CVP-2006-00002
Rev. 0

Cleanup Verification Package for the 118-B-6, 108-B Solid Waste Burial Ground

Prepared for the U.S. Department of Energy
by Washington Closure Hanford

June 2006

EXECUTIVE SUMMARY

This cleanup verification package documents completion of remedial action for the 118-B-6, 108-B Solid Waste Burial Ground (also referred to as the 118-B-6 site). The 118-B-6 site is located within the 100-BC-2 Operable Unit in the 100-B/C Area of the Hanford Site in southeastern Washington State. The site consisted of two concrete pipes 5.5 m (18 ft) long by 1.8 m (6 ft) in diameter that were buried vertically in the ground. The two pipes were capped by a concrete pad measuring approximately 4.6 m (15 ft) by 3 m (10 ft) with two pear-shaped steel lids that provided access to the caissons. The site was located approximately 107 m (350 ft) northeast of the B Reactor. The site was used for the disposal of wastes from the "metal line" of the P-10 Tritium Separation Project. The site was active from 1950 through 1953.

The concrete caissons and pad were removed, and the sample results for the excavated waste site including the waste staging pile area verify attainment of the remedial action goals. Results of the sampling, laboratory analyses, and data evaluations for the 118-B-6 site indicate that all remedial action objectives and goals for direct exposure, protection of groundwater, and protection of the Columbia River have been met (see Table ES-1).

The site meets cleanup standards and has been reclassified as "interim closed out" in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) and the Waste Site Reclassification Guideline TPA-MP-14 (RL-TPA-90-0001) (DOE-RL 1998). A copy of the waste site reclassification form is included as Attachment ES-1.

Table ES-1. Summary of Cleanup Verification Results for the 118-B-6 Burial Ground.

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?	Ref.
Direct Exposure – Radionuclides	1. Attain 15 mrem/yr dose rate above background over 1,000 years.	1. Maximum dose rate calculated by RESRAD is 6.23 mrem/yr.	Yes	a
Direct Exposure – Nonradionuclides	1. Attain individual COC RAGs.	1. All individual COC concentrations are below background; therefore, direct exposure RAGs are met.	Yes	b
Meet Nonradionuclide Risk Requirements	1. Hazard quotient of <1 for noncarcinogens.	1. All individual COC concentrations are below background; therefore, excess risk calculations are not required.	Yes	b
	2. Cumulative hazard quotient of <1 for noncarcinogens.	2. All individual COC concentrations are below background; therefore, excess risk calculations are not required.		b
	3. Excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	3. There are no carcinogenic nonradionuclide COCs for this site.	NA	
	4. Attain a total excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	4. There are no carcinogenic nonradionuclide COCs for this site.	NA	
Groundwater/ River Protection – Radionuclides	1. Attain single COC groundwater and river protection RAGs.	1. Groundwater and river RAGs for tritium, the sole radionuclide COC, have been attained.	Yes	a
	2. Attain National Primary Drinking Water Standards: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.	2. The organ-specific dose rate is below the 4 mrem/yr dose rate limit.		a
	3. Meet drinking water standards for alpha emitters: the more stringent of the 15 pCi/L MCL or 1/25th of the derived concentration guide per DOE Order 5400.5.	3. There are no alpha-emitting COCs for this site.	NA	
	4. Meet total uranium standard of 21.2 pCi/L.[c]	4. Uranium is not a COC for this site.	NA	
Groundwater/ River Protection – Nonradionuclides	1. Attain individual nonradionuclide groundwater and river cleanup requirements.	1. All the groundwater and river RAGs have been attained.	Yes	b
Other supporting information	1. Sampling plan (Appendix C).			d

[a] *118-B-6 Burial Ground RESRAD Calculation Brief*, 0100B-CA-V0276, Rev. 0, Washington Closure Hanford, Richland, Washington.
[b] *118-B-6 Burial Ground Cleanup Verification 95% UCL Calculations*, 0100B-CA-V0274, Rev. 1, Washington Closure Hanford, Richland, Washington.
[c] The EPA has promulgated a drinking water MCL of 30 µg/L for total uranium (40 CFR 141.66). Based on the isotopic distribution of uranium on the Hanford Site, the 30 µg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in the *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* calculation brief (BHI 2001).
[d] *118-B-6 Burial Ground Shallow, Deep Zone, and Stockpile Sampling Plan*, 0100B-CA-V0271, Rev. 0, Washington Closure Hanford, Richland, Washington.

COC = contaminant of concern
MCL = maximum contaminant level
NA = not applicable
RAG = remedial action goal
RESRAD = RESidual RADioactivity (dose model)

Attachment ES-1

Waste Site Reclassification Form

Date Submitted: 5/1/06 **Originator:** R. A. Carlson **Phone:** 948-6650	**Operable Unit(s):** 100-BC-2 **Waste Site ID:** 118-B-6, 108-B Solid Waste Burial Ground **Type of Reclassification Action:** Rejected ☐ Closed Out ☐ Interim Closed Out ☒ No Action ☐	**Control Number:** 2006-005 **Lead Agency:** EPA

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

Description of current waste site condition:

Remedial action at this site has been performed in accordance with remedial action objectives and goals established by the U.S. Environmental Protection Agency and the Washington State Department of Ecology, in concurrence with the U.S. Department of Energy, Richland Operations Office. The selected remedial action involves (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility at the 200 Areas of the Hanford Site, and (3) backfilling the site with clean soil to adjacent grade elevations. The excavation and disposal activities have been completed.

Basis for reclassification:

The results of verification sampling of the soils at the 118-B-6 waste site demonstrated that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also showed that residual contaminant concentrations are protective of groundwater and the Columbia River. The waste site has a deep zone; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 118-B-6, 108-B Solid Waste Burial Ground* (CVP-2006-00002), Washington Closure Hanford, Richland, Washington.

D. C. Smith DOE Project Manager	Signature	6/8/06 Date
NA Ecology Project Manager	Signature	Date
D. A. Faulk EPA Project Manager	Signature	6/8/06 Date

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ACRONYMS AND ABBREVIATIONS

BCL	below cleanup level
COC	contaminant of concern
DQA	data quality assessment
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
RAG	remedial action goal
RDR/RAWP	remedial design report/remedial action work plan
RESRAD	RESidual RADioactivity dose assessment model
ROD	record of decision
SAP	sampling and analysis plan
UCL	upper confidence limit
WAC	*Washington Administrative Code*

1.0 INTRODUCTION

The purpose of this cleanup verification package is to document that the 118-B-6 Solid Waste Burial Ground site was remediated in accordance with the *Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units, Hanford Site (100 Area Burial Grounds), Benton County, Washington* (ROD) (EPA 2000). Remedial action objectives and goals for the 118-B-6 site were established by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy, Richland Operations Office, in concurrence with the Washington State Department of Ecology. These goals and objectives are documented in the 100 Area Burial Grounds ROD (EPA 2000) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005). The ROD (EPA 2000) provides the U.S. Department of Energy, Richland Operations Office the authority, guidance, and objectives to conduct this remedial action.

The preferred remedy specified in the ROD (EPA 2000) and conducted for the 118-B-6 site included (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility (ERDF) at the 200 Areas of the Hanford Site, and (3) backfilling the site with overburden and clean soil to average adjacent grade elevation. Excavation was driven by remedial action objectives for direct exposure, protection of groundwater, and protection of the Columbia River. For the respective points of compliance, remedial action goals (RAGs) summarized in Table 1 were established for the radionuclide and nonradionuclide contaminants of concern (COCs). Waste site COCs were identified in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005) and are listed in Table 1.

Soil cleanup levels were established in the interim action ROD based on a limited ecological risk assessment. Although not required by the ROD (EPA 2000), a comparison against ecological risk screening levels has been made for the site COCs, as identified in the RDR/RAWP. None of the COC concentrations exceeded screening values. A baseline risk assessment for the river corridor portion of the Hanford Site began in 2004, which includes a more complete quantitative ecological risk assessment. That baseline risk assessment will be used as part of the final closeout decision for this site.

Table 1. Summary of Remedial Action Goals.

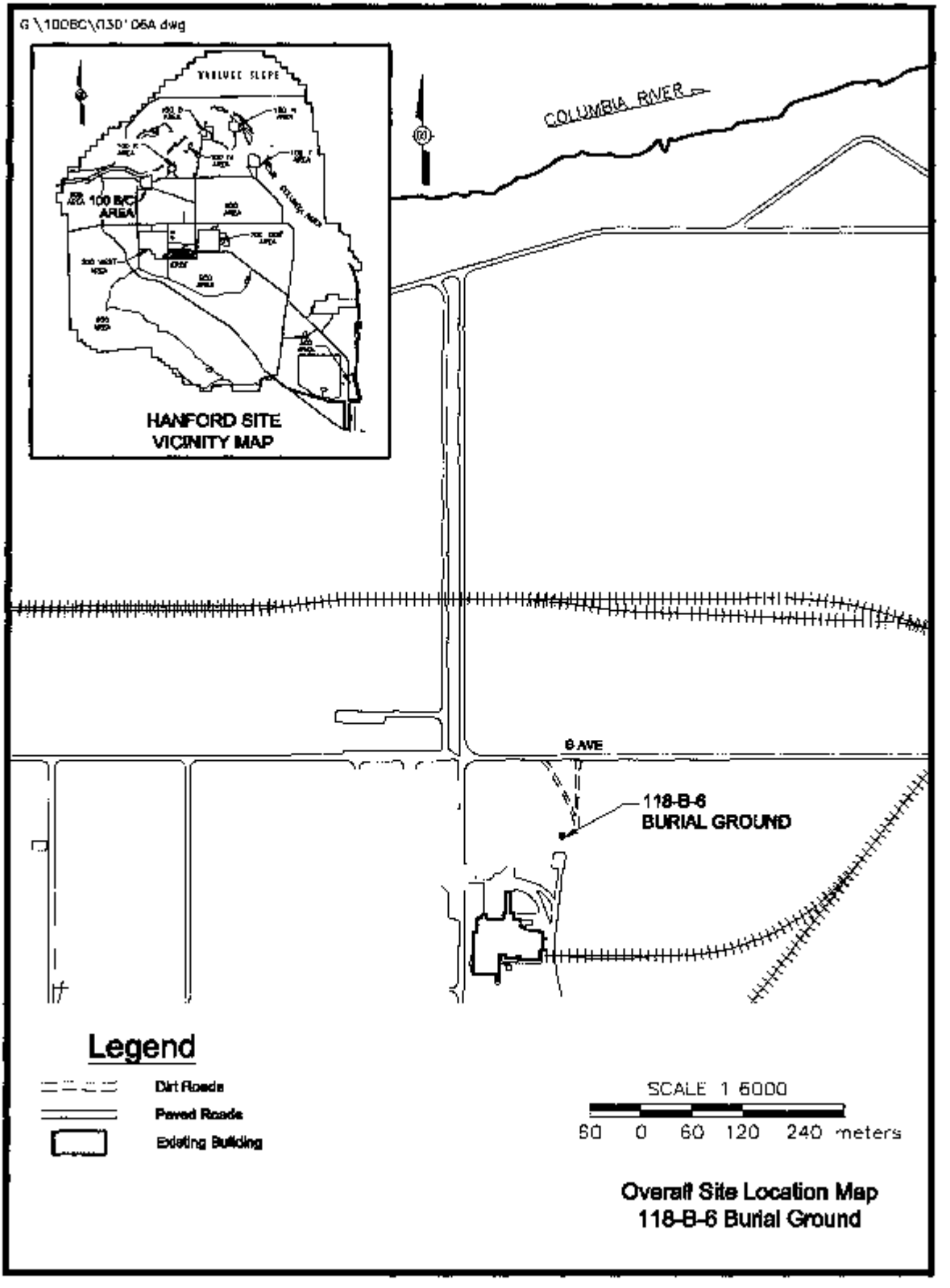
COCs	Direct Exposure RAG	Groundwater Protection RAG (pCi/L)	Columbia River Protection RAG (pCi/L)
Radionuclides			
Tritium	15 mrem/yr (cumulative)[a]	20,000 mrem/yr (cumulative)	20,000 mrem/yr (cumulative)
COCs	**Direct Exposure RAGs (mg/kg)**	**Soil RAG for Groundwater Protection (mg/kg)**	**Soil RAG for Columbia River Protection (mg/kg)**
Nonradionuclides			
Lead	353[b]	10.2[c]	10.2[c]
Mercury	24[d]	0.33[c]	0.33[c]

[a] Lookup values that correspond to the 15 mrem/yr dose rate are based on a generic site model and are presented in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005).
[b] *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children*, EPA/540/R-93/081, Publication No. 9285.7, U.S. Environmental Protection Agency, Washington, D.C. (EPA 1994).
[c] Where cleanup levels are less than background, cleanup levels default to background (WAC 173-340-700[4][d]) (1996).
[d] WAC 173-340 Method B noncarcinogenic cleanup limit.
COC = contaminant of concern
RAG = remedial action goal
WAC = *Washington Administrative Code*

2.0 SITE DESCRIPTION AND SUPPORTING INFORMATION

The 118-B-6 site is located in the 100-BC-2 Operable Unit of the 100-B/C Area approximately 107 m (350 ft) northeast of the B Reactor (Figure 1). The site consisted of two concrete pipes 5.5 m (18 ft) long by 1.8 m (6 ft) in diameter that were buried vertically in the ground. One of the concrete caissons was filled with waste and capped, while the other was partially filled with waste, covered with a thin layer of concrete, and left for future use. The caissons were covered by a concrete pad, measuring approximately 4.6 m (15 ft) by 3 m (10 ft), with two pear-shaped steel lids that provided access to the concrete burial pipes. The site was used for the disposal of wastes such as spent lithium-aluminum alloy, lead from pots, mercury from manometers and Toepler pumps, aluminum cladding, and wastes generated as a result of the P-10 Tritium Production Project.

Figure 1. Hanford Site Map and 118-B-6 Site Plan.



3.0 REMEDIAL ACTION FIELD ACTIVITIES

3.1 EXCAVATION AND DISPOSAL

Remedial action at the 118-B-6 site began in November 2004. Excavation of the site involved removing the uncontaminated overburden, caissons, concrete pad, buried materials, and underlying contaminated soil. Contaminated materials were disposed at ERDF.

In December 2004, the majority of excavation was completed. However, leach tests done on soil samples taken from the bottom of the excavation showed levels of tritium that required an additional 1.5 m (5 ft) of soil removal. This additional excavation was completed in June 2005, with focused sampling results indicating that no further remediation was required. Pre- and post-remediation topographic maps are shown in Figures 2 and 3, respectively. At the conclusion of excavation activities, the elevation of the bottom of the excavation was at 136 m (446 ft). The excavation was approximately 885 m^2 (9,523 ft^2) in area with a depth of approximately 7 m (23 ft). Approximately 577 metric tons (636 tons) of material from the site was disposed at ERDF.

3.2 CLEANUP VERIFICATION SAMPLING AND ANALYSIS

Final cleanup verification samples were collected on January 9, 2006. Verification sample data were used in calculations for this site (see Appendices A and C). The verification samples were submitted to offsite laboratories for analysis using approved EPA analytical methods, as required per the *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001). Each verification sample was a composite formed by combining soil collected at four randomly selected nodes within each sampling area. The sample design methodology and sample location figures are presented in the calculation brief for verification sample design in Appendix C.

The division of the site excavation into shallow zone and deep zone decision units as shown on the sample design figures in Appendix C is a function of the applicable RAGs. The direct exposure, groundwater protection, and river protection RAGs are applicable to soils within 4.6 m (15 ft) of the ground surface. This soil zone is referred to as the shallow zone. The groundwater protection and river protection RAGs are applicable to soils greater than 4.6 m (15 ft) below the ground surface. This soil zone is referred to as the deep zone. The 118-B-6 site consisted of both a shallow and a deep zone decision unit. The site was excavated to a depth of approximately 7 m (23 ft), with the shallow zone consisting of the excavation sidewalls to a depth of 4.6 m (15 ft) and the deep zone consisting of the excavation sidewalls below 4.6 m (15 ft) together with the floor of the excavation. All deep zone samples were collected below 4.6 m (15 ft).

Figure 2. 118-B-6 Pre-Remediation Topographic Plan.

