CVP-2003-00018
Rev. 0

Cleanup Verification Package for the 105-DR Large Sodium Fire Facility (122-DR-1:2, 100-D-53/122-DR-1:4, 132-DR-2/122-DR-1:5), the 119-DR Exhaust Stack Sampling Building (100-D-64), and the 100-D-23 and 100-D-54 Dry Wells

Prepared for the U.S. Department of Energy
By Bechtel Hanford, Inc.

February 2004

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EXECUTIVE SUMMARY

E1.0 INTRODUCTION

This cleanup verification package (CVP) documents completion of remedial/removal action for the soil column and below-grade structures of the 105-DR Large Sodium Fire Facility (LSFF) (122-DR-1:2, 100-D-53/122-DR-1:4, 132-DR-2/122-DR-1:5), the 119-DR Exhaust Stack Sampling Building (100-D-64), and the 100-D-23 and 100-D-54 Dry Wells. These sites are located south of the 105-DR Reactor Building in the 100-DR-2 Operable Unit in the 100-D Area of the Hanford Site in southeastern Washington State.

The LSFF is a *Resource Conservation and Recovery Act of 1976* (RCRA)-permitted waste treatment, storage, and disposal (TSD) unit, which was operated from 1972 to 1986 under RCRA TSD Permit No. T-1-1. The LSFF was used to study the fire and safety aspects associated with sodium and other alkali metal fires for application to liquid metal reactors. The LSFF occupied the former supply/exhaust fan room of the 105-DR Reactor Building and used the 105-DR Reactor Building exhaust system, which includes the 117-DR Filter Building, exhaust tunnels, exhaust stack, exhaust stack sampling building, and exhaust stack sampling building drywell. The 105-DR Reactor began plutonium production operations in 1950 and ceased operation in 1964. The 105-DR Reactor Building exhaust system began operations in 1960, and ceased operations in 1964 in conjunction with the 105-DR Reactor. The exhaust system was reactivated in 1972 for the LSFF.

Portions of the permitted LSFF TSD unit included in this CVP are the 117-DR Exhaust Filter Building (100-D-53/122-DR-1:4), which also includes the downstream (post-filter) tunnel between the filter building and the exhaust stack and the underground exhaust tunnel between the 105-DR Building and the 117-DR Building (100-DR-1:2), and the 116-DR Exhaust Stack (132-DR-2/122-DR-1:5). In July 2003, remedial/removal action activities removed the 117-DR Exhaust Filter Building (100-D-53/122-DR-1:4), the

downstream (post-filter) tunnel, and the upper 0.9 m (3 ft) of the 116-DR Reactor Exhaust Stack (132-DR-2/122-D-1:5). With regards to LSFF subunit 122-D-1:2, the underground tunnel between the 105-DR Building and the 117-DR Exhaust Filter Building was removed in its entirety. The 315 and 316 exhaust plenums, commonly referred to as the upper and lower exhaust tunnels, are also associated with the 122-D-1:2 subunit. Of these, the upper exhaust tunnel and approximately the top 0.9 m (3 ft) of the lower exhaust tunnel were removed. The 119-DR Exhaust Stack Sampling Building and two stack sampling building dry wells (100-D-23 and 100-D-54) were also demolished and excavated as part of remedial/removal action activities in July 2003.

Note that four of the seven RCRA subunits of the LSFF (122-DR-1) were previously closed out under the *105-DR Large Sodium Fire Facility Closure Plan* (LSFF Closure Plan) (DOE-RL 1995a) and are not discussed in this CVP. These subunits include the exhaust fan room, small fire room, large fire room, sodium handling room, and an office area (122-DR-1:1); the gravel scrubber (122-DR-1:3); the 116-DR-8 Crib and associated piping (122-DR-1:6); and the outdoor storage area (122-DR-1:7). Certification of closure of these LSFF TSD subunits is documented in the *105-DR Large Sodium Fire Facility Soil Sampling Data Evaluation Report* (WHC 1996) and in a Washington State Department of Ecology letter regarding closure certification for 122-DR-1 subunits 1, 3, 6, and 7 (Ecology 1996).

The LSFF Closure Plan deferred the remaining three LSFF TSD subunits (122-DR-1:2, 122-DR-1:4, and 122-DR-1:5) to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) process (EPA et al. 1998). Closure of these three subunits under CERCLA is addressed in this CVP. The RCRA closure of these subunits will be addressed in a separate RCRA closure document based on the information in this CVP.

