U	32.9	0.560	B	1.65

Attachment	1	Sheet No.	11 of 14
Originator	N. K. Schiffern	Date	3/25/13
Checked	C. H. Dobie	Date	3/25/13
Calc. No.	0100N-CA-V0192	Rev. No.	0

Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Metals.

Sample Location	HEIS Number	Sample Date	Zinc		
			mg/kg	Q	PQL
SZ-3	J1R515	11/5/2012	47.1		24.6
Duplicate of J1R515	J1R525	11/5/2012	46.9		27.8
SZ-1	J1R513	11/5/2012	52.1		30.1
SZ-2	J1R514	11/6/2012	46.0		28.8
SZ-4	J1R516	11/6/2012	68.4		28.5
SZ-5	J1R517	11/5/2012	46.4		29.5
SZ-6	J1R518	11/5/2012	41.1		27.8
SZ-7	J1R519	11/6/2012	51.4		27.1
SZ-9	J1R521	11/5/2012	44.6		28.6
SZ-10	J1R522	11/6/2012	40.8		28.7
SZ-11	J1R523	11/6/2012	48.2		25.0
SZ-12	J1R524	11/6/2012	54.0		28.5
Split of J1R515	J1R541	11/5/2012	41.1	X	0.38
DZ-1	J1R2V0	10/10/2012	51.3		29.0
Duplicate of J1R2V0	J1R2W1	10/10/2012	50.7		27.0
DZ-2	J1R2V1	10/10/2012	48.7		21.0
DZ-3	J1R2V2	10/10/2012	43.6		25.6
DZ-4	J1R2V3	10/10/2012	53.4		25.6
DZ-5	J1R2V4	10/10/2012	55.8		26.6
DZ-6	J1R2V5	10/10/2012	49.6		25.8
DZ-7	J1R2V6	10/10/2012	57.2		25.6
DZ-8	J1R2W6	10/10/2012	74.0		26.1
DZ-9	J1R2V7	10/10/2012	53.2		24.4
DZ-10	J1R2V8	10/10/2012	45.8		23.2
DZ-11	J1R2V9	10/10/2012	53.6		24.4
DZ-12	J1R2W8	10/10/2012	58.3		29.1
Split of J1R2V0	J1R2W0	10/10/2012	49.3	N	0.36
FS-1	J1R2W5	10/10/2012	58.3		26.1
FS-2	J1R2W4	10/10/2012	54.4		20.0
FS-3	J1R2W3	10/10/2012	71.1		25.7
FS-4	J1R2W7	10/10/2012	54.2		24.8
SZ-8 [b]	J1R520	11/6/2012	50.0		30.5
Equipment Blank	J1R2W2	10/10/2012	2.00	B	6.58

Attachment	1	Sheet No.	12 of 14
Originator	N. K. Schiffern	Date	3/25/13
Checked	C. H. Dobie	Date	3/25/13
Calc. No.	0100N-CA-V0192	Rev. No.	0

Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Anions

Sample Location	HEIS Number	Sample Date	Bromide			Chloride			Fluoride			Nitrogen in Nitrate			Nitrogen in Nitrite			Nitrogen in Nitrite and 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
SZ-3	J1R515	11/5/2012																0.17	B	0.10
Duplicate of J1R515	J1R525	11/5/2012																0.39	B	0.10
SZ-1	J1R513	11/5/2012																0.79		0.10
SZ-2	J1R514	11/6/2012																2.49		0.10
SZ-4	J1R516	11/6/2012																1.81		0.10
SZ-5	J1R517	11/5/2012																0.47		0.09
SZ-6	J1R518	11/5/2012																0.90		0.10
SZ-7	J1R519	11/6/2012																1.21		0.10
SZ-9	J1R521	11/5/2012																1.23		0.10
SZ-10	J1R522	11/6/2012																0.30	B	0.10
SZ-11	J1R523	11/6/2012																0.41	B	0.10
SZ-12	J1R524	11/6/2012																6.81		0.10
Split of J1R515	J1R541	11/5/2012	0.39	U	0.39	5.8		2.0	0.84	UN	0.84	0.61	B	0.32	0.34	U	0.34	0.38	B	0.32
DZ-1	J1R2V0	10/10/2012																0.10	U	0.10
Duplicate of J1R2V0	J1R2W1	10/10/2012																0.16	B	0.10
DZ-2	J1R2V1	10/10/2012																0.19	B	0.10
DZ-3	J1R2V2	10/10/2012																0.54		0.10
DZ-4	J1R2V3	10/10/2012																0.22	B	0.10
DZ-5	J1R2V4	10/10/2012																0.29	B	0.10
DZ-6	J1R2V5	10/10/2012																0.63		0.10
DZ-7	J1R2V6	10/10/2012																0.55		0.10
DZ-8	J1R2W6	10/10/2012																0.17	B	0.10
DZ-9	J1R2V7	10/10/2012																1.04		0.10
DZ-10	J1R2V8	10/10/2012																0.25	B	0.09
DZ-11	J1R2V9	10/10/2012																0.22	B	0.10
DZ-12	J1R2W8	10/10/2012																0.49	B	0.10
Split of J1R2V0	J1R2W0	10/10/2012																0.31	BM	0.30
FS-1	J1R2W5	10/10/2012																0.82		0.10
FS-2	J1R2W4	10/10/2012																1.67		0.10
FS-3	J1R2W3	10/10/2012																0.59		0.10
FS-4	J1R2W7	10/10/2012																1.49		0.10
SZ-8 [b]	J1R520	11/6/2012																0.21	B	0.10

Attachment	1	Sheet No.	13 of 14
Originator	N. K. Schiffern	Date	3/25/13
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Attachment 1. UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Verification Sample Results - Anions

Sample Location	HEIS Number	Sample Date	Phosphorous in phosphate			Sulfate			Percent moisture (wet sample)			Percent Solids			pH Measurement		
			mg/kg	Q	PQL	mg/kg	Q	PQL	ug/kg	Q	PQL	%	Q	PQL	pH	Q	PQL
SZ-3	J1R515	11/5/2012										96.6		0.1			
Duplicate of J1R515	J1R525	11/5/2012										96.5		0.1			
SZ-1	J1R513	11/5/2012										94.0		0.1			
SZ-2	J1R514	11/6/2012										96.4		0.1			
SZ-4	J1R516	11/6/2012										95.8		0.1			
SZ-5	J1R517	11/5/2012										96.1		0.1			
SZ-6	J1R518	11/5/2012										96.3		0.1			
SZ-7	J1R519	11/6/2012										95.3		0.1			
SZ-9	J1R521	11/5/2012										93.6		0.1			
SZ-10	J1R522	11/6/2012										96.6		0.1			
SZ-11	J1R523	11/6/2012										95.3		0.1			
SZ-12	J1R524	11/6/2012										95.6		0.1			
Split of J1R515	J1R541	11/5/2012	1.3	U	1.3	3.8	B	1.8	3.7		0.10				9.28		0.0100
DZ-1	J1R2V0	10/10/2012										99.3		0.1			
Duplicate of J1R2V0	J1R2W1	10/10/2012										99.3		0.1			
DZ-2	J1R2V1	10/10/2012										99.2		0.1			
DZ-3	J1R2V2	10/10/2012										99.5		0.1			
DZ-4	J1R2V3	10/10/2012										99.3		0.1			
DZ-5	J1R2V4	10/10/2012										99.0		0.1			
DZ-6	J1R2V5	10/10/2012										98.7		0.1			
DZ-7	J1R2V6	10/10/2012										99.2		0.1			
DZ-8	J1R2W6	10/10/2012										99.2		0.1			
DZ-9	J1R2V7	10/10/2012										99.2		0.1			
DZ-10	J1R2V8	10/10/2012										99.4		0.1			
DZ-11	J1R2V9	10/10/2012										99.0		0.1			
DZ-12	J1R2W8	10/10/2012										99.2		0.1			
Split of J1R2V0	J1R2W0	10/10/2012							1.4		0.10						
FS-1	J1R2W5	10/10/2012										99.1		0.1			
FS-2	J1R2W4	10/10/2012										98.9		0.1			
FS-3	J1R2W3	10/10/2012										99.0		0.1			
FS-4	J1R2W7	10/10/2012										97.7		0.1			
SZ-8 [b]	J1R520	11/6/2012										94.7		0.1			
Equipment Blank	J1R2W2	10/10/2012										100		0.1			