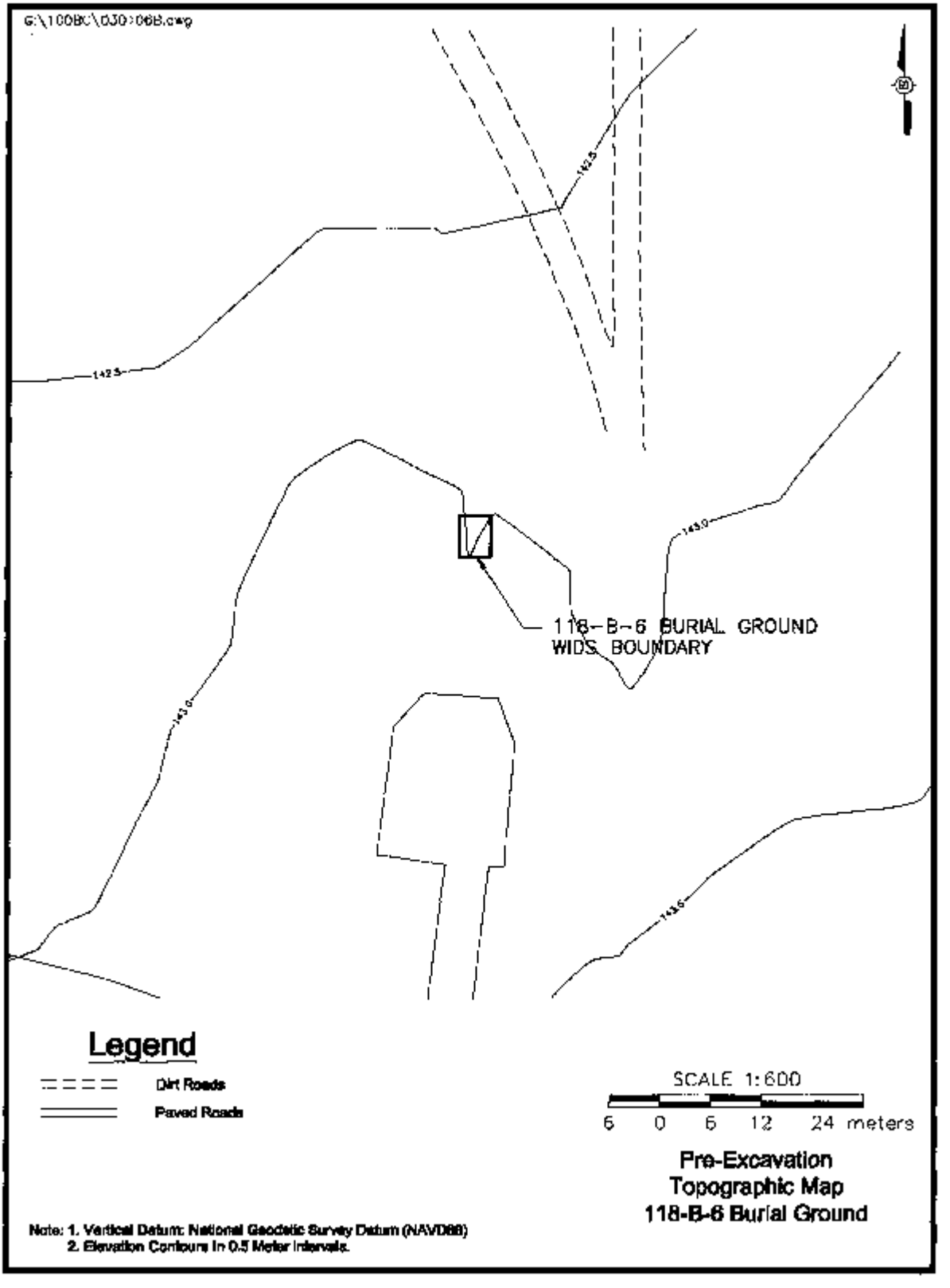
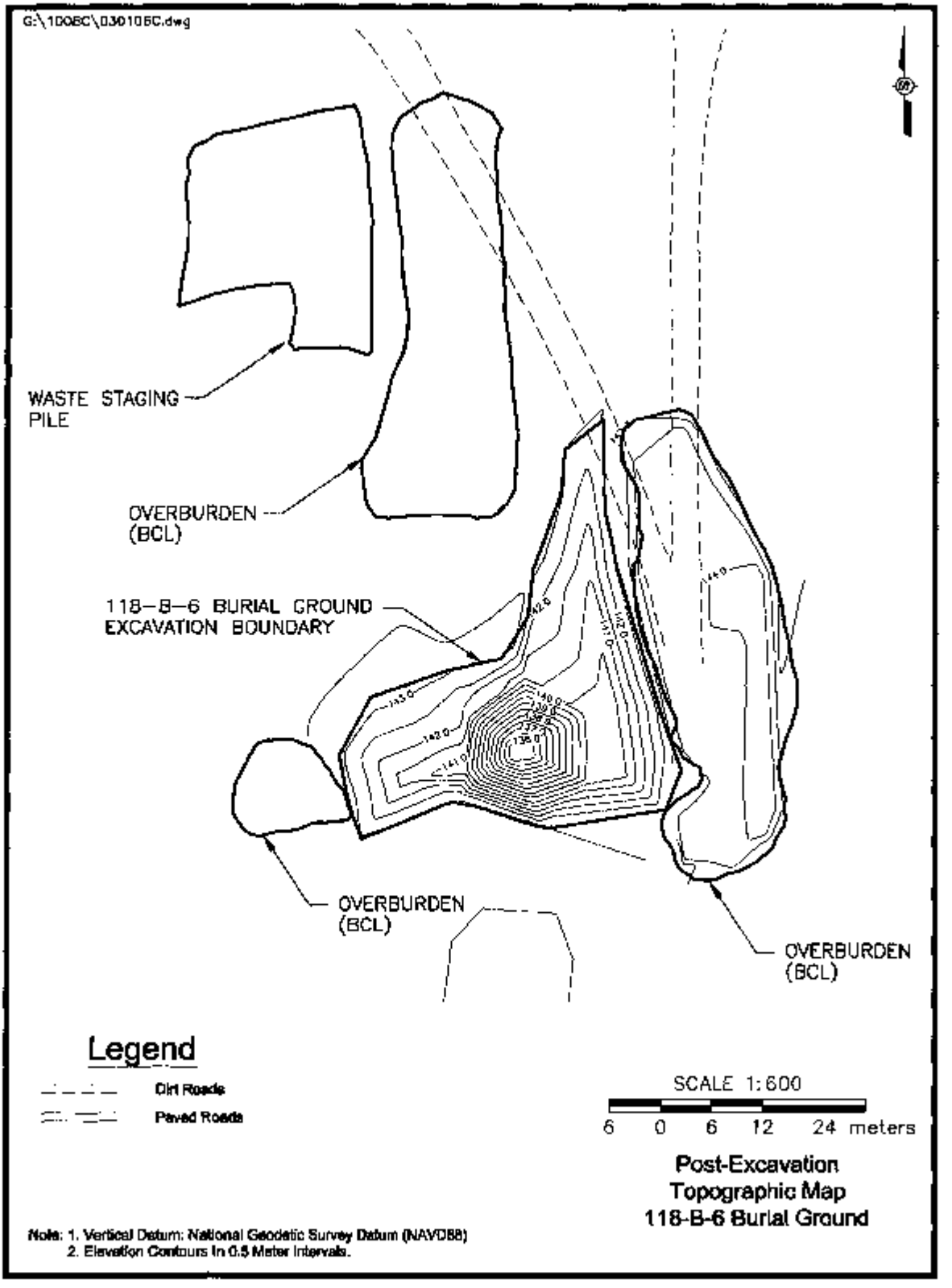


Figure 3. 118-B-6 Post-Remediation Topographic Plan.



As specified in the SAP (DOE-RL 2001), four composite samples were collected from each of the shallow zone, deep zone, below cleanup level (BCL) overburden, and staging pile decision units.

4.0 CLEANUP VERIFICATION DATA EVALUATION

This section presents the evaluation and modeling of the 118-B-6 cleanup verification data for comparison with the data quality criteria and RAGs.

4.1 DATA QUALITY ASSESSMENT PROCESS

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

The DQA for the 118-B-6 site determined that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. All analytical data were found to be acceptable for decision-making purposes. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. The cleanup verification sample analytical data are stored in the Environmental Restoration project-specific database for data evaluation prior to archiving in the Hanford Environmental Information System and are summarized in Appendix A. The detailed DQA is presented in Appendix B.

4.2 CONTAMINANTS OF CONCERN 95% UPPER CONFIDENCE LIMIT

The primary statistical calculation to support cleanup verification is the 95% upper confidence limit (UCL) on the arithmetic mean of the data. The 95% UCL values for each COC are computed for each decision unit (e.g., for the shallow zone, deep zone, BCL overburden, and staging pile, as appropriate). Prior to calculating the 95% UCL, the individual sample results are reviewed and, as appropriate, adjusted per the SAP (DOE-RL 2001) and RDR/RAWP (DOE-RL 2005).

Verification sampling summary statistics (95% UCL values) are listed in Table 2. Individual sample cleanup verification results are presented in Appendix A.

- **Radionuclides**: The laboratory reported value is used in the calculation of the 95% UCL. In cases where the laboratory does not report a value for data qualified with a "U" (i.e., less than the detection limit), half of the minimum detectable activity is used in the calculation of the 95% UCL.

- **Nonradionuclides:** For data flagged with a "U" (i.e., less than detection), a value equal to one-half the practical quantitation limit is used in the calculation of the 95% UCL, as required by Washington State Department of Ecology regulations (*Washington Administrative Code* [WAC] 173-340-740[7][g]).

For nonradionuclides, if greater than half of the sample results for a given COC are below detection, then the statistical value is set equal to the maximum concentration detected (i.e., versus computing a 95% UCL).

Statistical calculations are presented in the 118-B-6 cleanup verification 95% UCL calculation brief (Appendix C). Table 2 summarizes the cleanup verification data set used for RESidual RADioactivity (RESRAD) modeling. It should be noted that the tritium activity in the deep zone (1,996 pCi/g) exceeds the lookup value of a generic waste site (15.8 pCi/g) presented in Table 2-7 of the RDR/RAWP (DOE-RL 2005). However, RESRAD predicts that the tritium groundwater protection RAG (20,000 pCi/L) will not be exceeded because the area of the 118-B-6 deep zone (56 m^2) is significantly smaller than the generic waste site (10,000 m^2) and will, therefore, cause much less impact to groundwater. Additional protection is provided because the 100-B/C Area will continue to be under institutional controls in the future, preventing mobilization of tritium by irrigation water and allowing tritium, with a half-life of 12.3 years, to decay.

Table 2. Cleanup Verification Data Set.

Radionuclide COCs	Radionuclide Activity[a] (pCi/g)			
	Shallow Zone	Staging Pile	BCL Overburden	Deep Zone
Tritium	160	36.7	238	1,996
Nonradionuclide COCs	**Nonradionuclide Concentration[a] (mg/kg)**			
	Shallow Zone	**Staging Pile**	**BCL Overburden**	**Deep Zone**
Lead	6.7	5.2	6.5	4.9
Mercury	0.08	0.02 (ND)	0.03	0.02 (ND)

[a] The shallow, staging pile, BCL overburden, and deep zone concentrations are from the *118-B-6 Burial Ground Cleanup Verification 95% UCL Calculations*, Calculation No. 0100B-CA-V0274, Rev. 1. Refer to Appendix C for additional details on determination of statistical values.

BCL = below cleanup level
COC = contaminant of concern
ND = not detected (in all samples in the data set)

4.3 SITE-SPECIFIC CLEANUP VERIFICATION MODEL

The statistical values summarized in Table 2 were evaluated and used to develop a site-specific cleanup verification model. The 118-B-6 site cleanup verification model

comprises three depth intervals: (1) the shallow zone and overburden, (2) the contaminated deep zone, and (3) the uncontaminated deep (vadose) zone. Based on the conservative assumption that residual contaminant levels in the deep zone data set extend uniformly to groundwater (as discussed in the RDR/RAWP [DOE-RL 2005]), residual soil activities of tritium would result in prediction of a groundwater concentration exceeding the RAG. Because this approach is overly conservative, test pit and borehole data from analogous sites at the 100-B/C Area were used to develop a refined model of the deep zone, including an underlying portion of uncontaminated vadose zone soil. A schematic cross section of this site-specific cleanup verification model is included in the RESRAD calculation in Appendix C.

A test pit was dug in the bottom of the initial excavation (4.6 m [18 ft]) at the 118-B-6 site. Tritium samples were taken in the soil at three depths below the ground surface as follows:

- 6.4 m (21 ft) below ground surface: 7,540 pCi/g
- 8.2 m (27 ft) below ground surface: 1,560 pCi/g
- 9.4 m (31 ft) below ground surface: 237 pCi/g

Additional excavation of 1.5 m (5 ft) (final depth of 7 m [23 ft] below ground surface) was completed to reduce the residual concentration of tritium. After final excavation was complete the statistical concentration of tritium in the deep zone was 1,990 pCi/g, as determined in the 95% UCL (Appendix C).

Because the concentrations in the test pit decreased from 7,540 pCi/g to 237 pCi/g within 3 m (10 ft), it was believed to be reasonable to apply the analogous site model based on the 116-C-1 Liquid Waste Disposal Trench. The 118-B-6 site is analogous to the 116-C-1 Liquid Waste Disposal Trench site where the hexavalent chromium values were demonstrated to reach zero within 3 m [10 ft]). Because hexavalent chromium and tritium both have coefficient distribution (k_d) values of zero, the concentration of tritium (like the concentration of hexavalent chromium) would be expected to decrease to zero within 3 m (10 ft) below the bottom of the final excavation. Therefore, a contaminated deep zone thickness of 6.8 m (22 ft) and an uncontaminated vadose zone (below the contaminated zone) of 11 m (36 ft) was used for RESRAD modeling.

4.4 RESRAD MODELING

The individual radionuclide cleanup verification statistical values (Table 2) were entered into the RESRAD computer code, Version 6.30 (ANL 2005), to estimate the dose rate and to estimate the impact on groundwater and the river from residual COC concentrations. The direct radiation exposure dose rate to the resident living in his or her basement (rural-residential scenario) was conservatively estimated by substituting (for analysis purposes) a case where the resident is standing on level ground with the soil containing concentrations representative of residual (i.e., post-cleanup) shallow zone soils. This is conservative because it ignores the potential shielding effects of

concrete basement walls and any clean backfill between residual soils and the basement walls.

The RESRAD modeling methodologies, results, input values, and the site-specific cleanup verification model are included in the RESRAD calculation brief (Appendix C). Because tritium is the only radionuclide COC, a comparison to drinking water standards (maximum contaminant level) calculation brief was not necessary, and is therefore not included in Appendix C. Specific results from the calculations are discussed in the RAG evaluation section (Section 6.0).

5.0 EVALUATION OF REMEDIAL ACTION GOAL ATTAINMENT

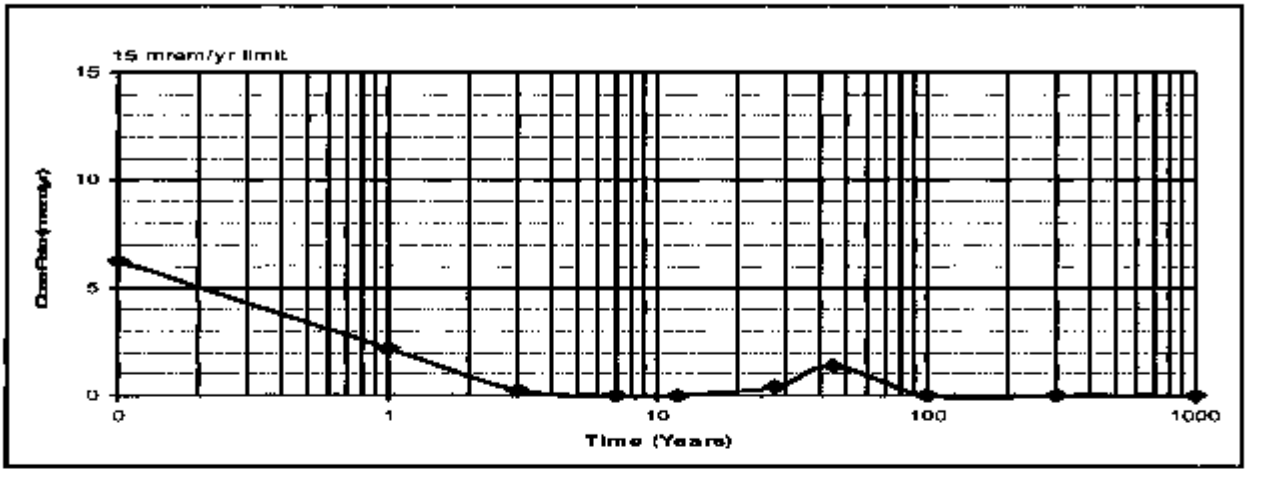
This section demonstrates that remedial actions at the 118-B-6 site have achieved the applicable RAGs. Sections 5.1, 5.2, and 5.3 address attainment of direct exposure RAGs, groundwater protection RAGs, and Columbia River protection RAGs, respectively. Section 5.4 documents application of the WAC 173-340 three-part test to the shallow zone, deep zone, BCL overburden, and staging pile. This test is required for nonradionuclide COCs only and is based on the most restrictive RAG for each zone.

5.1 DIRECT EXPOSURE SOIL REMEDIAL ACTION GOALS ATTAINED

5.1.1 Radionuclides

The results of the RESRAD dose rate estimates for the site, all-pathways scenarios are presented in Figure 4. This dose rate represents the dose contributions from soils at relevant time periods. The dose rate is largest at present (year 2006), 6.23 mrem/yr, and decreases to 0 mrem/yr in 1,000 years for the shallow zone, deep zone, BCL overburden, and staging pile. The estimated dose rate in the year 2018 is 2.02×10^{-5} mrem/yr for the site. The 2018 date corresponds to the 30-year site cleanup schedule of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989). All dose rate estimates are less than the 15 mrem/yr RAG. The RESRAD computations are presented in detail in the referenced calculation briefs summarized in Appendix C.

Figure 4. RESRAD Analysis – All-Radionuclides, All-Pathways Dose Rate Estimate.



5.1.2 Nonradionuclides

5.1.2.1 Direct Comparison to RAGs. Table 3 compares the cleanup verification statistical values presented in Table 2 to the direct exposure RAGs presented in Table 1.

Table 3. Attainment of Nonradionuclide Direct Exposure Standards.

Nonradionuclides	Direct Exposure RAG (mg/kg)	Statistical Value (mg/kg)			Direct Exposure RAGs Attained?[a]
		Shallow Zone	Staging Pile	BCL Overburden	
Lead	353[b]	6.7	5.2	6.5	Yes
Mercury	24[c]	0.08	0.02 (ND)	0.03	Yes

[a] Criterion is comparison to the cleanup criteria (RAG).
[b] *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children*, EPA/540/R-93/081, Publication No. 9285.7, U.S. Environmental Protection Agency, Washington, D.C. (EPA 1994).
[c] Noncarcinogenic cleanup level calculated per *Washington Administrative Code* 173-340-740(3), Method B, 1996.
BCL = below cleanup level
ND = not detected (in all samples in the data set)
RAG = remedial action goal

5.1.2.2 Noncarcinogenic Hazard Quotient RAG Attained. For noncarcinogenic COCs, WAC 173-340 specifies the evaluation of the hazard quotient, which is given as daily intake divided by a reference dose. For cleanup actions under the ROD (EPA 2000), a comparable conservative approach is used to demonstrate attainment of the noncarcinogenic risk requirements.

Lead and mercury, the only nonradionuclide COCs for this site, were detected below background in all decision units; therefore, calculation of excess risk is not required.

5.1.2.3 Carcinogenic Risk RAG Attained. For individual nonradionuclide carcinogenic COCs, the WAC 173-340 Method B cleanup limits are based on an incremental cancer risk of 1×10^{-6}. For nonradionuclide carcinogenic COCs, the total excess cancer risk must be less than 1×10^{-5} (EPA et al. 1998).

There are no nonradionuclide carcinogenic COCs at this site; therefore, the calculation for carcinogenic risk is not required.

5.2 GROUNDWATER REMEDIAL ACTION GOALS ATTAINED

5.2.1 Radionuclides

The estimated groundwater concentrations for all of the radionuclide COCs contributed by the site soils are shown in the RESRAD calculation brief (Appendix C). Table 4 shows the total peak concentration predicted for tritium and provides the individual RAGs for comparison. Tritium is not predicted to exceed the RAGs; therefore, the RAGs are attained.

Table 4. Estimated Peak Radionuclide Groundwater Concentrations (Shallow Zone, Deep Zone, BCL Overburden, and Staging Pile Impacts) Compared to RAGs.

Radionuclide	Peak Concentration (pCi/L)	RAG (pCi/L)	RAGS Attained? (Yes/No)
Tritium	18,500	20,000	Yes

BCL = below cleanup level
RAG = remedial action goal

The tritium concentrations in groundwater were calculated by the RESRAD model. Tritium was calculated to reach groundwater within 1,000 years at concentrations below the drinking water RAG of 20,000 pCi/L. Because tritium is the only radionuclide COC, a comparison to drinking water standards (maximum contaminant level) calculation brief was not necessary.

5.2.2 Nonradionuclides

Table 5 illustrates the comparison of cleanup verification statistical values to the groundwater protection RAGs. The table shows that the residual concentration (statistical value) of lead and mercury for the site is less than the listed groundwater protection soil RAG.

Table 5. Attainment of Nonradionuclide Remedial Action Goals for Protection of Groundwater and the Columbia River.

Nonradio-nuclides	Soil RAG for Groundwater Protection (mg/kg)	Soil RAG for Columbia River Protection (mg/kg)	Cleanup Verification Data Value (mg/kg)	Groundwater and/or River Protection RAGs Exceeded?	Does RESRAD Predict Migration to Groundwater in 1,000 Years?
Shallow Zone					
Lead	10.2[a]	10.2[a]	6.7	No	NA
Mercury	0.33[a]	0.33[a]	0.08	No	NA
Waste Staging Pile					
Lead	10.2[a]	10.2[a]	5.2	No	NA
Mercury	0.33[a]	0.33[a]	0.02 (ND)	No	NA
BCL Overburden					
Lead	10.2[a]	10.2[a]	6.5	No	NA
Mercury	0.33[a]	0.33[a]	0.03	No	NA
Deep Zone					
Lead	10.2[a]	10.2[a]	4.9	No	NA
Mercury	0.33[a]	0.33[a]	0.02 (ND)	No	NA

[a] Where cleanup levels are less than background or required detection limits, cleanup levels default to background (WAC 173-340-700[4][d]).

BCL = below cleanup level
NA = Not applicable. RESRAD modeling was not performed because residual concentrations meet the groundwater and river protection RAGs.
ND = not detected (in all samples in the data set)
RAG = remedial action goal
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

5.3 COLUMBIA RIVER REMEDIAL ACTION GOALS ATTAINED

5.3.1 Radionuclides

The river protection RAGs for radionuclides are identical to the groundwater protection RAGs. The RESRAD modeling results were compared to the groundwater protection RAGs in Table 4.

The results indicated that radionuclides are not predicted to reach groundwater (and, by extension, not predicted to reach the Columbia River) at levels above 4 mrem/yr; therefore, the Columbia River protection RAGs have been attained.

5.3.2 Nonradionuclides

Table 5 illustrates the comparison of cleanup verification statistical values to the Columbia River protection RAGs. The table shows that the residual concentration (statistical value) of lead and mercury for the site is less than the listed river protection soil RAGs.

5.4 WAC 173-340 THREE-PART TEST FOR NONRADIONUCLIDES

Sections 5.1, 5.2, and 5.3 looked separately at compliance with direct exposure RAGs, groundwater protection soil RAGs, and Columbia River protection soil RAGs. Section 5.4 documents application of the WAC 173-340 three-part test for nonradionuclides using the most restrictive RAGs applicable to each decision unit (i.e., shallow zone, deep zone, BCL overburden, and staging pile). The most restrictive RAG is defined as the lowest of the direct exposure, groundwater protection, and river protection RAGs. The direct exposure, groundwater protection, and river protection RAGs are applicable to the shallow zone, BCL overburden, and staging pile. Groundwater and river protection RAGs are applicable to the deep zone. The WAC 173-340 three-part test consists of the following criteria: (1) the cleanup verification statistical value must be less than the cleanup level, (2) no single detection can exceed two times the cleanup criteria, and (3) the percentage of samples exceeding the cleanup criteria must be less than 10%.

Table 6 summarizes the results of the WAC 173-340 three-part test (WAC 173-340-740[7]) for the shallow, deep zone, BCL overburden, and staging pile sample data sets. For lead and mercury, the table lists the most restrictive applicable RAG (selected from the RAGs in Table 1), the maximum detected value, the total number of samples collected, and the number of samples exceeding the most restrictive RAG. The final column of the table describes the result of applying the three WAC 173-340 criteria using the values listed in the preceding columns. Table 6 shows that lead and mercury pass the WAC 173-340 three-part test for all data sets.

Table 6. Application of the WAC 173-340 Three-Part Test. (2 Pages)

Nonradionuclides	Most Stringent Applicable RAG (mg/kg)	Statistical Value (mg/kg)[a]	Maximum Detected (mg/kg)[b]	Total Number of Samples[c]	Number Exceeding Criteria[d]	RAGs Attained? (Yes/No)
Shallow Zone						
Lead	10.2[e]	6.7	7.7	4	0	Yes
Mercury	0.33[e]	0.08	0.08	4	0	Yes

Table 6. Application of the WAC 173-340 Three-Part Test. (2 Pages)

Nonradionuclides	Most Stringent Applicable RAG (mg/kg)	Statistical Value (mg/kg)[a]	Maximum Detected (mg/kg)[b]	Total Number of Samples[c]	Number Exceeding Criteria[d]	RAGs Attained? (Yes/No)
Waste Staging Pile						
Lead	10.2[e]	5.2	6.1	4	0	Yes
Mercury	0.33[e]	0.02 (ND)	(ND)	4	0	Yes
BCL Overburden						
Lead	10.2[e]	6.6	7.0	4	0	Yes
Mercury	0.33[e]	0.03	0.03	4	0	Yes
Deep Zone						
Lead	10.2[e]	4.9	5.1	5	0	Yes
Mercury	0.33[e]	0.02 (ND)	ND	5	0	Yes

[a] Criterion is comparison to the cleanup criteria (RAG).
[b] Criterion is no single detection can exceed two times the cleanup criteria.
[c] The total number of samples includes field duplicate samples, which are included in the evaluation as separate samples.
[d] Criterion is the percentage of samples exceeding the cleanup criteria must be less than 10%.
[e] Where cleanup levels are less than background or required detection limits (RDLs), cleanup levels default to background or RDLs per WAC 173-340-700(4)(d), and WAC 173-340-707(2), respectively. The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party project managers.

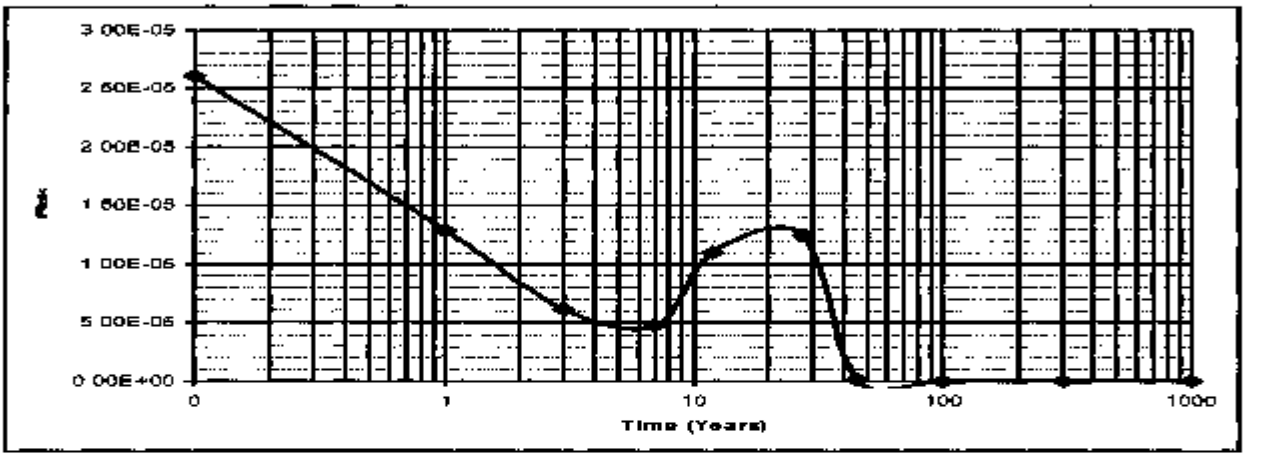
BCL = below cleanup level
ND = not detected (in all samples in the data set)
RAG = remedial action goal
WAC = *Washington Administrative Code*

6.0 RADIONUCLIDE RISK INFORMATION

The radionuclide RAG for direct exposure is derived from the ROD (EPA 2000) and is expressed in terms of an allowable radiation dose rate above background (i.e., 15 mrem/yr). The RAG evaluation (Section 5.0) involved using the RESRAD model to estimate total annual radiation dose rates for 1,000 years for comparison to the RAG. Radiation presents a carcinogenic risk, and the RESRAD model also calculates the excess lifetime cancer risk associated with the estimated radiation dose rates using the EPA's Health Effects Assessment Summary Tables (update dated April 16, 2001, "Update of Radionuclide Carcinogenicity Slope Factors," available on the Internet at www.epa.gov/radiation/heast). The "National Oil and Hazardous Substances Pollution Contingency Plan" (40 *Code of Federal Regulations* 300) presents a target range for residual risk of 10^{-4} to 10^{-6}. Figure 5 illustrates excess lifetime cancer risk for the shallow zone, staging pile, BCL overburden, and deep zone as estimated using the RESRAD model. It should be noted that the increased risk predicted in the middle years of the curve in Figure 5 is caused by summing all of the tritium sources (shallow,

zone, staging pile, BCL overburden, and deep zone) in the risk calculation. The depth of the deep zone tritium causes it to be mobilized to groundwater and affect risks at later years. Tritium from the other sources affects risk by direct exposure while deep zone tritium affects risk due to drinking water ingestion. Therefore, there is an increase in the curve when deep zone tritium is predicted to reach groundwater. Because of radioactive decay, the risk decreases over time. The estimated risk is largest, 2.61×10^{-5}, at present (year 2006), and decreases to 0 in 1,000 years. The estimated risk in 2018 is 1.10×10^{-5}.

Figure 5. RESRAD Analysis – Radionuclide Risk, All Pathways.



7.0 STATEMENT OF PROTECTIVENESS

This cleanup verification package demonstrates that remedial action at the 118-B-6 site has achieved the remedial action objectives and corresponding RAGs established in the ROD (EPA 2000) and RDR/RAWP (DOE-RL 2005). The remaining soils at the 118-B-6 site have been sampled, analyzed, and modeled. The results of this effort indicate that the materials from the 118-B-6 site containing COCs at concentrations exceeding RAGs have been excavated and disposed at ERDF. These results also indicate that residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario and that residual concentrations throughout the site pose no threat to groundwater or the Columbia River. Institutional controls are required for the site to prevent drilling or excavation into deep zone soils. The 118-B-6 site is verified to be remediated in accordance with the ROD (EPA 2000) and may be backfilled.

8.0 REFERENCES

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APPENDIX A

SUMMARY OF VERIFICATION SOIL SAMPLING AND ANALYTICAL RESULTS

Table A-1. 118-B-6 Shallow Zone Sample Data.

Sampling Area	HEIS Number	Sample Date	Lead			Mercury			Tritium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	pCi/g	Q	MDA
A1	J10VP6	1/9/2006	7.7		1.8	0.02	U	0.02	0.720	UJ	3.1
A2	J10VP7	1/9/2006	5.6		1.8	0.08		0.02	1.22	UJ	3.0
A3	J10VP8	1/9/2006	3.3		1.7	0.02	U	0.02	241	J	4.1
A4	J10VP9	1/9/2006	3.3		1.7	0.02	U	0.02	4.52	J	3.1

Table A-2. 118-B-6 Deep Zone Sample Data.

Sampling Area	HEIS Number	Sample Date	Lead			Mercury			Tritium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	pCi/g	Q	MDA
A2	J10VN6	1/9/2006	3.2		1.7	0.02	U	0.02	800	J	3.2
Duplicate of J10VN6	J10VN7	1/9/2006	3.9		1.7	0.02	U	0.02	764	J	3.1
A1	J10VN4	1/9/2006	4.7		1.8	0.02	U	0.02	165	J	4.1
A3	J10VN2	1/9/2006	5.1		1.8	0.02	U	0.02	220	J	2.9
A4	J10VN3	1/9/2006	3.1		1.8	0.02	U	0.02	2780	J	4.6
Split of J10VN6	J10WM7	1/9/2006	2.5		1.0	0.035	U	0.035	53.3		0.0320

The following acronyms apply to all tables in this appendix:

BCL = below cleanup level
HEIS = Hanford Environmental Information System
J = estimate
MDA = minimum detectable activity
PQL = practical quantitation limit
Q = qualifier
U = undetected

Table A-3. 118-B-6 Waste Staging Pile Sample Data.

Sampling Area	HEIS Number	Sample Date	Lead			Mercury			Tritium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	pCi/g	Q	MDA
A1	J10VP3	1/9/2006	4.0		1.8	0.02	U	0.02	28.6	J	3.7
A2	J10VP2	1/9/2006	3.2		1.7	0.01	U	0.01	42.3	J	3.7
A3	J10VP4	1/9/2006	6.1		1.7	0.01	U	0.01	23.1	J	3.8
A4	J10VP5	1/9/2006	3.1		1.7	0.02	U	0.02	16.0	J	2.8

Table A-4. 118-B-6 BCL Overburden Sample Data.

Sampling Area	HEIS Number	Sample Date	Lead			Mercury			Tritium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	pCi/g	Q	MDA
A1	J10VP1	1/9/2006	4.7		1.8	0.03		0.02	232	J	4.0
A2	J10VP0	1/9/2006	4.4		1.8	0.02		0.01	256	J	3.2
A3	J10VN9	1/9/2006	5.9		1.8	0.02	U	0.02	1.14	UJ	3.0
A4	J10VN8	1/9/2006	7.0		1.7	0.03		0.02	2.02	UJ	3.5

APPENDIX B

DATA QUALITY ASSESSMENT

B1.0 DATA QUALITY ASSESSMENT FOR THE 118-B-6 SITE

B1.1 OVERVIEW

This data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data quality requirements specified by project objectives and performance specifications. The DQA involves a review of the sampling process as documented in the field logbook (WCH 2006) as well as a scientific and statistical evaluation of the data to determine if they are of the right type, quality, and quantity to support their intended use (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.

This DQA was performed in accordance with WCH-EE-01, *Environmental Investigations Procedures*. The DQA is also based on guidelines presented in *Guidance for Data Quality Assessment: Practical Methods for Data Analysis* (EPA 2000). Statistical tests used in this DQA were performed as specified in the *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005).

All of the analytical data are evaluated and a portion validated for compliance with quality assurance (QA) project plan requirements (DOE-RL 2001). Data evaluation is performed to determine if the laboratory carried out all steps required by the SAP and the laboratory contract governing the conduct of analysis and reporting of the data. This evaluation also examines the laboratory data to determine if an analyte is present or absent in a sample and the degree of overall uncertainty associated with that determination. Data validation was done in accordance with validation procedures (BHI 2000a, 2000b) as part of data evaluation. The appropriate statistical test is performed on the adjusted raw analytical data (see calculation briefs in Appendix C) to determine statistical values for each contaminant. The number of samples collected for cleanup verification is then evaluated to confirm assumptions concerning contaminant variability.

The DQA for the 118-B-6 site determined that the data are of the right type, quality, and quantity to support site cleanup verification decisions within specified error tolerances. All analytical data were found acceptable for decision-making purposes. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. Additional quality requirements of the QA project plan included data acquisition requirements. The cleanup verification sample analytical data are stored in the Environmental Restoration project-specific database prior to archiving in the Hanford Environmental Information System and are summarized in Appendix A.

The following subsections describe the DQA results for the 118-B-6 site, including formal data validation, supplementary data evaluation, and field QA/quality control (QC)

program results. The statistical evaluation of the data is provided in the calculation brief excerpts included in Appendix C.

B1.2 LABORATORY QUALITY ASSURANCE/QUALITY CONTROL ANALYSIS

All verification samples are subject to laboratory-specific QA requirements, including instrument procurement, maintenance, calibration, and operation. Additional laboratory requirements for internal QC checks are performed as appropriate for the analytical method at a rate of 1 per sample delivery group (SDG), or 1 in 20, whichever is more frequent. Laboratory internal QC checks include the following:

- Laboratory Contamination. Each analytical batch contains a laboratory (method) blank (material of similar composition as the samples with known/minimal contamination of the analytes of interest) carried through the complete analytical process. The method blank is used to evaluate false-positive results in samples due to contamination during handling at the laboratory.

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

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

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

Verification sample laboratories are also subject to periodic and random assessments of the laboratory performance, systems, and overall program. These assessments are performed by the Washington Closure Hanford Quality Assurance and Services group to ensure that the laboratories are performing to meet laboratory contract requirements.

B1.3 DATA VALIDATION RESULTS

The laboratory data from SDG K0167 were validated to Level C per WCH-EE-01, Procedure 2.5, "Data Package Validation Process." Level C validation procedures are specified in *Data Validation Procedure for Radiochemical Analysis* (BHI 2000a) and *Data Validation Procedure for Chemical Analysis* (BHI 2000b).

Under the Level C validation procedure, the following items were reviewed, as appropriate, for each analytical method:

- Sample holding times
- Method blanks
- MS recovery
- Surrogate recovery
- Tracer and/or carrier recovery (applies only to radionuclides)
- Sample duplicates or MS/MSD
- Associated LCS results
- Data package completeness
- Achievement of practical quantitation limits (PQLs) as specified in the SAP (DOE-RL 2001).

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

The adequacy of laboratory QA/QC was evaluated for precision, accuracy, completeness, and target detection limits (TDLs) pursuant to the SAP. The data validation reported that, of the data given formal validation, the laboratory met the majority of the standards for performance for precision (±30%), accuracy (±30% or ±20% for analysis by gamma spectroscopy), detection limits, and completeness (>90%).

SDG K0167 consisted of samples J10VP6, J10VP7, J10VP8, J10VP9, J10VN6, J10VN4, J10VN2, J10VN3, J10VP3, J10VP2, J10VP4, J10VP5, J10VP1, J10VP0, J10VN9, and J10VN8. In addition, a duplicate (J10VN7) to J10VN6, and an equipment blank, J10VN5, were collected. Samples were analyzed for lead, mercury, and tritium.

The DQA noted no major deficiencies. A summary of minor deficiencies noted during validation of SDG K0167 include the following.

B1.3.1 Sample Holding Times

No deficiencies were noted.

B1.3.2 Method Blanks

The PQL and/or TDL requirements identified in the SAP (DOE-RL 2005a) were used to evaluate the method blanks. For radionuclides, the correct term analogous to the nonradionuclide PQL is MDA.

No deficiencies were noted.

B1.3.3 Equipment Blanks

No deficiencies were noted.

B1.3.4 Matrix Spike Recovery

All tritium results from SDG K0167 were qualified as estimated and flagged as "J," due to the lack of an MS analysis.

Matrix spikes for radionuclides are not typically done by the laboratory. Other accuracy measures, such as blind audit samples against known standards, are used to access laboratory accuracy for radionuclides. This issue is minor and does not impact the quality or usability of the cleanup verification data.

B1.3.5 Surrogate Recovery

No deficiencies were noted.

B1.3.6 Tracer Recovery

No deficiencies were noted.

B1.3.7 Sample Duplicates/Matrix Spike Duplicate

In SDG K0167, an RPD of 42.9% was calculated for the lead result in the duplicate. No qualification was assigned to the data. This out-of-limit RPD is likely due to sample heterogeneity. Heterogeneity of soil samples is well known. Contaminants are not always distributed evenly throughout the sample. It is likely that the individual sample aliquots did not have equivalent amounts of inert material, such as rock. This out-of-limit RPD does not affect data quality or usability.

B1.3.8 Associated Batch Laboratory Control Sample Results

No deficiencies were noted.

B1.3.9 Data Package Completeness

SDG K0167 met the completion requirements of the SAP (DOE-RL 2005a).

B1.3.10 Achievement of Target Detection Limits

The nonradionuclide PQL and radionuclide MDA (listed as PQL in the SAP) TDL goals identified in the SAP (DOE-RL 2005a) were used to develop the required detection limits submitted to the laboratory by the project.

All analytes met the TDLs.

B1.4 DATA EVALUATION

The formal data validation described in the previous section included evaluation of SDG K0167; however, a DQA is required for all SDGs. A split sample (J10WM7) of J10VN6, was collected and submitted for analysis in SDG J00045. Supplementary data evaluation was performed on all the SDGs, whether validated or unvalidated. The following paragraphs include the results of the data evaluation of all remaining SDGs associated with the verification sampling of the 118-B-6 site.