Attachment	1	Sheet No.	14 of 14
Originator	N. K. Schiffern	Date	3/25/13
Checked	C. H. Dobie	Date	3/25/13
Calc. No.	0100N-CA-V0192	Rev. No.	0

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 100-N Field Remediation Job No. 14655

Area: 100-N

Discipline: Environmental Calculation No: 0100N-CA-V0193

Subject: UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites Direct Contact Hazard Quotient and Carcinogenic Risk Calculations

Computer Program: Excel Program No: Excel 2003

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Summary = 3 Total = 4	N. K. Schiffern N K Schiffern	C. H. Dobie C H Dobie	J. D. Skoglie J D Skoglie	D. F. Obenauer D. F. Obenauer	8/15/13

SUMMARY OF REVISION

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

DE01-437.03

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern	Date:	3/27/2013	Calc. No.:	0100N-CA-V0193	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	C. H. Dobie	Date:	3/27/2013
Subject:	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 1 of 3	

PURPOSE:

Provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2006b), the following criteria must be met:

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

GIVEN/REFERENCES:

1) DOE-RL, 2006a, *100-N Area Sampling and Analysis Plan for CERCLA Waste Sites*, DOE/RL-2005-92, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

2) DOE-RL, 2006b, *Remedial Design Report/Remedial Action Work Plan for the 100-N Area*, DOE/RL-2005-93, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

4) WCH, 2013, *UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites Cleanup Verification 95% UCL Calculations, Calculation Number 0100N-CA-V0192*, Washington Closure Hanford, Inc., Richland, Washington.

SOLUTION:

1) Generate an HQ for each noncarcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the individual HQ of <1.0 (DOE-RL 2006b).

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 2006b).

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern NKS	Date:	3/25/2013	Calc. No.:	0100N-CA-V0193	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	C. H. Dobie CD	Date:	3/25/2013
Subject:	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 2 of 3	

METHODOLOGY:

The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites are comprised of two decision units for verification sampling consisting of a shallow zone decision unit and a deep zone decision unit. Also collected were four focused samples from the deep zone excavation area. Sample location SZ-8 was eliminated from the shallow zone decision unit, and is treated as a focused sample from the deep zone decision unit as discussed in the RSVP for these sites. The direct contact hazard quotient and carcinogenic risk calculations for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites were conservatively calculated for the entire shallow zone decision unit (except for SZ-8) using the greater of the maximum or statistical verification soil sample results (WCH 2013). Of the contaminants of potential concern (COPCs) for these sites, boron and hexavalent chromium 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 maximum value for boron is 1.69 mg/kg, divided by the noncarcinogenic RAG value of 16000 mg/kg (calculated in accordance with the noncarcinogenic toxics effects formula in WAC 173-340-740[3]), produces an HQ value of 1.1×10^{-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 1.6×10^{-3}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum or statistical value is divided by the carcinogenic RAG value, then multiplied by 1.0×10^{-6}. For example, the maximum value for hexavalent chromium is 0.37 mg/kg, divided by 2.1 mg/kg, and multiplied as indicated, produces a value of 1.8×10^{-7}. Comparing this value, and all other individual values, to the requirement of $<1 \times 10^{-6}$, this criterion is met.

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk can be obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual cancer risk values prior to rounding are used for this calculation. The sum of the excess cancer risk values is 1.8×10^{-7}. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

RESULTS:

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

Table 1 shows the results of the hazard quotient and excess cancer risk calculations.

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern NS	Date:	3/27/2013	Calc. No.:	0100N-CA-V0193	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	C. H. Dobie CD	Date:	3/27/2013
Subject:	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 3 of 3	

Table 1. Direct Contact Hazard Quotient and Excess Cancer Risk Results for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites.