To ensure adequate data quality, DQA investigators reviewed the study objectives in the SAP (DOE-RL 2001) to determine the context for assessing the data. The context for assessing the data includes evaluating the sample data using a comparison of analytical results to the precision, accuracy, representativeness, comparability and completeness (PARCC) parameters as specified in the SAP. This section summarizes the results of the PARCC parameter comparison and presents an evaluation of the affected data.

B1.4.1 Supplemental Data Evaluation

In accordance with Appendix G of the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005), the following evaluations were performed:

- Assessment of detection limits
- Laboratory accuracy and precision via MS, MSD, or duplicates and LCSs
- Contamination during sampling via equipment blanks
- Sampling heterogeneity via field duplicates
- Sampling and laboratory variability via field splits.

The following additional information was evaluated because this information directly affects data quality.

B1.4.2 Sample Holding Times

No deficiencies were noted.

B1.4.3 Method Blanks

No deficiencies were noted.

B1.4.4 Matrix Spike, Tracer, Carrier Recovery

No deficiencies were noted with the contaminants of concern (COCs).

B1.4.5 Sample Duplicates, Matrix Spike/Matrix Spike Duplicate Results

No deficiencies were noted.

B1.4.6 Associated Batch Laboratory Control Sample Results

No deficiencies were noted.

B1.4.7 Data Package Completeness

All data packages were complete.

B1.4.8 Achievement of Target Detection Limits

All analytes met the TDLs.

B1.5 FIELD QUALITY ASSURANCE/QUALITY CONTROL

Field QA/QC measures were used to assess potential cross-contamination of the collected samples. The QA/QC sample results are used to assess analytical precision and accuracy and contamination. Equipment blanks are used to assess contamination from cleaning the equipment, field duplicates are used to assess precision, and field splits are used to assess accuracy.

B1.5.1 Equipment Blank Samples

No COCs were detected in the equipment blank for nonradionuclides or radionuclides.

B1.5.2 Field Duplicate Samples

A duplicate (J10VN7) of sample J10VN6 was collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates which are used to evaluate precision in the analytical process. Field duplicates are evaluated by computing the RPD of the duplicate samples for each COC, as needed. Only analytes with values above five times the detection limits for both the main and duplicate samples are compared. None of the analytes required calculation of the RPDs. The SAP (DOE-RL 2001) requires a minimum of 1 field duplicate for every 20 (or less) field samples. As shown in Appendix A, sufficient field duplicates were taken. Based on the validation criteria (BHI 2000a, 2000b) and U.S. Environmental Protection Agency functional guidelines for precision, the data are usable.

B1.6 SUITABILITY OF DATA

The conclusion of the DQA is that the data are of the right type, quality, and quantity to support the intended use. Detection limits, precision, accuracy, and SDG completeness were analyzed to determine if any analytical results should be rejected as a result of QA/QC deficiencies. All COC analytical data were found acceptable for decision-making purposes, and the raw data are acceptable for calculating the required statistical values.

B2.0 REFERENCES

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APPENDIX C

RESRAD INPUT PARAMETERS AND CALCULATION BRIEF EXCERPTS

RESRAD INPUT PARAMETERS FOR THE SHALLOW ZONE – RADIONUCLIDES

1RESRAD, Version 6.30 T≈ Limit = 0.5 year 03/02/2006 14:21 Page 1
Summary : Tritium at 118-B-6 Shallow Zone with Irrigation - Rural Residential Scenario
File : Run#1_118-B-6_SZ_With_Irrigation.RAD

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1RESRAD, Version 6.30 T* Limit = 0.5 year 03/02/2006 14:21 Page 2
Summary : Tritium at 118-B-6 Shallow Zone with Irrigation - Rural Residential Scenario
File : Run#1_118-B-6_SZ_With_Irrigation.RAD

Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 2001 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	H-3	6.400E-08	6.400E-08	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	H-3	6.400E-08	6.400E-08	DCF3(1)
D-34	Food transfer factors:			
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(1,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(1,2)
D-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	H-3 , fish	1.000E+00	1.000E+00	BIOFAC(1,1)
D-5	H-3 , crustacea and mollusks	1.000E+00	1.000E+00	BIOFAC(1,2)

1RESRAD, Version 6 30 T= Limit = 0 5 year 03/02/2006 14 21 Page 3
Summary Tritium at 118-B-6 Shallow Zone with Irrigation - Rural Residential Scenario
File Run#1_118-B-6_SZ_With_Irrigation RAD

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	8 300E+02	1 000E+04	---	AREA
R011	Thickness of contaminated zone (m)	4 600E+00	2 000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	3 250E+01	1 000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1 500E+01	2 500E+01	---	BRDL
R011	Time since placement of material (yr)	0 000E+00	0 000E+00	---	TI
R011	Times for calculations (yr)	1 000E+00	1 000E+00	---	T(2)
R011	Times for calculations (yr)	3 000E+00	3 000E+00	---	T(3)
R011	Times for calculations (yr)	7 000E+00	1 000E+01	---	T(4)
R011	Times for calculations (yr)	1 200E+01	3 000E+01	---	T(5)
R011	Times for calculations (yr)	2 760E+01	1 000E+02	---	T(6)
R011	Times for calculations (yr)	4 500E+01	3 000E+02	---	T(7)
R011	Times for calculations (yr)	1 000E+02	1 000E+03	--	T(8)
R011	Times for calculations (yr)	3 000E+02	0 000E+00	---	T(9)
R011	Times for calculations (yr)	1 000E+03	0 000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g) H-3	1 600E+02	0 000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L) H-3	not used	0 000E+00	---	W1(1)
R013	Cover depth (m)	0 000E+00	0 000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1 500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1 000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1 600E+00	1 500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0 000E+00	1 000E-03	---	VCZ
R013	Contaminated zone total porosity	4 000E-01	4 000E-01	---	TPCZ
R013	Contaminated zone field capacity	1 500E-01	2 000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2 500E+02	1 000E+01	---	HCCZ
R013	Contaminated zone b parameter	4 050E+00	5 300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3 400E+00	2 000E+00	---	WIND
R013	Humidity in air (g/m**3)	8 000E+00	8 000E+00	---	HUMID
R013	Evapotranspiration coefficient	9 100E-01	5 000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1 600E-01	1 000E+00	---	PRECIP
R013	Irrigation (m/yr)	7 600E-01	2 000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2 000E-01	2 000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1 000E+06	1 000E+06	---	WAREA
R013	Accuracy for water/soil computations	1 000E-03	1 000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1 600E+00	1 500E+00	---	DENSAQ
R014	Saturated zone total porosity	4 000E-01	4 000E-01	---	TPSZ
R014	Saturated zone effective porosity	2 500E-01	2 000E-01	---	EPSZ
R014	Saturated zone field capacity	1 500E-01	2 000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5 530E+03	1 000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1 250E-03	2 000E-02	---	HGWT
R014	Saturated zone b parameter	4 050E+00	5 300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1 000E-03	1 000E-03	---	VWT
R014	Well pump intake depth (m below water table)	4 600E+00	1 000E+01	---	DWIBWT
R014	Model Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2 500E+02	2 500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat zone 1, thickness (m)	1.780E+01	4.000E+00	--	H(1)
R015	Unsat zone 1, soil density (g/cm**3)	1.600E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat zone 1, total porosity	4.000E-01	4.000E-01	---	THETA(1)
R015	Unsat zone 1, effective porosity	2.500E-01	2.000E-01	-	EPUZ(1)
R015	Unsat zone 1, field capacity	1.500E-01	2.000E-01	---	PCUZ(1)
R015	Unsat zone 1, soil-specific b parameter	4.050E+00	5.300E+00	--	BUZ(1)
R015	Unsat zone 1, hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	--	HCUZ(1)
R016	Distribution coefficients for H-3				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	--	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.969E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	--	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	--	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	--	SHF1
R017	Fraction of time spent indoors	6.000E-01	5.000E-01	--	FIND
R017	Fraction of time spent outdoors (on site)	2.000E-01	2.500E-01	--	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA	FS
R017	Radii of shape factor array (used if FS = -1)				
R017	Outer annular radius (m), ring 1	not used	5.000E+01	-	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2	not used	7.071E+01	--	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3	not used	0.000E+00	--	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m) ring 6	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m) ring 7	not used	0.000E+00	-	RAD_SHAPE(7)
R017	Outer annular radius (m) ring 8	not used	0.000E+00	-	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9	not used	0.000E+00	--	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m) ring 11	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12	not used	0.000E+00	--	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA				
R017	Ring 1	not used	1 000E+00	---	FRACA(1)
R017	Ring 2	not used	2 732E-01	---	FRACA(2)
R017	Ring 3	not used	0 000E+00	---	FRACA(3)
R017	Ring 4	not used	0 000E+00	---	FRACA(4)
R017	Ring 5	not used	0 000E+00	---	FRACA(5)
R017	Ring 6	not used	0 000E+00	---	FRACA(6)
R017	Ring 7	not used	0 000E+00	---	FRACA(7)
R017	Ring 8	not used	0 000E+00	---	FRACA(8)
R017	Ring 9	not used	0 000E+00	---	FRACA(9)
R017	Ring 10	not used	0 000E+00	-	FRACA(10)
R017	Ring 11	not used	0 000E+00	---	FRACA(11)
R017	Ring 12	not used	0 000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1 100E+02	1 600E-02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	2 700E+00	1 400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	1 000E+02	9 200E+01	- -	DIET(3)
R018	Meat and poultry consumption (kg/yr)	3 600E+01	6 300E+01	--	DIET(4)
R018	Fish consumption (kg/yr)	1 970E+01	5 400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9 000E-01	9 000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	7 300E+01	3 650E+01	-	SOIL
R018	Drinking water intake (L/yr)	7 300E+02	5 100E+02	---	DWI
R018	Contamination fraction of drinking water	1 000E+00	1 000E+00	--	FDW
R018	Contamination fraction of household water	not used	1 000E+00	--	FHHW
R018	Contamination fraction of livestock water	1 000E+00	1 000E+00	--	FLW
R018	Contamination fraction of irrigation water	1 000E+00	1 000E+00	--	FIRW
R018	Contamination fraction of aquatic food	5 000E-01	5 000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0 415E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0 415E-01	FMEAT
R018	Contamination fraction of milk	-1	-1	0 415E-01	FMILK
R019	Livestock fodder intake for meat (kg/day)	6 800E+01	6 800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5 500E+01	5 500E+01	--	LFI6
R019	Livestock water intake for meat (L/day)	5 000E+01	5 000E+01	-	LWI5
R019	Livestock water intake for milk (L/day)	1 600E+02	1 600E+02		LWI6
R019	Livestock soil intake (kg/day)	5 000E-01	5 000E-01	--	LSI
R019	Mass loading for foliar deposition (g/m**3)	1 000E-04	1 000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1 500E-01	1 500E-01	--	DM
R019	Depth of roots (m)	9 000E-01	9 000E-01	--	DROOT
R019	Drinking water fraction from ground water	1 000E+00	1 000E+00		FGWDW
R019	Household water fraction from ground water	not used	1 000E+00	-	FGWHH
R019	Livestock water fraction from ground water	1 000E+00	1 000E+00	--	FGWLW
R019	Irrigation fraction from ground water	1 000E+00	1 000E+00	-	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7 000E-01	7 000E-01		YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1 500E+00	1 500E+00	-	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1 100E+00	1 100E+00	-	YV(3)
R19B	Growing Season for Non Leafy (years)	1 700E-01	1 700E-01	--	TE(1)
R19B	Growing Season for Leafy (years)	2 500E-01	2 500E-01	--	TE(2)
R19B	Growing Season for Fodder (years)	8 000E-02	8 000E-02	--	TE(3)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.694E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days)				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec)				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

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Summary : Tritium at 118-B-6 Shallow Zone with Irrigation - Rural Residential Scenario
File : Run#1_118-B-6_SZ_With_Irrigation.RAD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Number of graphical time points	64	---	---	NPTS
TITL	Maximum number of integration points for dose	9	---	---	LYMAX
TITL	Maximum number of integration points for risk	33	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

RESRAD INPUT PARAMETERS FOR THE WASTE STAGING AREA -- RADIONUCLIDES

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Summary : Tritium at 118-B-6 Waste Staging Area with Irrigation - Rural Residential Scena
File : Run#2_118-B-6_Waste_Staging_Area_With_Irrigation.RAD

Table of Contents

Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 2001 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	H-3	6.400E-08	6.400E-08	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	H-3	6.400E-08	6.400E-08	DCF3(1)
D-34	Food transfer factors:			
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(1,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(1,2)
D-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	H-3 , fish	1.000E+00	1.000E+00	BIOFAC(1,1)
D-5	H-3 , crustacea and mollusks	1.000E+00	1.000E+00	BIOFAC(1,2)

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Summary Tritium at 118-B-6 Waste Staging Area with Irrigation - Rural Residential Scena
File Run#2_118-B-6_Waste_Staging_Area_With_Irrigation RAD

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	4 870E+02	1 000E+04	---	AREA
R011	Thickness of contaminated zone (m)	4 600E+00	2 000E+00	---	THICKC
R011	Length parallel to aquifer flow (m)	1 250E+01	1 000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1 500E+01	2 500E+01	---	BRDL
R011	Time since placement of material (yr)	0 000E+00	0 000E+00	---	TI
R011	Times for calculations (yr)	1 000E+00	1 000E+00	---	T(2)
R011	Times for calculations (yr)	3 000E+00	3 000E+00	---	T(3)
R011	Times for calculations (yr)	7 000E+00	1 000E+01	---	T(4)
R011	Times for calculations (yr)	1 200E+01	3 000E+01	---	T(5)
R011	Times for calculations (yr)	2 760E+01	1 000E+02	---	T(6)
R011	Times for calculations (yr)	4 500E+01	3 000E+02	---	T(7)
R011	Times for calculations (yr)	1 000E+02	1 000E+03	---	T(8)
R011	Times for calculations (yr)	3 000E+02	0 000E+00	---	T(9)
R011	Times for calculations (yr)	1 000E+03	0 000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g) H-3	3 670E+01	0 000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L) H-3	not used	0 000E+00	---	W1(1)
R013	Cover depth (m)	0 000E+00	0 000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1 500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1 000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1 600E+00	1 500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0 000E+00	1 000E-03	---	VCZ
R013	Contaminated zone total porosity	4 000E-01	4 000E-01	---	TPCZ
R013	Contaminated zone field capacity	1 500E-01	2 000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2 500E+02	1 000E+01	---	HCCZ
R013	Contaminated zone b parameter	4 050E+00	5 300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3 400E+00	2 000E+00	---	WIND
R013	Humidity in air (g/m**3)	8 000E+00	8 000E+00	---	HUMID
R013	Evapotranspiration coefficient	9 100E-01	5 000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1 600E-01	1 000E+00	---	PRECIP
R013	Irrigation (m/yr)	7 600E-01	2 000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2 000E-01	2 000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1 000E+06	1 000E+06	.	WAREA
R013	Accuracy for water/soil computations	1 000E-03	1 000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1 600E+00	1 500E+00	---	DENSAQ
R014	Saturated zone total porosity	4 000E-01	4 000E-01	---	TPSZ
R014	Saturated zone effective porosity	2 500E-01	2 000E-01	---	EPSZ
R014	Saturated zone field capacity	1 500E-01	2 000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5 530E+03	1 000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1 250E-03	2 000E-02	---	HGWT
R014	Saturated zone b parameter	4 050E+00	5 300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1 000E-03	1 000E-03	---	VWT
R014	Well pump intake depth (m below water table)	4 600E+00	1 000E+01	---	DWIBWT
R014	Model Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2 500E+02	2 500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
RD15	Unsat. zone 1, thickness (m)	1.780E+01	4.000E+00	---	H(1)
RD15	Unsat. zone 1, soil density (g/cm**3)	1.600E+00	1.500E+00	---	DENSUZ(1)
RD15	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
RD15	Unsat. zone 1, effective porosity	2.500E-01	2.000E-01	---	EPUZ(1)
RD15	Unsat. zone 1, field capacity	1.500E-01	2.000E-01	---	FCUZ(1)
RD15	Unsat. zone 1, soil-specific b parameter	4.050E+00	5.300E+00	---	BUZ(1)
RD15	Unsat. zone 1, hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for H-3				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.969E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.000E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA	FS
R017	Radii of shape factor array (used if FS = -1)				
R017	Outer annular radius (m), ring 1	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

D Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.100E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	2.700E+00	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	1.000E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	3.600E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	1.970E+01	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	7.300E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	D 2.44E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	D 2.43E-01	FMEAT
R018	Contamination fraction of milk	-1	-1	D 2.43E-01	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.694E+01	---	C02F
STOR	Storage times of contaminated foodstuffs (days)				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	-	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	--	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	- .	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec)				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	RRXC
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	CMPL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Number of graphical time points	64	---	---	NPTS
TITL	Maximum number of integration points for dose	9	---	---	LYMAX
TITL	Maximum number of integration points for risk	33	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

RESRAD INPUT PARAMETERS FOR THE BCL STOCKPILE (OVERBURDEN) -- RADIONUCLIDES

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

1RESRAD, Version 6.30 T* Limit = 0.5 year 03/02/2006 14:26 Page 2
Summary : Tritium at 118-B-6 Waste Staging Area with Irrigation - Rural Residential Scena
File : Run#3_118-B-6_BCL_Stockpile_With_Irrigation.RAD

Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 2001 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	H-3	6.400E-08	6.400E-08	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	H-3	6.400E-08	6.400E-08	DCF3(1)
D-34	Food transfer factors:			
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(1,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(1,2)
D-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	H-3 , fish	1.000E+00	1.000E+00	BIOFAC(1,1)
D-5	H-3 , crustacea and mollusks	1.000E+00	1.000E+00	BIOFAC(1,2)

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Summary: Tritium at 118-B-6 Waste Staging Area with Irrigation - Rural Residential Scena
File: Run#3_118-B-6_BCL_Stockpile_With_Irrigation.RAD

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.492E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	4.600E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	2.180E+01	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	7.000E+00	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.200E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	2.760E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	4.500E+01	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	3.000E+02	0.000E+00	---	T(9)
R011	Times for calculations (yr)	1.000E+03	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g) H-3	2.380E+02	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L) H-3	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.900E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	8.000E+00	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.100E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.500E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	1.500E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5.530E+03	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.250E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	4.600E+00	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	NODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS

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Summary Tritium at 118-B-6 Waste Staging Area with Irrigation - Rural Residential Scena
File Run#3_118-B-6_SCL_Stockpile_With_Irrigation.RAD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	1.780E+01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.600E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.500E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	1.500E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	4.050E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for H-3				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.969E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
RD17	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	--	INHALR
RD17	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
RD17	Exposure duration	3.000E+01	3.000E+01	---	ED
RD17	Shielding factor, inhalation	4.000E-01	4.000E-01	--	SHF3
RD17	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
RD17	Fraction of time spent indoors	6.000E-01	5.000E-01	--	FIND
RD17	Fraction of time spent outdoors (on site)	2.000E-01	2.500E-01	---	FOTD
RD17	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA	FS
RD17	Radii of shape factor array (used if FS = -1)				
RD17	Outer annular radius (m), ring 1	not used	5.000E+01	---	RAD_SHAPE(1)
RD17	Outer annular radius (m), ring 2	not used	7.071E+01	---	RAD_SHAPE(2)
RD17	Outer annular radius (m), ring 3	not used	0.000E+00	---	RAD_SHAPE(3)
RD17	Outer annular radius (m), ring 4	not used	0.000E+00	---	RAD_SHAPE(4)
RD17	Outer annular radius (m), ring 5	not used	0.000E+00	---	RAD_SHAPE(5)
RD17	Outer annular radius (m), ring 6	not used	0.000E+00	---	RAD_SHAPE(6)
RD17	Outer annular radius (m), ring 7	not used	0.000E+00	--	RAD_SHAPE(7)
RD17	Outer annular radius (m), ring 8	not used	0.000E+00	---	RAD_SHAPE(8)
RD17	Outer annular radius (m), ring 9	not used	0.000E+00	---	RAD_SHAPE(9)
RD17	Outer annular radius (m), ring 10	not used	0.000E+00	---	RAD_SHAPE(10)
RD17	Outer annular radius (m), ring 11	not used	0.000E+00	---	RAD_SHAPE(11)
RD17	Outer Annular radius (m), ring 12	not used	0.000E+00	--	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (IF different from user input)	Parameter Name
RD17	Fractions of annular areas within AREA				
RD17	Ring 1	not used	1 000E+00	---	FRACA(1)
RD17	Ring 2	not used	2 732E-01	---	FRACA(2)
RD17	Ring 3	not used	0 000E+00	---	FRACA(3)
RD17	Ring 4	not used	0 000E+00	---	FRACA(4)
RD17	Ring 5	not used	0 000E+00	---	FRACA(5)
RD17	Ring 6	not used	0 000E+00	---	FRACA(6)
RD17	Ring 7	not used	0 000E+00	---	FRACA(7)
RD17	Ring 8	not used	0 000E+00	---	FRACA(8)
RD17	Ring 9	not used	0 000E+00	---	FRACA(9)
RD17	Ring 10	not used	0 000E+00	---	FRACA(10)
RD17	Ring 11	not used	0 000E+00	---	FRACA(11)
RD17	Ring 12	not used	0 000E+00	---	FRACA(12)
RD18	Fruits, vegetables and grain consumption (kg/yr)	1 100E+02	1 600E+02	---	DIET(1)
RD18	Leafy vegetable consumption (kg/yr)	2 700E+00	1 400E+01	---	DIET(2)
RD18	Milk consumption (L/yr)	1 000E+02	9 200E+01	---	DIET(3)
RD18	Meat and poultry consumption (kg/yr)	3 600E+01	6 300E+01	---	DIET(4)
RD18	Fish consumption (kg/yr)	1 970E+01	5 400E+00	---	DIET(5)
RD18	Other seafood consumption (kg/yr)	9 000E-01	9 000E-01	---	DIET(6)
RD18	Soil ingestion rate (g/yr)	7 300E+01	3 650E+01	---	SOIL
RD18	Drinking water intake (L/yr)	7 300E+02	5 100E+02	---	DWI
RD18	Contamination fraction of drinking water	1 000E+00	1 000E+00	---	FDW
RD18	Contamination fraction of household water	not used	1 000E+00	---	FHHW
RD18	Contamination fraction of livestock water	1 000E+00	1 000E+00	---	FLW
RD18	Contamination fraction of irrigation water	1 000E+00	1 000E+00	---	FIRW
RD18	Contamination fraction of aquatic food	5 000E-01	5 000E-01	---	FR9
RD18	Contamination fraction of plant food	-1	-1	0 500E+00	FPLANT
RD18	Contamination fraction of meat	-1	-1	0 746E-01	FMEAT
RD18	Contamination fraction of milk	-1	-1	0 746E-01	FMILK
RD19	Livestock fodder intake for meat (kg/day)	6 800E+01	6 800E+01	---	LFI5
RD19	Livestock fodder intake for milk (kg/day)	5 500E+01	5 500E+01	---	LFI6
RD19	Livestock water intake for meat (L/day)	5 000E+01	5 000E+01	---	LWI5
RD19	Livestock water intake for milk (L/day)	1 600E+02	1 600E+02	---	LWI6
RD19	Livestock soil intake (kg/day)	5 000E-01	5 000E-01	---	LSI
RD19	Mass loading for foliar deposition (g/m**3)	1 000E-04	1 000E-04	---	MLFD
RD19	Depth of soil mixing layer (m)	1 500E-01	1 500E-01	---	DM
RD19	Depth of roots (m)	9 000E-01	9 000E-01	---	DROOT
RD19	Drinking water fraction from ground water	1 000E+00	1 000E+00	---	FGWDW
RD19	Household water fraction from ground water	not used	1 000E+00	---	FGWHH
RD19	Livestock water fraction from ground water	1 000E+00	1 000E+00	---	FGWLW
RD19	Irrigation fraction from ground water	1 000E+00	1 000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m^^2)	7 000E-01	7 000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1 500E+00	1 500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1 100E+00	1 100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1 700E-01	1 700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2 500E-01	2 500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8 000E-02	8 000E-02	---	TE(3)

Site-Specific Parameter Summary (continued)

D Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	1 000E-01	1 000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1 000E+00	1 000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1 000E+00	1 000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2 500E-01	2 500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2 500E-01	2 500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2 500E-01	2 500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2 500E-01	2 500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2 500E-01	2 500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2 500E-01	2 500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2 000E+01	2 000E+01	---	WLAM
C14	C-12 concentration in water (g/cm^3)	not used	2 000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3 000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2 000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9 800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3 000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7 000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1 000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8 000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2 000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8 894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days)				
STOR	Fruits, non-leafy vegetables, and grain	1 400E+01	1 400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1 000E+00	1 000E+00	---	STOR_T(2)
STOR	Milk	1 000E+00	1 000E+00	---	STOR_T(3)
STOR	Meat and poultry	2 000E+01	2 000E+01	---	STOR_T(4)
STOR	Fish	7 000E+00	7 000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7 000E+00	7 000E+00	---	STOR_T(6)
STOR	Well water	1 000E+00	1 000E+00	---	STOR_T(7)
STOR	Surface water	1 000E+00	1 000E+00	---	STOR_T(8)
STOR	Livestock fodder	4 500E+01	4 500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1 500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm^3)	not used	2 400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4 000E-02	---	TPCV
R021	Total porosity of the building foundation	not used	1 000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5 000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3 000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec)				
R021	in cover material	not used	2 000E-06	---	DIFCV
R021	in foundation material	not used	3 000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2 000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2 000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5 000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2 500E+00	---	HRM
R021	Building interior area factor	not used	0 000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1 000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2 500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1 500E-01	---	EMANA(2)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Number of graphical time points	64	---	---	NPTS
TITL	Maximum number of integration points for dose	9	---	---	LYMAX
TITL	Maximum number of integration points for risk	33	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

RESRAD INPUT PARAMETERS FOR THE DEEP ZONE – RADIONUCLIDES

Summary : Tritium at 118-B-6 Deep Zone with Irrigation - Rural Residential Scenario
File : Run#4_118-B-6_DZ_With_Irrigation.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 2001 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	H-3	6.400E-08	6.400E-08	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	H-3	6.400E-08	6.400E-08	DCF3(1)
D-34	Food transfer factors:			
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(1,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(1,2)
D-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	H-3 , fish	1.000E+00	1.000E+00	BIOFAC(1,1)
D-5	H-3 , crustacea and mollusks	1.000E+00	1.000E+00	BIOFAC(1,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (IF different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	5 600E+01	1 000E+04	---	AREA
R011	Thickness of contaminated zone (m)	6 800E+00	2 000E+00	---	THICKD
R011	Length parallel to aquifer flow (m)	8 400E+00	1 000E+02	--	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1 500E+01	2 500E+01	---	BRDL
R011	Time since placement of material (yr)	0 000E+00	0 000E+00	---	TI
R011	Times for calculations (yr)	1 000E+00	1 000E+00	---	T(2)
R011	Times for calculations (yr)	3 000E+00	3 000E+00	---	T(3)
R011	Times for calculations (yr)	7 000E+00	1 000E+01	---	T(4)
R011	Times for calculations (yr)	1 200E+01	3 000E+01	---	T(5)
R011	Times for calculations (yr)	2 760E+01	1 000E+02	--	T(6)
R011	Times for calculations (yr)	4 500E+01	3 000E+02	---	T(7)
R011	Times for calculations (yr)	1 000E+02	1 000E+03	---	T(8)
R011	Times for calculations (yr)	3 000E+02	0 000E+00	---	T(9)
R011	Times for calculations (yr)	1 000E+03	0 000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g) H-3	1 996E+03	0 000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L) H-3	not used	0 000E+00	---	W1(1)
R013	Cover depth (m)	1 600E+00	0 000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1 600E+00	1 500E+00	--	DENSCV
R013	Cover depth erosion rate (m/yr)	0 000E+00	1 000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1 600E+00	1 500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0 000E+00	1 000E-03	---	VCZ
R013	Contaminated zone total porosity	4 000E-01	4 000E-01	---	TPCZ
R013	Contaminated zone field capacity	1 500E-01	2 000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2 500E+02	1 000E+01	---	HCCZ
R013	Contaminated zone b parameter	4 050E+00	5 300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3 400E+00	2 000E+00	---	WIND
R013	Humidity in air (g/m**3)	8 000E+00	8 000E+00	---	HUMID
R013	Evapotranspiration coefficient	9 100E-01	5 000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1 600E-01	1 000E+00	---	PRECIP
R013	Irrigation (m/yr)	7 600E-01	2 000E-01	---	RI
R013	Irrigation mode	overhead	overhead	--	IDITCH
R013	Runoff coefficient	2 000E-01	2 000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1 000E+06	1 000E+06	---	WAREA
R013	Accuracy for water/soil computations	1 000E-03	1 000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1 600E+00	1 500E+00	---	DENSAQ
R014	Saturated zone total porosity	4 000E-01	4 000E-01	---	TPSZ
R014	Saturated zone effective porosity	2 500E-01	2 000E-01	---	EPSZ
R014	Saturated zone field capacity	1 500E-01	2 000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5 630E+03	1 000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1 250E-03	2 000E-02	---	HGWT
R014	Saturated zone b parameter	4 050E+00	5 300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1 000E-03	1 000E-03	--	VWT
R014	Well pump intake depth (m below water table)	4 600E+00	1 000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2 500E+02	2 500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
RD15	Unsat. zone 1, thickness (m)	1.100E+01	4.000E+00	---	H(1)
RD15	Unsat. zone 1, soil density (g/cm**3)	1.600E+00	1.500E+00	- -	DENSUZ(1)
RD15	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	- -	TPUZ(1)
RD15	Unsat. zone 1, effective porosity	2.500E-01	2.000E-01	---	EPUZ(1)
RD15	Unsat. zone 1, field capacity	1.500E-01	2.000E-01	---	FCUZ(1)
RD15	Unsat. zone 1, soil-specific b parameter	4.050E+00	5.300E+00	-	BUZ(1)
RD15	Unsat. zone 1, hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCUZ(1)
RD16	Distribution coefficients for H-3				
RD16	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(1)
RD16	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	--	DCNUCU(1,1)
RD16	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(1)
RD16	Leach rate (/yr)	0.000E+00	0.000E+00	2.288E-02	ALEACH(1)
RD16	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
RD17	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
RD17	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
RD17	Exposure duration	3.000E+01	3.000E+01	--	ED
RD17	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
RD17	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
RD17	Fraction of time spent indoors	6.000E-01	5.000E-01	---	FIND
RD17	Fraction of time spent outdoors (on site)	2.000E-01	2.500E-01	---	FOTD
RD17	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA	FS
RD17	Radii of shape factor array (used if FS = -1)				
RD17	Outer annular radius (m), ring 1	not used	5.000E+01	--	RAD_SHAPE(1)
RD17	Outer annular radius (m), ring 2	not used	7.071E+01	--	RAD_SHAPE(2)
RD17	Outer annular radius (m), ring 3	not used	0.000E+00	---	RAD_SHAPE(3)
RD17	Outer annular radius (m), ring 4	not used	0.000E+00	--	RAD_SHAPE(4)
RD17	Outer annular radius (m), ring 5	not used	0.000E+00	--	RAD_SHAPE(5)
RD17	Outer annular radius (m), ring 6	not used	0.000E+00	--	RAD_SHAPE(6)
RD17	Outer annular radius (m), ring 7	not used	0.000E+00	-	RAD_SHAPE(7)
RD17	Outer annular radius (m), ring 8	not used	0.000E+00	- -	RAD_SHAPE(8)
RD17	Outer annular radius (m), ring 9	not used	0.000E+00		RAD_SHAPE(9)
RD17	Outer annular radius (m), ring 10	not used	0.000E+00		RAD_SHAPE(10)
RD17	Outer annular radius (m), ring 11	not used	0.000E+00	--	RAD_SHAPE(11)
RD17	Outer annular radius (m), ring 12	not used	0.000E+00		RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.100E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	2.700E+00	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	1.000E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	3.600E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	1.970E+01	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-02	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	7.300E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.280E-01	FPLANT
R018	Contamination fraction of meat	-1	-1	0.280E-02	FMEAT
R018	Contamination fraction of milk	-1	-1	0.280E-02	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m^3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	2.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m^2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m^2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m^2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (IF different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12C2
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-14 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	AVFSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days)				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec)				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFC2
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (if different from user input)	Parameter Name
TITL	Number of graphical time points	32	--	- -	NPTS
TITL	Maximum number of integration points for dose	5	---	---	LYMAX
TITL	Maximum number of integration points for risk	17	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

CALCULATION BRIEF EXCERPTS

DISCLAIMER FOR CALCULATIONS

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

CALCULATION BRIEFS

The following calculation briefs have been prepared in accordance with WCH-DE-01, *Design Engineering Procedures Manual*, EDPI-4.37-01, "Project Calculations," Washington Closure Hanford, Richland, Washington.

118-B-6 Burial Ground Shallow, Deep Zone, and Stockpile Sampling Plan, Calculation No. 0100B-CA-V0271, Rev. 0, Washington Closure Hanford, Richland, Washington.

118-B-6 Burial Ground Cleanup Verification 95% UCL Calculations, Calculation No. 0100B-CA-V0274, Rev. 1, Washington Closure Hanford, Richland, Washington.

118-B-6 Burial Ground RESRAD Calculation Brief, Calculation No. 0100B-CA-V0276, Rev. 0, Washington Closure Hanford, Richland, Washington.

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

CALCULATION COVER SHEET

Project Title:	118-B-6 Burial Ground Sample Design	**Job No.**	14655
Area	100-B/C Area		
Discipline	Environmental Engineering	**Calc. No.**	0100B-CA-V0271
Subject	118-B-6 Burial Ground Shallow, Deep Zone, and Stockpile Sampling Plan		
Computer Program	Excel	**Program No.**	Excel 2003

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

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sht Calc = 2 Shts Attach1 = 1 Sht Attach2 = 1 Sht Attach3 = 4 Shts Total = 9 Shts	G. Cruz 12/12/05	C.A. Bentz 12/12/05	D.L. Bowers 12-28-05	D.N. Sturm	12-28-05

SUMMARY OF REVISIONS

*Obtain Calc No from DIS

January 2003

DE01-437.03

Washington Closure Hanford

CALCULATION SHEET

Originator G. Cruz **Date** 12/12/2005 **Calc. No.** 0100B-CA-V0271 **Rev. No.** 0

Project 118-B-6 Burial Ground Sample Design **Job No.** 14655 **Checked** CAB **Date** 12/12/05

Subject 118-B-6 Burial Ground Shallow, Deep Zone, and Stockpile Sampling Plan **Sheet No.** 1 of 2

Problem:	Calculate and display required sampling nodes in concurrence with 100 Area Burial Grounds Remedial Action Sampling and Analysis Plan, DOE/RL-2001-35 Rev. 0, for verification and closure.	
Given:	-SAP (DOE/RL-2001-35 Rev. 0) requirements	
	-Shallow Zone Sampling Area (Surface area of each zone determined from CAD program, Attachment 3, Sht 1of4, CAD file 1BC:121205A, 118-B-6 Burial Ground Shallow Zones Sampling Plan)	
	-Deep Zone Sampling Area (Surface area of each zone determined from CAD program, Attachment 3, Sht 2of4, CAD file 1BC:121205B, 118-B-6 Burial Ground Deep Zone Sampling Plan)	
	-Stockpile (BCL) Sampling Area (Surface area of each zone determined from CAD program, Attachment 3, Sht 3of4, CAD file 1BC:121205C, 118-B-6 Burial Ground Stockpile (BCL) Sampling Plan)	
	-Staging Pile Sampling Area (Surface area of each zone determined from CAD program, Attachment 3, Sht 4of4, CAD file 1BC:121205D, 118-B-6 Burial Ground Stockpile (Staging Area) Sampling Plan)	
SAP Requirements:		
	-Develop a 16 node sampling grid for the sampling area	
Shallow Zone:	-Use table 3-2 of the SAP to determine which four of the sixteen nodes will be sampled to collect clean up verification samples	
	-Develop a 16 node sampling grid for the sampling area	
Overburden:	-Use table 3-2 of the SAP to determine which four of the sixteen nodes will be sampled to collect clean up verification samples	
	-Develop a 16 node sampling grid for the sampling area	
Deep Zone:	-Use table 3-2 of the SAP to determine which four of the sixteen nodes will be sampled to collect clean up verification samples	
Determination of Shallow Zone Sampling Grid:		
Shallow Zone Sampling Grid Area determined from Table 3-2, SAP Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)		
Total Area:	829.57	m^2
Area of Decision Subunits (total area 1 subunit)	829.57	m^2
Decision Subunit divided into 4 Sampling Areas:	207.39	m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):	12.96	m^2
Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)		
	See Attachment 3, Sht 1of4, 118-B-6 Burial Ground Shallow Zone Sampling Plan, for Sample Location Table	

Washington Closure Hanford

CALCULATION SHEET

Originator G. Cruz Date 11/8/2005 Calc. No. 0100B-CA-V0271 Rev. No. 0

Project 118-B-6 Burial Ground Sample Design Job No. 14655 Checked AB Date 12/2/05

Subject 118-B-6 Burial Ground Shallow, Deep Zone, and Stockpile Sampling Plan Sheet No. 2 of 2

Determination of Deep Zone Sampling Grid:			
Deep Zone Sampling Grid Area determined from Table 3-2, SAP Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)			
Total Area:		55.41	m^2
Area of Decision Subunits (total area 1 subunit)		55.41	m^2
Decision Subunits divided into 4 Sampling Areas:		13.85	m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):		0.86	m^2
Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)	See Attachment 3, Sht 2of4, 118-B-6 Burial Ground Deep Zone Sampling Plan, for Sample Location Table		
Determination of Stockpile (BCL) Sampling Grid:			
Stockpile (BCL) Sampling Grid Area determined from Table 3-2, SAP Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)			
Total Area:		1491.14	m^2
Area of Decision Subunits (total area 1 subunit)		1491.14	m^2
Decision Subunits divided into 4 Sampling Areas:		372.78	m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):		23.29	m^2
Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)	See Attachment 3, Sht 3of4, 118-B-6 Burial Ground Stockpile (BCL) Sampling Plan, for Sample Location Table		
Determination of Stockpile (Staging Area) Sampling Grid:			
Stockpile (Staging Area) Sampling Grid Area determined from Table 3-2, SAP Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)			
Total Area:		486.78	m^2
Area of Decision Subunits (total area 1 subunit)		486.78	m^2
Decision Subunits divided into 4 Sampling Areas:		121.69	m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):		7.60	m^2
Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)	See Attachment 3, Sht 4of4, 118-B-6 Burial Ground Stockpile (Staging Area) Sampling Plan, for Sample Location Table		

Washington Closure Hanford

Originator S. Cruz Date 12/12/2005 Calc. No. 0100B-CA-V0271 Rev. No. 0

Project 116-B-6 Burial Ground Sample Design Job No. 14655 Checked [illegible] Date 12/12/05

Subject 116-B-6 Burial Ground Shallow, Deep Zone, and Stockpile Sampling Plan Sheet No 1of1

ATTACHMENT 1

Sample Grid Point Lookup Table.