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	1.69	16,000	1.1E-04	--	--
Chromium, hexavalent[c]	0.37	240	1.5E-03	2.1	1.8E-07
Totals					
Cumulative Hazard Quotient:			**1.6E-03**		
Cumulative Excess Cancer Risk:					**1.8E-07**

Notes:

[a] = From WCH (2013).

[b] = Value obtained from the RDR/RAWP (DOE-RL 2006b) 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

CONCLUSION:

The calculations in Table 1 demonstrate that the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites meet the requirements for the direct contact hazard quotients and carcinogenic (excess cancer) risk, respectively, as identified in the RDR/RAWP (DOE-RL 2006b) and SAP (DOE-RL 2006a). The direct contact hazard quotients and carcinogenic (excess cancer) risk calculations are for use in the RSVP for these sites.

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CALCULATION COVER SHEET

Project Title: 100-N Field Remediation **Job No. 14655**

Area: 100-N

Discipline: Environmental *Calculation No: 0100N-CA-V0203

Subject: UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater

Computer Program: Excel Program No: Excel 2003

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 3 Total = 4	N. K. Schiffern N.K. Schiffern	C. H. Dobie CH Dobie	J. D. Skoglie [illegible]	D. F. Obenauer D. F. Obenauer	8/15/13

SUMMARY OF REVISION

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern	Date:	03/27/13	Calc. No.:	0100N-CA-V0203	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	C. H. Dobie	Date:	03/27/13
Subject:	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites Hazard Quotient and Carcinogenic Risk Calculations 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 UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) for the 100-N Area (DOE-RL 2006), the following criteria must be met:

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

GIVEN/REFERENCES:

1) DOE-RL, 2006, *Remedial Design Report/Remedial Action Work Plan for the 100-N Area,* DOE/RL-2005-93, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

3) WCH, 2013, *UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites Cleanup Verification 95% UCL Calculations, Calculation Number 0100N-CA-V0192*, 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 (DOE-RL 2006).

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 (DOE-RL 2006).

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern NS	Date:	03/27/13	Calc. No.:	0100N-CA-V0203	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	C. H. Dobie CD	Date:	03/27/13
Subject:	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites Hazard Quotient and Carcinogenic Risk Calculations for Protection of Groundwater					Sheet No.	2 of 3

METHODOLOGY:

The UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites underwent statistical sampling at two decision unit; a shallow zone decision unit and a deep zone decision unit. In addition, four focused samples were collected from the deep zone decision unit. Sample location SZ-8 was eliminated from the shallow zone decision unit, and is treated as a focused sample from the deep zone decision unit as discussed in the RSVP for these sites. The protection of groundwater hazard quotient and carcinogenic risk calculations for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites were conservatively calculated for the entire waste sites using the statistical or maximum value for each analyte (WCH 2013). Based on the generic site RESRAD model (DOE-RL 2006) and a vadose zone of approximately 14m (46 ft) thickness, a K_d of 5.3 or greater is required to show no predicted migration to groundwater in 1,000 years. Boron and hexavalent chromium are included because they have a K_d of less than 5.3, and no Hanford background value has been established. All other site nonradionuclide COPCs were undetected, quantified below background levels, or have a K_d greater than or equal to 5.3. 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 (µg/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 µg (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 1.69 mg/kg, divided by the noncarcinogenic RAG value of 320 mg/kg is 5.3×10^{-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 UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites is 8.2×10^{-2}. Comparing this value to the requirement of <1.0, this criterion is met.

3) No carcinogenic constituents met the criteria for evaluation in groundwater at the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites; therefore, no calculations of excess carcinogenic risk were performed.

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern NS	Date:	03/27/13	Calc. No.:	0100N-CA-V0203	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	C. H. Dobie CD	Date:	03/27/13
Subject:	UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31Waste Sites Hazard Quotient and Carcinogenic Risk Calculations for Protection of Groundwater					Sheet No. 3 of 3	

RESULTS:

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

Table 1 shows the results of the calculations.

Table 1. Hazard Quotient and Excess Cancer Risk Results for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 Waste Sites.