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

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

Washington Closure Hanford

Originator G. Cruz Date 12/12/2005 Calc. No. 0100B-CA-V0271 Rev. No. 0

Project 118-B-6 Burial Ground Sample Design Job No. 14655 Checked GB Date 12/12/05

Subject 118-B-6 Burial Ground Shallow, Deep Zone, and Stockpile Sampling Plan Sheet No. 1of1

ATTACHMENT 2

Number of Decision Subunits Based on Area.

Site Verification Sampling Frequencies Based on Area.

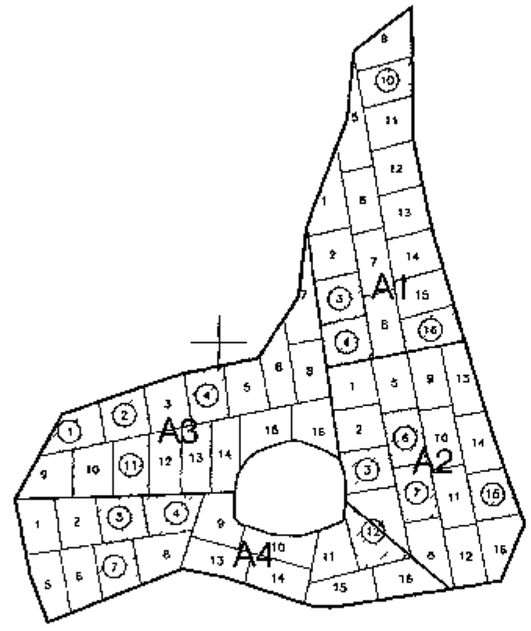
Decision Unit[a]	Waste Site Size[b]	Decision Subunits	Blocks[c]	Discrete Samples	Composite Samples
Shallow zone – 0 to 15 ft	Small: < 100,000 ft^2	1	4	16	4
	Medium: >100,000 ft^2 < 400,000 ft^2	4	16	64	16
	Large: >400,000 ft^2	8	32	128	32
Deep Zone - >15 ft	Small: < 100,000 ft^2	1	4	16	4
	Medium: >100,000 ft^2 < 400,000 ft^2	4	16	64	16
	Large: >400,000 ft^2	8	32	128	32
Overburden/layback stockpiles	Small: < 100,000 ft^2	1	4	16	4
	Medium: >100,000 ft^2 < 400,000 ft^2	4	16	64	16
	Large: >400,000 ft^2	8	32	128	32
Staging pile areas (residual soil)	Small: < 100,000 ft^2	1	4	16	4
	Medium: >100,000 ft^2 < 400,000 ft^2	4	16	64	16
	Large: >400,000 ft^2	8	32	128	32

[a] The shallow zone, deep zone, overburden stockpile, and staging pile areas each represent single decision units. The total number of decision units will vary because individual waste sites may not have a deep zone, overburden stockpile, and/or staging pile areas.
[b] Area of exposed surface after excavation or area of stockpile base (as applicable).
[c] Decision subunits are divided into four blocks to ensure that random sampling locations are not bunched together in one area.

18C 121205A

E 565350

N 144650



SCALE 1 400

4 0 4 8 16 meters

NOTES

1 SHALLOW ZONE NODE AREAS ARE APPROXIMATELY 12 96 SQUARE METERS
2 SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE
3 THE SHALLOW ZONE CONSISTS OF SAMPLING AREAS A1 A2 A3 & A4 WITHIN DECISION SUBUNIT 1

LEGEND

(8) CLEAN UP VERIFICATION SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	S-A1-3	144653 52	565359 52
		S-A1-4	144650 07	565360 89
		S-A1-10	144671 09	565363 15
		S-A1-16	144651 07	565366 70
	A2	S-A2-3	144639 83	565381 80
		S-A2-6	144642 42	565384 78
		S-A2-7	144638 04	565385 67
		S-A2-15	144637 93	565371 71
	A3	S-A3-1	144642 84	565338 35
		S-A3-2	144644 17	565342 70
		S-A3-4	144645 72	565349 08
		S-A3-11	144640 17	565343 19
	A4	S-A4-3	144635 99	565342 34
		S-A4-4	144638 38	565346 76
		S-A4-7	144632 03	565341 97
		S-A4-12	144634 93	565362 31

3 1 4
GIRRZ 12/12/05
CA Eagle 12/12/05
0100B CA-V0271 0

ATTACHMENT 3

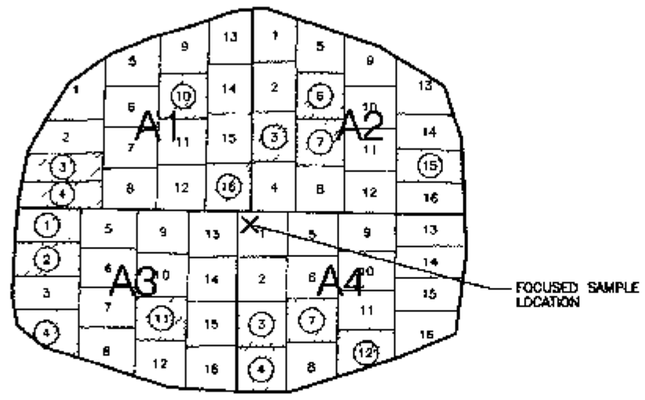
U.S DEPARTMENT OF ENERGY
DOE RICHLAND OPERATIONS OFFICE
RIVER CORRIDOR CLOSURE CONTRACT

100-B/C AREA
100 AREA REMEDIAL DESIGN
118-B-6 BURIAL GROUND
SHALLOW ZONE SAMPLING PLAN

1BC 121205B

E 565350

N 144640



SCALE 1 100
1 0 1 2 4 meters

N

NOTES

1 DEEP ZONE NODE AREAS ARE APPROXIMATELY 0 86 SQUARE METERS
2 SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE
3 THE DEEP ZONE CONSISTS OF SAMPLING AREAS A1 A2 A3 & A4 WITHIN DECISION SUBUNIT 1

LEGEND

(8) CLEAN UP VERIFICATION SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	D-A1-3	144639 03	565352 20
		D-A1-4	144638 49	565352 19
		D-A1-10	144640 46	565354 54
		D-A1-16	144638 60	565355 44
	A2	D-A2-3	144639 54	565356 32
		D-A2-6	144640 48	565357 22
		D-A2-7	144638 53	565357 22
		D-A2-16	144639 07	565359 39
	A3	D-A3-1	144637 87	565351 99
		D-A3-2	144637 19	565351 80
		D-A3-4	144635 72	565351 80
		D-A3-11	144636 62	565354 14
	A4	D-A4-3	144635 91	565356 16
		D-A4-4	144635 61	565356 10
		D-A4-7	144635 68	565357 06
		D-A4-12	144635 34	565358 15

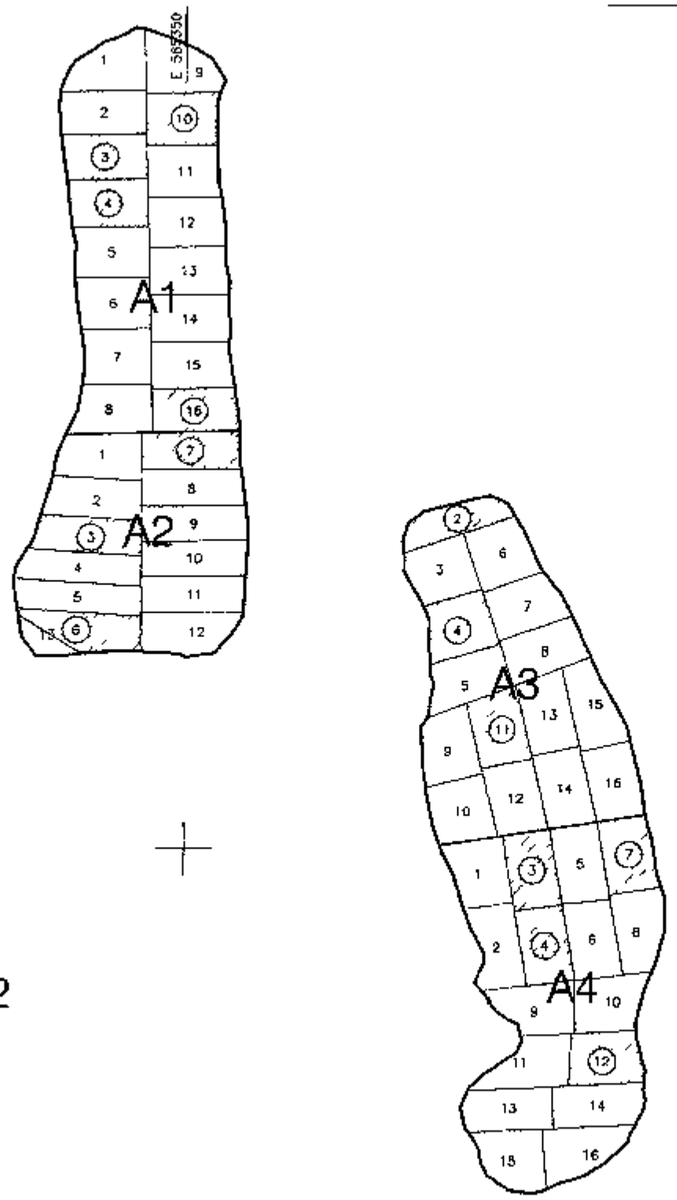
Sheet No 2 of 4
Date 12/12/05
Date 02/16/06
Rev No 0

ATTACHMENT 3

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

100-B/C AREA
100 AREA REMEDIAL DESIGN
118-B-6 BURIAL GROUND
DEEP ZONE SAMPLING PLAN

1BC 121205C



NOTES

1. STOCKPILE NODE AREAS ARE APPROXIMATELY 23 29 SQUARE METERS
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE
3. THE STOCKPILE CONSISTS OF SAMPLING AREAS A1 A2 A3 & A4 WITHIN DECISION SUBUNIT 1

LEGEND

(8) CLEAN UP VERIFICATION SAMPLING NODE

SAMPLE LOCATION TABLE

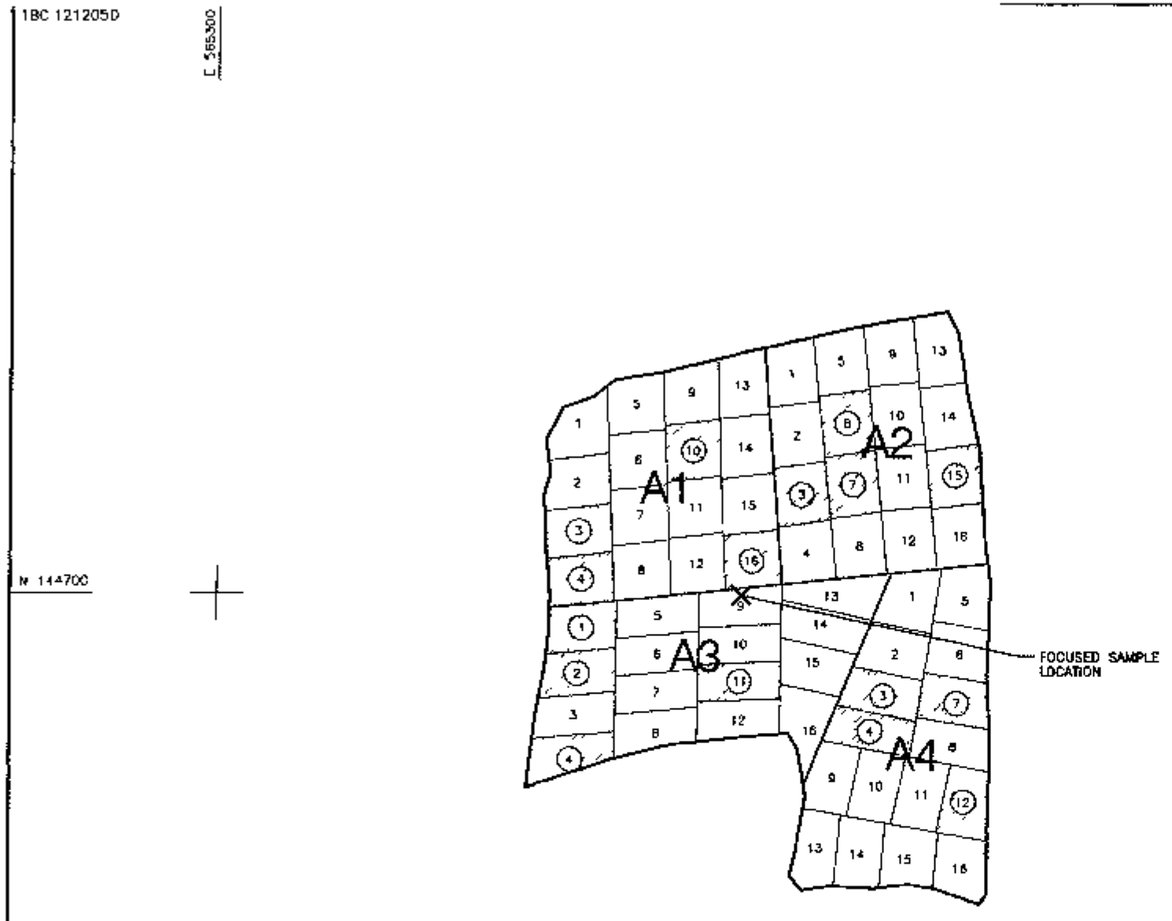
DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	O-A1-3	144705 18	565343 62
		O-A1-4	144701 46	565343 98
		O-A1-10	144708 25	565348 80
		O-A1-16	144684 93	565350 87
	A2	O A2-5	144674 80	565342 53
		O-A2-6	144667 45	565341 53
		O-A2-7	144681 74	565350 40
		O-A2-15	144634 21	565329 75
	A3	O-A3 1	144630 98	565324 55
		O-A3-2A	144629 08	565328 53
		O-A3-2B	144676 52	565371 36
		O A3 6	144667 41	565371 42
		O-A3-11	144658 55	565374 93
	A4	O A4-3	144648 31	565377 38
		O-A4-4	144642 29	565378 36
		O-A4-7	144648 57	565384 95
		O-A4-12	144633 07	565382 97

Sheet No 3 of 4
12/16/05
0

ATTACHMENT 3

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

100-B/C AREA
100 AREA REMEDIAL DESIGN
118-B-6 BURIAL GROUND
STOCKPILE (BCL) SAMPLING PLAN



NOTES

1 STAGING PILE NODE AREAS ARE APPROXIMATELY 7 60 SQUARE METERS
2 SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE
3 THE STAGING PILE CONSISTS OF SAMPLING AREAS A1 A2 A3 & A4 WITHIN DECISION SUBUNIT 1

LEGEND

(B) CLEAN UP VERIFICATION SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	0-A1-3	144703 12	565317 79
		0-A1-4	144706 73	565317 90
		0-A1 10	144707 15	565323 33
		0-A1-16	144701 64	565325 24
	A2	0-A2-3	144704 98	565328 69
		0-A2-6	144708 53	565330 89
		0-A2-7	144705 47	565331 19
		0-A2-15	144705 92	565335 15
	A3	0-A3-1	144698 32	565317 92
		0-A3-2	144698 05	565317 72
		0-A3-4	144691 77	565317 40
		0-A3-11	144695 60	565326 86
	A4	0-A4-3	144694 95	565332 70
		0-A4-4	144693 20	565332 08
		0-A4-7	144694 57	565336 26
		0-A4-12	144689 68	565336 61

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G. CRW
C.A. Bowe
DOOR-CA-V0271

Sheet No 4 of 4
Date 12/12/05
Rev 0

ATTACHMENT 3

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

100-B/C AREA
100 AREA REMEDIAL DESIGN
118-B-6 BURIAL GROUND
STOCKPILE (STAGING AREA) SAMPLING PLAN

CALCULATION COVER SHEET

Project Title:	100-B/C Area Field Remediation	**Job No.**	14655
Area	100-B/C		
Discipline	Environmental	***Calc. No.**	0100B-CA-V0274
Subject	118-B-6 Burial Ground Cleanup Verification 95% UCL Calculations		
Computer Program	Excel	**Program No.**	Excel 2003

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

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 7 Total = 8	*Approved* *3/1/2006* J M Capron	*Approved* *3/2/2006* T M Blakley	*Approved* *3/5/2006* L M Dittmer	*Approved* *3/9/2006* D N Strom	*3/9/2006*
1	Cover = 1 Sheets = 7 Total = 8	3/23/06 J M Capron	3/23/06 T M Blakley	3/30/06 L M Dittmer	D N Strom	4-4-06

SUMMARY OF REVISIONS

1	Replaced cover page for convenience. Revised Sheet 3, Line 26 (decision unit names corrected)

* Obtain calc no. from *DIS*

DE01437.03 (12/09/2004)

Washington Closure Hanford CALCULATION SHEET

Originator J M Capron Date 03/01/06 Calc No 01008-CA-V0274 Rev. No. 0
Project 100-B/C Area Field Remediation Job No. 14655 Checked T M Blakley Date 3/2/06
Subject 118-B-6 Burial Ground Cleanup Verification 95% UCL Calculations Sheet No. 1 of 7

Summary

Purpose:
Calculate the 95% upper confidence limit (UCL) to evaluate compliance with cleanup standards for the subject site Also, calculate the carcinogenic risk for applicable nonradionuclide analytes, perform the *Washington Administrative Code* (WAC) 173-340 (Model Toxics Control Act [MTCA]) 3-part test, if required, and calculate the relative percent difference (RPD) for each contaminant of concern (COC)

Table of Contents:

Given/References:
1) Sample Results
2) All lookup values, remedial action goals (RAGs), and background values are taken from DOE-RL (2001b and 2005) and Ecology (1996)
3) DOE-RL, 2001a, *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan* (SAP), DOE/RL-2001-35, Rev 0, U S Department of Energy, Richland Operations Office, Richland, Washington
4) DOE-RL, 2001b, Hanford Site Background Part 1, Soil Background for Nonradioactive Analytes, DOE/RL-92-24, Rev 4, U S Department of Energy, Richland Operations Office, Richland, Washington
5) DOE-RL, 2005b, *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev 5, U S Department of Energy, Richland Operations Office, Richland, Washington
6) Ecology, 1992, *Statistical Guidance for Ecology Site Managers*, Publication #92-54, Washington State Department of Ecology, Olympia, Washington
7) Ecology, 1993, *Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-Detection Limit or Below-PQL Values (Censored Data Sets)*, Publication #92-54, Washington State Department of Ecology, Olympia, Washington
8) Ecology, 1996, *Model Toxics Control Act Cleanup Levels and Risk Calculations (CLARC II)*, Publication #94-145 Washington State Department of Ecology, Olympia, Washington
9) EPA, 1994, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, U S Environmental Protection Agency, Washington, D C
10) WAC 173-340, 1996, "Model Toxics 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 2005) Use data from the attached worksheets to calculate the 95% UCL, hazard quotients, excess carcinogenic risk, perform the WAC 173-340 3-part test for nonradionuclides, and calculate the RPD for each COC in the primary-duplicate and primary-split sample pairs

Calculation Description:
The subject calculations were performed on data from soil verification samples from the 118-B-6 burial ground The data were entered into an EXCEL 2003 spreadsheet and calculations performed by utilizing the built-in spreadsheet functions and/or creating formulas within the cells The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2005) is documented by this calculation Split and duplicate RPD results are used in evaluation of data quality and are presented in the cleanup verification package (CVP) for this site

Methodology.
For nonradioactive analytes with <50% of the data below detection limits and all radionuclide analytes, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL For nonradioactive analytes with >50% of the data below detection limits, the maximum value for the data set is used instead of the 95% UCL All nonradionuclide data reported as being below detection limits are set to ½ the detection limit value for calculation of the statistics (Ecology 1993) For radionuclide data, calculation of the statistics was done on the reported value In cases where the laboratory does not report a value below the minimum detectable activity (MDA), half of the MDA is used in the calculation For the statistical evaluation of primary-duplicate sample pairs the samples are averaged before being included in the data set, after adjustments for censored data as described above

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

Washington Closure Hanford **CALCULATION SHEET**

Originator J M Capron Date 03/01/06 Calc. No. 0100B CA-V0274 Rev. No. 0
Project 100-B/C Area Field Remediation Job No. 14655 Checked T M Stalder Date 3/2/06
Subject 118-B-6 Burial Ground Cleanup Verification 95% UCL Calculations Sheet No. 2 of 7

Summary (continued)

The hazard quotient (for shallow zone nonradionuclide COCs) is determined by dividing the statistical value (derived in this calculation) by the WAC 173-340 non-carcinogenic cleanup limit. The excess nonradionuclide carcinogenic risk is determined by dividing the statistical value by the WAC 173-340 carcinogenic cleanup limit and then multiplying by 10^{-6}.

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

The RPD is calculated when both the primary value and either the duplicate or split values are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method, listed in Table II-1 of the SAP (DOE-RL 2005a). The RPD calculations use the following formula: RPD =[|M-S|/((M+S)/2)|*100

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

For quality assurance/quality control (QA/QC) split and duplicate RPD calculations, a value less than +/- 30% indicates the data compare favorably. For regulatory splits, a threshold of 35% is used (EPA 1994). If the RPD is greater than 30% (or 35% for regulatory split data), further investigation regarding the usability of the data is performed. Additional discussion as necessary is provided in the data quality assessment section of the applicable CVP.

If regulator split comparison is required, an additional parameter is evaluated. A control limit of +/- 2 times the TDL shall be used if either the main or regulator split value is less than 5 times the TDL and above detection. In the case where only one result is greater than 5 times the TDL and the other is below, the +/- 2 times the TDL criteria applies. Therefore, the following calculation is performed as part of the evaluation for these two cases involving regulator split data: difference = main - regulator split. If the difference is greater than +/- 2 times the TDL, then further investigation regarding the usability of the data is performed and presented in the applicable CVP data quality assessment section.

No regulatory split samples were collected for this site.

Washington Closure Hanford **CALCULATION SHEET**

Originator J. M. Capron Date 03/23/06 Calc. No. 0100B-CA-V0274 Rev. No. 1
Project 100-B/C Area Field Remediation Job No. 14655 Checked T. M. Bielsky Date 3/27/06
Sheet No. 3 of 7

Subject 118-B-6 Burial Ground Cleanup Verification 95% UCL Calculations

Summary (continued)

Results:
The results presented in the summary tables that follow are for use in RESidual RADioactivity dose/risk analysis and the CVP for this site.

Results Summary

Analyte	Shallow Zone		Deep Zone		Waste Staging Area		BCL Stockpile		Units
	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	
Lead	6.7		4.9		5.2		8.5		mg/kg
Mercury	0.08		0.02	U	0.02	U	0.03		mg/kg
Tritium	160		1996		36.7		236		pCi/g

BCL = below cleanup level
U = undetected

WAC 173-340 Evaluation (Shallow Zone)

3-Part Test:
95% UCL > Cleanup Limit? NA
> 10% above Cleanup Limit? NA
Any sample > 2x Cleanup Limit? NA

Because all nonradionuclide COC levels are below background, performance of the 3-part test and calculation of excess risk are not required.

Risk Estimate:
Nonrad noncarcinogenic index sum: NA
Nonrad carcinogenic risk: NA

WAC 173-340 Evaluation (Deep Zone)

3-Part Test:
95% UCL > Cleanup Limit? NA
> 10% above Cleanup Limit? NA
Any sample > 2x Cleanup Limit? NA

Because all nonradionuclide COC levels are below background, performance of the 3-part test is not required.

WAC 173-340 Evaluation (Waste Staging Area)

3-Part Test:
95% UCL > Cleanup Limit? NA
> 10% above Cleanup Limit? NA
Any sample > 2x Cleanup Limit? NA

Because all nonradionuclide COC levels are below background, performance of the 3-part test and calculation of excess risk are not required.

Risk Estimate:
Nonrad noncarcinogenic index sum: NA
Nonrad carcinogenic risk: NA

WAC 173-340 Evaluation (BCL Stockpile)

3-Part Test:
95% UCL > Cleanup Limit? NA
> 10% above Cleanup Limit? NA
Any sample > 2x Cleanup Limit? NA

Because all nonradionuclide COC levels are below background, performance of the 3-part test and calculation of excess risk are not required.

Risk Estimate:
Nonrad noncarcinogenic index sum: NA
Nonrad carcinogenic risk: NA

Relative Percent Difference Results* QA/QC Analysis

Analyte	Deep Zone	
	Duplicate Analysis	Split Analysis
Lead		
Mercury		
Tritium		

*A blank cell indicates that RPD evaluation was not required.
QA/QC = quality assurance/quality control
RPD = relative percent difference

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron — Date 03/01/06 — Calc. No. 0100B-CA-V0274 — Rev. No. 0
Project 100-B/C Area Field Remediation — Job No. 14655 — Checked T. M. Blakley — Date 3/2/06
Subject 118-B-6 Burial Ground Cleanup Verification 95% UCL Calculations — Sheet No. 4 of 7

118-B-6 Shallow Zone Sample Data

Sampling Area	HEIS Number	Sample Date	Lead mg/kg	Q	PQL	Mercury mg/kg	Q	PQL	Tritium pCi/g	Q	MDA
A1	J10VP6	1/9/2006	7.7		1.8	0.02	U	0.02	0.720	UJ	3.1
A2	J10VP7	1/9/2006	5.6		1.6	0.06		0.02	1.22	UJ	3.0
A3	J10VP8	1/9/2006	3.3		1.7	0.02	U	0.02	241	J	4.1
A4	J10VP9	1/9/2006	3.3		1.7	0.02	U	0.02	4.52	J	3.1

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Lead mg/kg			Mercury mg/kg			Tritium pCi/g		
A1	J10VP6	1/9/2006	7.7			0.01			0.720		
A2	J10VP7	1/9/2006	5.6			0.06			1.22		
A3	J10VP8	1/9/2006	3.3			0.01			241		
A4	J10VP9	1/9/2006	3.3			0.01			4.52		

Statistical Computations

	Lead			Mercury			Tritium		
Statistical value based on	Small data set. Use nonparametric z-stat.			Nonradionuclide data set >50% censored. 95% UCL value not calculated.			Radionuclide data set. Use nonparametric z-stat.		
N	4			4			4		
% < Detection limit	0%			75%			50%		
mean	5.0			0.03			62		
st. dev	2.1			0.04			119		
Z-statistic	1.645			1.645			1.645		
95% UCL on mean	8.7			NA			160		
max value	7.7			0.06			241		
Statistical value	8.7			0.06			160		
Background	NA			NA			NA		
Statistical value above background	8.7			0.06			160		
Most Stringent Cleanup Limit for nonradionuclide and RAG type	10.2	BG/GW/River Protection		0.33	BG/GW/River Protection				
WAC 173-340 3-PART Test									
95% UCL > Cleanup Limit?	NA			NA					
> 10% above Cleanup Limit?	NA			NA					
Any sample > 2X Cleanup Limit?	NA			NA					
RISK EVALUATION									
WAC 173-340 Non-Carcinogenic Cleanup:	353			24					
Hazard quotient for each nonradionuclide	NA			NA					
WAC 173-340 Carcinogenic Cleanup:	NA			NA					
Risk for each carcinogenic nonradionuclide	NA			NA					
WAC 173-340 Compliance? NA	Because all lead values are below background (10.2 mg/kg), performance of the 3-part test and calculation of excess risk are not required.			Because all mercury values are below background (0.33 mg/kg), performance of the 3-part test and calculation of excess risk are not required					
Nonrad noncarcinogenic index sum: NA									
Nonrad carcinogenic risk: NA									

BG = background
GW = groundwater
HEIS = Hanford Environmental Information System
J = estimated
MDA = minimum detectable activity
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
RAG = remedial action goal
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron — Date 03/01/06 — Calc. No. 0100B-CA-V0274 — Rev No 0
Project 100-B/C Area Field Remediation — Job No 14655 — Checked T. M. Blakley — Date 3/2/06
Subject 118-B-6 Burial Ground Cleanup Verification 95% UCL Calculations — Sheet No. 5 of 7

1 **118-B-6 Deep Zone Sample Data**

Sampling Area	HEIS Number	Sample Date	Lead mg/kg	Q	PQL	Mercury mg/kg	Q	PQL	Tritium pCi/g	Q	MDA
A2	J10VN6	1/9/2006	3.2		1.7	0.02	U	0.02	800	J	3.2
Duplicate of J10VN6	J10VN7	1/9/2006	3.9		1.7	0.02	U	0.02	764	J	3.1
A1	J10VN4	1/9/2006	4.7		1.8	0.02	U	0.02	165	J	4.1
A3	J10VN2	1/9/2006	5.1		1.8	0.02	U	0.02	220	J	2.8
A4	J10VN3	1/9/2006	3.1		1.9	0.02	U	0.02	2780	J	4.6

9 **Statistical Computation Input Data**

Sampling Area	HEIS Number	Sample Date	Lead mg/kg			Mercury mg/kg			Tritium pCi/g		
A2	J10VN6/ J10VN7	1/9/2006	3.6			0.01			782		
A1	J10VN4	1/9/2006	4.7			0.01			165		
A3	J10VN2	1/9/2006	5.1			0.01			220		
A4	J10VN3	1/9/2006	3.1			0.01			2780		

16 **Statistical Computations**

	Lead			Mercury			Tritium		
Statistical value based on	Small data set. Use nonparametric z-stat			Nonradionuclide data set >50% censored. 95% UCL value not calculated			Radionuclide data set. Use nonparametric z-stat		
N	4			4			4		
% < Detection limit	0%			100%			0%		
mean	4.1			0.01			967		
st. dev.	0.9			0			1228		
Z-statistic	1.645			1.645			1.645		
95% UCL on mean	4.9			NA			1996		
max value	5.1			0.02	U		2780		
Statistical value	4.9			0.02	U		1996		
Background	NA			NA			NA		
Statistical value above background	4.9			0.02	U		1996		
Most Stringent Cleanup Limit for nonradionuclide and RAG type	10.2	BG/GW/River Protection		0.33	BG/GW/River Protection				
WAC 173-340 3-PART Test									
95% UCL > Cleanup Limit?	NA			NA					
> 10% above Cleanup Limit?	NA			NA					
Any sample > 2X Cleanup Limit?	NA			NA					
WAC 173-340 Compliance? NA	Because all lead values are below background (10.2 mg/kg), performance of the 3-part test is not required			Because all mercury values are below background (0.33 mg/kg), performance of the 3-part test is not required					

35 **Split-Duplicate Analysis**

Sampling Area	HEIS Number	Sample Date	Lead mg/kg	Q	PQL	Mercury mg/kg	Q	PQL	Tritium pCi/g	Q	MDA
A2	J10VN6	1/9/2006	3.2		1.7	0.02	U	0.02	800	J	3.2
Duplicate of J10VN6	J10VN7	1/9/2006	3.9		1.7	0.02	U	0.02	764	J	3.1
Split of J10VN6	J10VN7	1/9/2006	2.5		1.0	0.035	U	0.035	539		0.0320
TDL			1			0.2			400		
Duplicate Analysis	Both > PQL/MDA?		Yes (continue)			No-Stop (acceptable)			Yes (continue)		
	Both > 5xTDL?		No-Stop (acceptable)						No-Stop (acceptable)		
	RPD										
Split Analysis	Both > PQL/MDA?		Yes (continue)			No-Stop (acceptable)			Yes (continue)		
	Both > 5xTDL?		No-Stop (acceptable)						No-Stop (acceptable)		
	RPD										

48 BG = background
49 GW = groundwater
50 HEIS = Hanford Environmental Information System
51 J = estimated
52 MDA = minimum detectable activity
53 NA = not applicable
54 PQL = practical quantitation limit
Q = qualifier
RAG = remedial action goal
RPD = relative percent difference
TDL = target detection limit
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

CALCULATION SHEET

Washington Closure Hanford

Originator J. M. Capron — Date 03/01/06 — Calc. No. 01006-CA-V0274 — Rev. No. 0
Project 100-B/C Area Field Remediation — Job No. 14655 — Checked T. M. Blakley — Date 3/2/06
Subject 118-B-6 Burial Ground Cleanup Verification 95% UCL Calculations — Sheet No. 6 of 7

118-B-6 Waste Staging Area Sample Data

Sampling Area	HEIS Number	Sample Date	Lead mg/kg	Q	PQL	Mercury mg/kg	Q	PQL	Tritium pCi/g	Q	MDA
A1	J10VP3	1/9/2006	4.0		1.8	0.02	U	0.02	28.6	J	3.7
A2	J10VP2	1/9/2006	3.2		1.7	0.01	U	0.01	42.3	J	3.7
A3	J10VP4	1/9/2006	6.1		1.7	0.01	U	0.01	23.1	J	3.6
A4	J10VP5	1/9/2006	3.1		1.7	0.02	U	0.02	16.0	J	2.6

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Lead mg/kg			Mercury mg/kg			Tritium pCi/g		
A1	J10VP3	1/9/2006	4.0			0.01			28.6		
A2	J10VP2	1/9/2006	3.2			0.005			42.3		
A3	J10VP4	1/9/2006	6.1			0.005			23.1		
A4	J10VP5	1/9/2006	3.1			0.01			16.0		

Statistical Computations

	Lead			Mercury			Tritium		
Statistical value based on	Small data set. Use nonparametric z-stat.			Nonradionuclide data set >50% censored. 95% UCL value not calculated.			Radionuclide data set. Use nonparametric z-stat.		
N	4			4			4		
% < Detection limit	0%			100%			0%		
mean	4.1			0.01			27.5		
st. dev.	1.4			0.003			11.1		
Z-statistic	1.645			1.645			1.645		
95% UCL on mean	5.2			NA			36.7		
max value	6.1			0.02	U		42.3		
Statistical value	5.2			0.02	U		36.7		
Background	NA			NA			NA		
Statistical value above background	5.2			0.02	U		36.7		
Most Stringent Cleanup Limit for nonradionuclide and RAG type	10.2	BG/GW/River Protection		0.33	BG/GW/River Protection				
WAC 173-340 3-PART Test									
95% UCL > Cleanup Limit?	NA			NA					
> 10% above Cleanup Limit?	NA			NA					
Any sample > 2X Cleanup Limit?	NA			NA					
RISK EVALUATION									
WAC 173-340 Non-Carcinogenic Cleanup:	353			24					
Hazard quotient for each nonradionuclide:	NA			NA					
WAC 173-340 Carcinogenic Cleanup:	NA			NA					
Risk for each carcinogenic nonradionuclide:	NA			NA					
WAC 173-340 Compliance? NA	Because all lead values are below background (10.2 mg/kg), performance of the 3-part test and calculation of excess risk are not required.			Because all mercury values are below background (0.33 mg/kg), performance of the 3-part test and calculation of excess risk are not required.					
Nonrad noncarcinogenic index sum: NA									
Nonrad carcinogenic risk: NA									

BG = background
GW = groundwater
HEIS = Hanford Environmental Information System
J = estimated
MDA = minimum detectable activity
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
RAG = remedial action goal
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

CALCULATION SHEET

Washington Closure Hanford

Originator J M Capron — Date 03/01/06 — Calc No 01008 CA V0274 — Rev No. 0
Project 100-B/C Area Field Remediation — Job No. 14655 — Checked T M Blakley — Date 3/2/06
Subject 118-B 6 Burial Ground Cleanup Verification 95% UCL Calculations — Sheet No. 7 of 7

118-B-6 BCL Stockpile Sample Data

Sampling Area	HEIS Number	Sample Date	Lead mg/kg	Q	PQL	Mercury mg/kg	Q	PQL	Tritium pCi/g	Q	MDA
A1	J10VP1	1/9/2006	4 7		1 8	0 03		0 02	292	J	4 6
A2	J10VP0	1/9/2006	4 4		1 8	0 02		0 01	258	J	3 2
A3	J10VN9	1/9/2006	5 9		1 8	0 02	U	0 02	1 14	UJ	3 0
A4	J10VN8	1/9/2006	7 0		1 7	0 03		0 02	2 02	UJ	3 5

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Lead mg/kg	Mercury mg/kg	Tritium pCi/g
A1	J10VP1	1/9/2006	4 7	0 03	292
A2	J10VP0	1/9/2006	4 4	0 02	258
A3	J10VN9	1/9/2006	5 9	0 01	1 14
A4	J10VN8	1/9/2006	7 0	0 03	2 02

Statistical Computations

	Lead	Mercury	Tritium
Statistical value based on	Small data set Use nonparametric z-stat	Small data set Use nonparametric z-stat	Radionuclide data set Use nonparametric z-stat
N	4	4	4
% < Detection limit	0%	25%	50%
mean	5 5	0 02	123
st dev	1 2	0 01	140
Z-statistic	1 645	1 645	1 645
95% UCL on mean	6 5	0 03	238
max value	7 0	0 03	256
Statistical value	6 5	0 03	238
Background	NA	NA	NA
Statistical value above background	6 5	0 03	238
Most Stringent Cleanup Limit for nonradionuclide and RAG type	10 2 BG/GW/River Protection	0 33 BG/GW/River Protection	
WAC 173-340 3-PART Test			
95% UCL > Cleanup Limit?	NA	NA	
> 10% above Cleanup Limit?	NA	NA	
Any sample > 2X Cleanup Limit?	NA	NA	
RISK EVALUATION			
WAC 173-340 Non-Carcinogenic Cleanup	353	24	
Hazard quotient for each nonradionuclide	NA	NA	
WAC 173-340 Carcinogenic Cleanup:	NA	NA	
Risk for each carcinogenic nonradionuclide	NA	NA	
WAC 173-340 Compliance? NA	Because all lead values are below background (10 2 mg/kg), performance of the 3-part test and calculation of excess risk are not required	Because all mercury values are below background (0 33 mg/kg), performance of the 3-part test and calculation of excess risk are not required	
Nonrad noncarcinogenic index sum: NA			
Nonrad carcinogenic risk NA			

BG = background
GW = groundwater
HEIS = Hanford Environmental Information System
J = estimated
MDA = minimum detectable activity
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
RAG = remedial action goal
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

CALCULATION COVER SHEET

Project Title 118-B-6 Burial Ground Cleanup Verification **Job No.** 14655
Area 100-BC Area
Discipline Environmental ***Calc. No.** 0100B-CA-V0276
Subject 118-B-6 Burial Ground RESRAD Calculation Brief
Computer Program RESRAD **Program No.** Version 6.30

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

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover – 1 pg Summary – 5 pg Attm. 1 - 37 pg Attm. 2 - 20 pg Attm. 3 - 22 pg Attm. 4 - 11 pg Attm. 5 - 20 pg Attm. 6 - 22 pg Attm. 7 - 11 pg Attm. 8 - 20 pg Attm. 9 - 22 pg Attm. 10 - 11 pg Attm. 11 - 20 pg Attm. 12 - 22 pg Attm. 13 - 11 pg Total - 239 pg 220	S. W. Clark S. W. Clark 3/8/06	M. W. Perrott M. W. Perrott 3/8/06	T. M. Blakley T. M. Blakley 3/8/06	D. N. Strom	3-08-06
SUMMARY OF REVISION						

*Obtain Calc. No. from DIS

DE01-437.03 (12/09/2004)

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	3/8/06	Calc. No.:	0100B-CA-V0276	Rev.:	0
Project:	118-B-6 Cleanup Verification	Job No:	14655	Checked:	M. W. Perrott	Date:	3/8/06
Subject:	118-B-6 Burial Ground Cleanup Verification RESRAD Calculation					Sheet No.	1 of 5

PURPOSE:

Calculate the predicted soil and groundwater concentrations, dose, and risk contributions from radionuclide contaminants in soils of the shallow zone, deep zone, waste staging area, and below cleanup levels (BCL) stockpile at the 118-B-6 Burial Ground remediation site over a period of 1,000 years.