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	1.69	320	5.3E-03	--	--
Chromium, hexavalent	0.37	4.8	7.7E-02	--	--
Totals					
Cumulative Hazard Quotient:			**8.2E-02**		
Cumulative Excess Cancer Risk:					**0.0E+00**

Notes:
[a] = From WCH (2013).
[b] = Value obtained from the Cleanup Levels and Risk Calculations (CLARC) database using Groundwater, Method B, results and the "100 times" model.
-- = not applicable
RAG = remedial action goal

CONCLUSION:

This calculation demonstrates that the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites meet the requirements for the hazard quotients and excess carcinogenic risk as identified in the RDR/RAWP (DOE-RL 2006).

APPENDIX C

DATA QUALITY ASSESSMENT

APPENDIX C

DATA QUALITY ASSESSMENT

VERIFICATION SAMPLING

A data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WCH 2012a). This DQA was performed in accordance with site-specific data quality objectives found in the *100-N Area Sampling and Analysis Plan for CERCLA Waste Sites* (100-N Area SAP) (DOE-RL 2006).

A review of the sample design (WCH 2012b), the field logbooks (WCH 2012a, 2013), and the applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design. In addition, ion chromatography (IC) anions analysis by EPA method 9056M was also requested for one sample delivery group (SDG), SDG J01616. Ion chromatography anions are not contaminants of potential concern (COPCs) for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste sites.

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

Verification data from samples collected at the UPR-100-N-4, UPR-100-N-8 and UPR-100-N-31 waste sites were provided by the laboratories in seven SDGs: SDG J01601, SDG J01616, SDG J01707, SDG JP0470, SDG K4000, SDG K4001, and SDG K4020. SDG K4000 was submitted for third-party validation. No major deficiencies were identified in the analytical data set. Minor deficiencies are discussed for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 data set, as follows below. If no comments are made about a specific analysis, it should be assumed that no deficiencies affecting the quality of the data were found.

MINOR DEFICIENCIES

SDG J01601

This SDG comprises one split sample (J1R2W0) from the excavation, deep zone decision unit. Field sample J1R2W0 is a split sample associated with J1R2V0. This sample was analyzed for inductively coupled plasma (ICP) metals, mercury, hexavalent chromium, nitrate/nitrite, gamma energy analysis (GEA), isotopic uranium, isotopic plutonium, strontium-90, nickel-63, carbon-14, and tritium. Minor deficiencies are as follows:

In the isotopic radionuclide analysis, due to the lack of a laboratory control sample (LCS) analysis, all plutonium-238 and uranium-235 data in SDG J01601 may be considered estimated. Estimated data are usable for decision-making purposes.

In the radionuclide analysis, due to the lack of matrix spike (MS) analysis, all carbon-14 and tritium results in SDG J01601 may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery is outside the quality control (QC) limits for silicon (16%). All silicon data in SDG J01601 may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, the MS recoveries are outside of the project acceptance criteria for nine analytes (aluminum [1,322%], antimony [65%], calcium [159%], copper [-8], iron [4,204%], manganese [211%], silicon [36%], vanadium [131%], and zinc [68%]). For aluminum, iron, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the variability of the native concentration rather than a measure of the recovery from the sample. Antimony, calcium, copper, silicon, vanadium, and zinc did not have mismatched spike and native concentrations in the MS. Antimony, calcium, copper, silicon, vanadium, and zinc results for SDG J01601 may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory duplicate relative percent differences (RPDs) for chromium (59%), copper (90%), lead (114%), and nickel (38%) are above the QC limits of 30%. All chromium, copper, lead, and nickel data in SDG J01601 may be considered estimated. Estimated data are usable for decision-making purposes.

SDG J01616

This SDG comprises one split sample (J1R541) from the excavation shallow zone decision unit. Field sample J1R541 is a split sample associated with J1R515. This sample was analyzed for ICP metals, mercury, IC anions, hexavalent chromium, hydrogen ion concentration (pH), nitrite/nitrate, GEA, isotopic uranium, isotopic plutonium, strontium-90, nickel-63, carbon-14, and tritium. Minor deficiencies are as follows:

In the radionuclide analysis, due to the lack of an LCS analysis, all plutonium-238 and uranium-235 data in SDG J01616 may be considered estimated. Estimated data are usable for decision-making purposes.