GIVEN/REFERENCES:

1) Cleanup verification data from *118-B-6 Burial Ground 95% UCL Calculation*, Calculation No. 0100B-CA-V0274, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
2) *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
2) Radioactive and nonradioactive contaminants of concern from the *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan*, DOE/RL-2001-35, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. For the purpose of these RESRAD calculations, the only radioactive contaminant of concern (COC) is tritium (H-3). The nonradionuclide contaminants of concern are lead and mercury. Concentrations of the nonradionuclide contaminants are below the remedial action goals per the RDR/RAWP and they are not considered further.
3) RESidual RADioactivity (RESRAD) computer code, version 6.30, to calculate compliance with residual radioactivity guidelines, developed for the U.S. Department of Energy by the Environmental Assessment Division of Argonne National Laboratory, Argonne, Illinois.
4) Sample design data from the *118-B-6 Burial Ground Sampling Plan*, Calculation No. 0100B-CA-V0271, Rev. 0, Bechtel Hanford, Inc., Richland, Washington..
5) Analogous site data from the *Cleanup Verification Package for the 116-C-1 Process Effluent Trench*, CVP-98-00006, Rev. 0, Bechtel Hanford, Inc., Richland, Washington, and the *Limited Field Investigation Report for the 100-BC-1 Operable Unit*, DOE/RL-93-06, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

SOLUTION:

1) RESRAD runs were performed for the residual contamination in the shallow zone, deep zone, waste staging area, and BCL stockpile at the 118-B-6 site. Table 1 shows the elevations (NGVD88) and dimensions of the relevant soil horizons. The ground surface elevation for excavation backfill is 144.0 m. The average groundwater elevation beneath the site is 121.6 m. The average elevation of the excavation floor is 135.6 m. The thickness of the deep zone between the bottom of the shallow zone and the excavation floor is 3.8 m (12.5 ft). Test pit and borehole data from analogous sites in the 100-BC Area show that contaminant concentrations that are below direct exposure cleanup levels decrease to background concentrations within 3 m (9.8 ft) below the elevation at which the contamination occurs. Therefore a thickness of 6.8 m (22.3 ft) is used for the contaminated deep zone. Attachment 1 shows the dimensions of each soil horizon and the contaminant

pathways considered for dose, risk, and groundwater protection. All input factors for the RESRAD runs are shown in the "Summary" section of the RESRAD "Part I: Mixture Sums and Single Radionuclide Guidelines" printouts in the Attachments to this Calculation Summary.

2) The years when the peak dose (or concentration) occurs in the groundwater for tritium (H-3) was examined by preliminary RESRAD modeling runs. These years were then added for all horizons in the final RESRAD runs. For the groundwater (well water) the peak years were year 27.6 for the deep zone and year 45 for the shallow zone, waste staging area, and BCL Stockpile. The 27.6- and 45-year time periods were included in all of the RESRAD runs. Year 12 was also added, corresponding to 2018, the date of the 30-year site cleanup schedule of the *Hanford Federal Facility Agreement and Consent Order*.

Table 1. Waste Site Dimensions for RESRAD Modeling

Parameter	Units	Shallow Zone	Deep Zone	Waste Staging Area	BCL Stockpile
Contaminated Zone Dimensions					
Cover Depth	m	0	4.6	0	0
Area of Contaminated Zone (CZ)	m^2	830	56	487	1,492
Length Parallel to Aquifer Flow	m	32.5	8.4	12.5	21.8
Elevations of Vadose Zone Horizons					
Elevation: Surface	m	144.0	144.0	144.0	144.0
Elevation: Bottom of Excavation	m	135.6	135.6	135.6	135.6
Elevation: Groundwater	m	121.6	121.6	121.6	121.6
Thickness: Contaminated Zone	m	4.6	6.8	4.6	4.6
Thickness: Unsaturated Zone	m	17.8	11	17.8	17.8

METHODOLOGY:

1) Runs of RESRAD Version 6.30 were completed for the shallow zone, deep zone, waste staging area, and the BCL stockpile using the tritium (H-3) concentrations shown in Table 2. RESRAD numerical output reports for dose, risk, and concentration for the shallow and deep zones are presented in the Attachments to this Calculation Summary.

Table 2. 118-B-6 Radionuclide Soil Concentrations

Radionuclide	Shallow Zone Soil Activity, pCi/g	Deep Zone Soil Activity, pCi/g	Waste Staging Area, pCi/g	BCL Stockpile, pCi/g
H-3 (tritium)	160	1,996	36.7	238

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RESULTS:

1) **Radionuclide "All Pathways" Dose Rate:** The "all pathways" (maximum) dose rates are shown in Table 3. The maximum total dose rate of 6.23 mrem/yr from the combined horizons occurs at year zero (2006).

Table 3. All Pathways Dose Rate (mrem/yr)

Vadose Zone Horizon	"All Pathways" Dose Contributions in mrem/yr at Each Time Slice (yr)									
	0	1	3	7	12	27.6	45	100	300	1000
Run #1 Shallow Zone	2.10E+00	7.42E-01	9.01E-02	1.33E-03	6.83E-06	3.38E-07	6.38E-01	9.65E-09	0	0
Run #2 Waste Staging Area	2.84E-01	1.00E-01	1.22E-02	1.80E-04	9.22E-07	6.94E-08	4.69E-02	5.17E-10	0	0
Run #3 BCL Stockpile	3.84E+00	1.36E+00	1.65E-01	2.43E-03	1.25E-05	2.51E-06	6.92E-01	8.06E-09	0	0
Run #4 Deep Zone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.99E-01	5.20E-03	7.27E-10	0	0
Total	6.23E+00	2.20E+00	2.67E-01	3.93E-03	2.02E-05	3.99E-01	1.38E+00	1.89E-08	0	0

2) **Radionuclide Excess Cancer Risk:** The radionuclide excess cancer risk results are shown on Table 4. The maximum total risk (2.61×10^{-5}) occurs at year zero (2006).

Table 4. Radionuclide Excess Cancer Risk

Vadose Zone Horizon	Excess Cancer Risk at Each Time Slice (yr)									
	0	1	3	7	12	27.6	45	100	300	1000
Run #1 Shallow Zone	9.40E-06	5.21E-06	2.85E-06	2.25E-06	2.44E-06	1.98E-06	2.76E-14	0	0	0
Run #2 Waste Staging Area	1.17E-06	5.34E-07	2.39E-07	1.71E-07	1.67E-07	1.31E-07	1.45E-15	0	0	0
Run #3 BCL Stockpile	1.55E-05	7.17E-06	3.00E-06	2.34E-06	2.67E-06	1.88E-06	2.33E-14	0	0	0
Run #4 Deep Zone	0	0	0	0	5.69E-06	8.37E-06	1.09E-07	1.52E-14	0	0
Total	2.61E-05	1.29E-05	6.09E-06	4.76E-06	1.10E-05	1.24E-05	1.09E-07	1.52E-14	0	0

3) **Radionuclide Groundwater Protection:** The tritium (H-3) concentrations in groundwater were calculated by the RESRAD model and are summarized in Table 5. Tritium (H-3) was calculated to reach groundwater within 1,000 years at concentrations below the drinking water remedial action goal (RAG) of 20,000 pCi/L. Because tritium (H-3) is the only contaminant of concern there is no need to do a comparison to drinking water standards (MCL) calculation brief for the 118-B-6 Burial Ground.

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Table 5. RESRAD Calculated Groundwater (Well Water) Concentrations.

RESRAD Run No.	Tritium (H-3) Groundwater Concentration in pCi/L at Each Time Slice (yr)										RAG pCi/L
	0	1	3	7	12	27.6	45	100	300	1000	
Run #1	0	0	0	0	0	0	6.83E+03	2.64E-04	1.86E-29	0	
Run #2	0	0	0	0	0	0	1.40E+03	1.55E-05	1.09E-30	0	
Run #3	0	0	0	0	0	0	1.01E+04	2.11E-04	1.48E-29	0	
Run #4	0	0	0	0	0	8.83E+03	1.15E+02	1.61E-05	1.64E-29	0	
Total	0	0	0	0	0	8.83E+03	1.85E+04	5.06E-04	5.08E-29	0	20,000

CONCLUSIONS:

- The "all pathways" (maximum) dose rates are shown in Table 3. The combined maximum all-pathways dose rate is 6.23 mrem/yr, occuring at year zero (2006).
- None of the site contaminants are projected to exceed remedial action goals (RAGs).
- The radionuclide excess lifetime cancer risk results are shown in Table 4. The maximum combined shallow and deep zone excess lifetime cancer risk (2.61×10^{-5}) occurs at year zero (2006).
- Tritium (H-3) is predicted to reach groundwater within 1,000 years at a maximum concentration of 18,500 pCi/L, which is below the RAG (20,000 pCi/L). Because tritium (H-3) is the only contaminant of concern, there is no need to do a comparison to drinking water standards (MCL) calculation brief for the 118-B-6 Burial Ground remediation site.

ATTACHMENTS:

1. Graphic showing 118-B-6 Vadose Zone Model (2 pages)
2. RESRAD Output: Run #1 - 118-B-6 Burial Ground Shallow Zone Radionuclides; Part I: Mixture Sums and Single Radionuclide Guidelines (20 pages)
3. RESRAD Output: Run #1 - 118-B-6 Burial Ground Shallow Zone Radionuclides; Part III: Intake Quantities and Health Risk Factors (22 pages)
4. RESRAD Output: Run #1 - 118-B-6 Burial Ground Shallow Zone Radionuclides; Part IV: Concentration of Radionuclides (11 pages)
5. RESRAD Output: Run #2 - 118-B-6 Burial Ground Waste Staging Area Radionuclides; Part I: Mixture Sums and Single Radionuclide Guidelines (20 pages)
6. RESRAD Output: Run #2 - 118-B-6 Burial Ground Waste Staging Area Radionuclides; Part III: Intake Quantities and Health Risk Factors (22 pages)
7. RESRAD Output: Run #2 - 118-B-6 Burial Ground Waste Staging Area Radionuclides; Part IV: Concentration of Radionuclides (11 pages)
8. RESRAD Output: Run #3 - 118-B-6 Burial Ground BCL Stockpile Radionuclides; Part I: Mixture Sums and Single Radionuclide Guidelines (20 pages)

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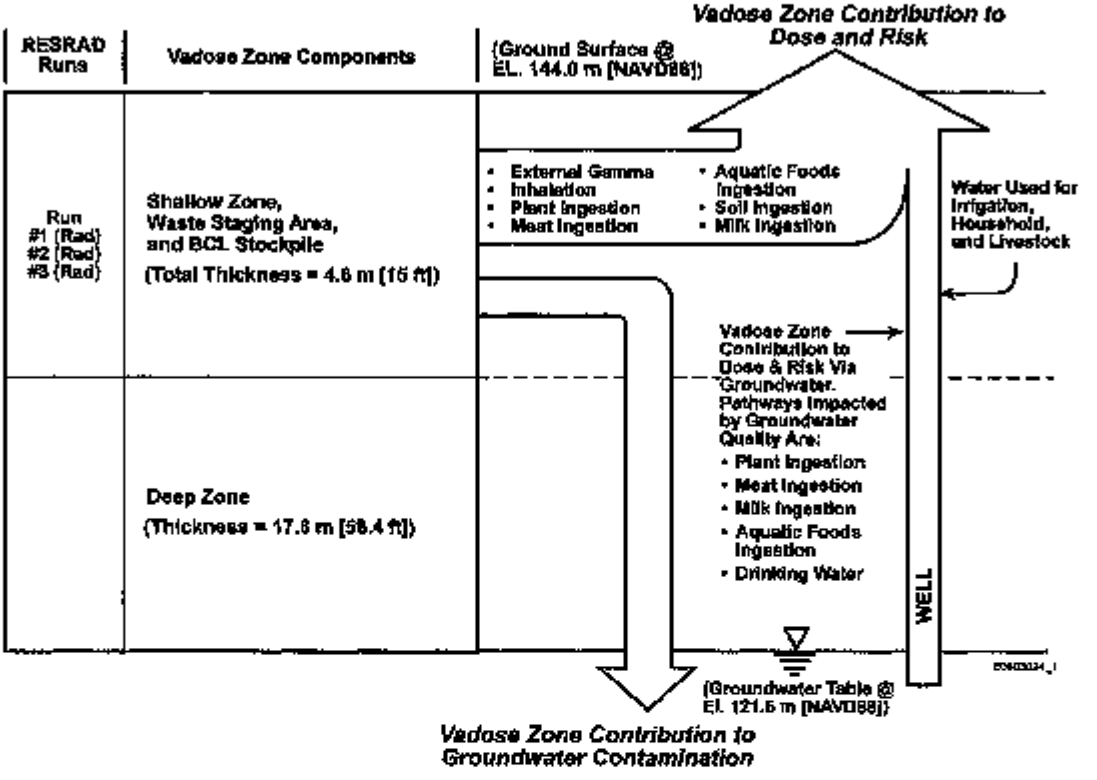
9. RESRAD Output: Run #3 - 118-B-6 Burial Ground BCL Stockpile Radionuclides; Part III: Intake Quantities and Health Risk Factors (22 pages)
10. RESRAD Output: Run #3 - 118-B-6 Burial Ground BCL Stockpile Radionuclides; Part IV: Concentration of Radionuclides (11 pages)
11. RESRAD Output: Run #4 - 118-B-6 Burial Ground Deep Zone Radionuclides; Part I: Mixture Sums and Single Radionuclide Guidelines (20 pages)
12. RESRAD Output: Run #4 - 118-B-6 Burial Ground Deep Zone Radionuclides; Part III: Intake Quantities and Health Risk Factors (22 pages)
13. RESRAD Output: Run #4 - 118-B-6 Burial Ground Deep Zone Radionuclides; Part IV: Concentration of Radionuclides (11 pages)

ATTACHMENT 1

118-B-6 Burial Ground Cleanup Verification Model



Attachment	1	Sheet No.	1 of 2
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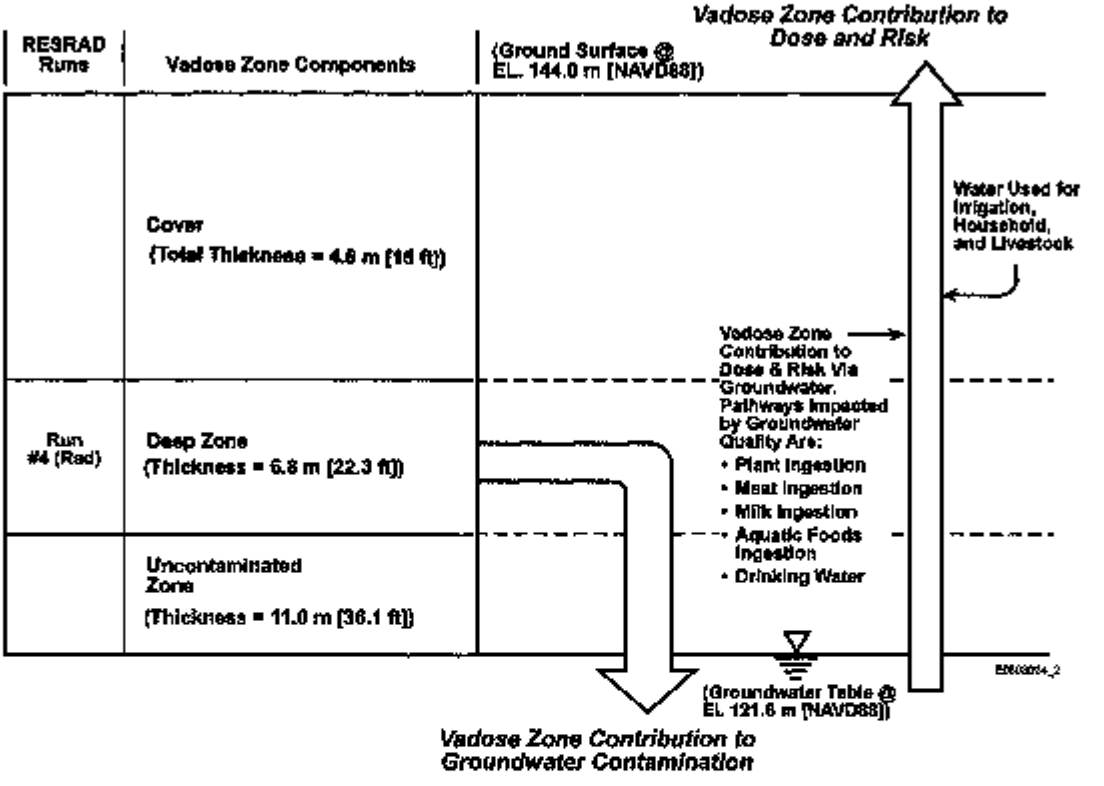
Calc. No.	01008-CA-V0276	Rev. No.	0

ATTACHMENT 1

118-B-6 Burial Ground Cleanup Verification Model



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