In the radionuclide analysis, due to the lack of MS analysis, all carbon-14 and tritium results in SDG J01616 may be considered estimated. Estimated data are usable for decision-making purposes

In the GEA, the laboratory duplicate RPD for radium-226 (31.5%) is above the project QC limit of 30%. Radium-226 is a naturally occurring element at the Hanford Site and was detected in the

field split sample below background levels. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Data are usable for decision-making purposes.

In the ICP metals analysis, zinc was detected in the MB. All zinc results in SDG J01616 may be considered estimated. The data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery is outside the QC limits for silicon (20%). All silicon data in SDG J01616 may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, the MS recoveries are outside of the project acceptance criteria for five analytes (aluminum [1,120%], antimony [59%], iron (2,328%], manganese [139%], and silicon [23%]). For aluminum, iron, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the variability of the native concentration rather than a measure of the recovery from the sample. Antimony and silicon did not have mismatched spike and native concentrations in the MS. Antimony and silicon results for SDG J01616 may be considered estimated. Estimated data are usable for decision-making purposes.

SDG J01707

This SDG comprises one statistical sample (J1RF75) from the excavation shallow zone decision unit. The J1RF75 sample was a resample for sample location SZ-8 and was analyzed for GEA only. No minor deficiencies were found in SDG J01707. The data are usable for decision-making purposes.

SDG JP0470

This SDG comprises two statistical samples (J1RF74, J1RF76) from the excavation shallow zone decision unit. The J1RF74 was a resample from sample location SZ-6 and was analyzed for strontium-90 only. The J1RF76 was a resample from sample location SZ-9 and was analyzed for GEA and strontium-90. Minor deficiencies are as follows.

In the GEA, the laboratory RPD for potassium-40 (33.6%) is above the project QC limit of 30%. Potassium-40 is a naturally occurring element at the Hanford Site and was detected well below background levels in sample J1RF76. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Data are usable for decision-making purposes.

SDG K4000

This SDG comprises 11 statistical samples (J1R2V0 through J1R2V9, J1R2W0 through J1R2W1) from the excavation deep zone decision unit. This SDG also includes one field duplicate pair (J1R2V0/J1R2W1). In addition, one field split sample (J1R2V0/J1R2W2) is associated with this SDG. All of these samples were analyzed for ICP metals, mercury,

hexavalent chromium, nitrite/nitrate, GEA, isotopic uranium, isotopic plutonium, strontium-90, nickel-63, carbon-14, and tritium. In addition, one equipment blank (J1R2W2) was collected and analyzed for ICP metals and mercury. This SDG was submitted for third-party validation. Minor deficiencies are as follows.

In the radionuclide analysis, due to the lack of an LCS analysis, all plutonium-238 data in SDG K4000 were qualified by third-party validation as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the radionuclide analysis, due to the lack of MS analysis, all carbon-14 and tritium results in SDG K4000 were qualified by third-party validation as estimated with "J' flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery is outside the QC limits for aluminum (182%). All aluminum data in SDG K4000 were qualified by third-party validation as estimated with "J" flags. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, the MS recoveries are out of the project acceptance criteria for six analytes (aluminum [342%], antimony [41.8%], calcium [131%], iron [1,970%], manganese [29.9%], and silicon [194%]). For aluminum, iron, manganese, and silicon, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the variability of the native concentration rather than a measure of the recovery from the sample. Antimony and calcium analytes did not have mismatched spike and native concentrations in the MS. All antimony and calcium results for SDG K4000 were qualified as estimated with "J" flags by third-party validation. Estimated data are usable for decision-making purposes.

SDG K4001

This SDG comprises four focused samples (J1R2W3 through J1R2W5, and J1R2W7) and two statistical samples (J1R2W6 and J1R2W8) from the excavation, deep zone decision unit. All of these samples were analyzed for ICP metals, mercury, hexavalent chromium, nitrite/nitrate, GEA, isotopic uranium, isotopic plutonium, strontium-90, nickel-63, carbon-14, and tritium. Minor deficiencies are as follows.

In the ICP metals analysis, aluminum and calcium were detected in the MB. Aluminum and calcium are nonregulated elements and are detected at significantly higher concentrations in field samples; therefore, there is no significant impact to the field sample data. These data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory duplicate RPD for nickel (66%) is above the acceptance criteria of 30%. All nickel data in SDG K4001 may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the MS recoveries are outside of the project acceptance criteria for three analytes (aluminum [316%], antimony [44%], and iron [1,260%]). For aluminum and iron,

the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the variability of the native concentration rather than a measure of the recovery from the sample. Antimony did not have mismatched spike and native concentrations in the MS. Antimony results for SDG K4001 may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery is outside the QC limits for aluminum (184%). All aluminum data in SDG K4001 may be considered estimated. Estimated data are acceptable for decision-making purposes.

SDG K4020

This SDG comprises 13 statistical samples (J1R513 through J1R525) from the excavation shallow zone decision unit. This SDG also includes one field duplicate pair (J1R515/J1R525). In addition, one field split sample (J1R515/J1R541) is associated with this SDG. All of these samples were analyzed for ICP metals, mercury, hexavalent chromium, nitrite/nitrate, GEA, isotopic uranium, isotopic plutonium, strontium-90, nickel-63, carbon-14, and tritium. Minor deficiencies are as follows.

In the radionuclide analysis, the laboratory RPD for uranium-233/234 (55%) is above the project QC limit of 30%. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. All uranium-233/234 data for SDG K4020 may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, sodium was detected in the MB, at very low levels. Field sample results for sodium are significantly higher than concentrations detected in the MB; therefore, there is no significant impact to the field sample data. The data are usable for decision-making purposes.

In the ICP metals analysis, the MS recoveries are outside of the project acceptance criteria for six analytes (aluminum [932%], antimony [34.3%], calcium [21.5%], iron [-469%], magnesium [69.8%], and manganese [4.20%]). For aluminum, calcium, iron, magnesium, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the variability of the native concentration rather than a measure of the recovery from the sample. Antimony did not have mismatched spike and native concentrations in the MS. To confirm quantitation, a post-digestion spike (PDS) was prepared for all subject analytes. Recovery in the PDS was acceptable for all analytes, with the exception of calcium (68.9%). For calcium the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. Antimony results for SDG K4020 may be considered estimated. 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) measurements 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 logbooks (WCH 2012a, 2013), and 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	Split Sample
Excavation shallow zone	J1R515	J1R525	J1R541
Excavation deep zone	J1R2V0	J1R2W1	J1R2W0

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.

Field split samples are used to determine systematic differences (bias) between laboratories. A statistical determination of systematic differences would require larger data sets than are presented here. Such a determination is complicated by variability introduced by the natural heterogeneities inherent in field soil samples and the analytical variability that each individual laboratory experiences. Therefore, when evaluating limited field split data, relatively large RPDs are expected. No major deficiencies in the RPD calculations were found for the split sample. Minor deficiencies for the field duplicates and split samples are as follows:

In the duplicate evaluation for sample J1R515, the RPD calculated for silicon (73.7 was above the field duplicate acceptance criteria (less than 30%). In the split evaluation, the RPDs calculated were all within the field split acceptance criteria (less than 35%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneity in the sample matrix. The data are usable for decision-making purposes.

In the duplicate evaluation of sample J1R2V0, the RPDs calculated were all within the field duplicate acceptance criteria (less than 30%). In the split evaluation, the RPD calculated for aluminum (62.3%), copper (93.4%), magnesium (41.1%), manganese (46.6%), silicon (118.5%), and vanadium (48.8%) were above the field split acceptance criteria (less than 35%).

Elevated RPDs in environmental samples are generally attributed to natural heterogeneity in the sample matrix. 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. In the duplicate/split evaluation of samples J1R515 and J1R2V0, cesium-137 required this check. A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are usable for decision-making purposes.

Summary

Limited, random, or sample matrix-specific influenced batch QC issues such as those discussed above are a potential for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 waste site verification sampling data found that the analytical results are accurate within the standard errors associated with the analytical methods, sampling, and sample handling. The DQA review for the UPR-100-N-4, UPR-100-N-8, and UPR-100-N-31 data set 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 Environmental Restoration 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.

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