The 117-DR Exhaust Filter Building (100-D-53/122-DR-1:4) was a reinforced-concrete structure 20.7 m (68 ft) long, 11.9 m (39 ft) wide, and 10.4 m (34 ft) deep, with 2.4 m (8 ft) of the building above grade. The facility was connected to the 105-DR Reactor

Building and the 116-DR Reactor Exhaust Stack by underground reinforced-concrete exhaust ducts (the post-filter duct is included in the 122-DR-1:4 and the pre-filter duct is included in the 122-DR-1:2). The aboveground portion of the 116-DR Stack (132-DR-2/122-DR-1:5) was decommissioned in 1999. The 119-DR Exhaust Stack Sampling Building (100-D-64) was a 33.4 m^2 (360 ft^2) single-story, pre-fabricated metal structure on a concrete slab. While not part of the LSFF, the two dry wells (100-D-23 and 100-D-54) and the 119-DR Exhaust Stack Sampling Building were included in the removal action.

The 100-D-23 Dry Well is shown on historical drawings to the south of the 119-DR Exhaust Stack Sampling Building, but was not located during walkdown or excavation activities. The dry well was likely removed during construction of the nearby gravel scrubber (122-DR-1:3) in 1982. The 100-D-54 Dry Well was a 56-cm (22-in.)-diameter concrete pipe with a depth of approximately 1.5 m (4.9 ft) and was likely constructed as a replacement to the 100-D-23 Dry Well. The 100-D-54 Dry Well was located southwest of the 119-DR Exhaust Stack Sampling Building.

The remediation and sampling requirements for the sites included in this CVP are obtained from a combination of Decontamination and Decommissioning Project documents. The requirements were obtained from the *Engineering Evaluation/Cost Analysis for the 105-DR and 105-F Reactor Facilities and Ancillary Facilities* (DOE-RL 1998b), *Removal Action Work Plan for 105-DR and 105-F Building Interim Safe Storage Projects and Ancillary Buildings* (DOE-RL 2002b), *105-F/-DR Phase II Sampling and Analysis Plan* (DOE-RL 1998a), *Sampling and Analysis Plan for the 105-F and 105-DR Phase III Below-Grade Structures and Underlying Soils* (Phase III SAP) (DOE-RL 2000), and two addenda to the Phase III SAP. The addenda are the *Approved Decommissioning Projects Discussion Papers* (BHI 2003b) and the *117-DR Exhaust Filter Building Proposed Additional Soil Sampling and 1720-HA Arsenal Removal/Disposal Summary* (BHI 2003a).

Remedial action objectives and goals applicable to the sites included in this CVP are obtained from a combination of regulatory documents. Objectives and goals for the 100-D-23 Dry Well are obtained from the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units* (Remaining Sites ROD) (EPA 1999). The 100-D-54 Dry Well is in the process of being included in the Remaining Sites ROD through a draft Explanation of Significant Differences. Objectives and goals for the components of the LSFF TSD unit (the 117-DR Exhaust Filter Building [100-D-53/122-DR-1:4], the 116-DR Reactor Exhaust Stack [132-DR-2/122-DR-1:5], the pre-filter exhaust tunnel [122-DR-1:2]), as well as the 119-DR Exhaust Stack Sampling Building (100-D-64) are obtained from the *Action Memorandum, USDOE Hanford 100 Area National Priorities List (NPL) 105-F and 105-DR Reactor Buildings and Ancillary Facilities* (Action Memorandum) (EPA et al. 1998). The objectives and goals are also included in the Phase III SAP (DOE-RL 2000) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2002a), which is referenced in the Action Memorandum.

The remedial or removal action goals and objectives 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. For ease of discussion, the terminology of remedial action goals and objectives are used throughout this CVP. Also for the purpose of this report, these sites (LSFF TSD unit components, 119-DR Sampling Building, and dry wells) are collectively referred to as the 117-DR facilities site throughout this CVP.

Based on consideration of the requirements of CERCLA and detailed analysis of alternatives, the Tri-Parties have selected the remove/dispose alternative under a rural-residential land use scenario for the 117-DR facilities site. The selected action for the 117-DR facilities 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 at the 200 Areas of the Hanford Site, and

(3) backfilling the site with clean soil to average adjacent grade elevation. An additional objective for structures includes the removal of the structure to a minimum of 0.9 m (3 ft) below surface grade. 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) were established to identify radionuclide and nonradionuclide contaminants of concern (COCs) and contaminants of potential concern. Waste site COCs for the 117-DR facilities site were identified through process knowledge and are specified in the Phase III SAP (DOE-RL 2000). The COC list was further refined and amended with the *117-DR Exhaust Filter Building Proposed Additional Soil Sampling and 1720-HA Arsenal Removal/ Disposal Summary* (BHI 2003a). The COCs consist of the following:

- Americium-241
- Carbon-14
- Cesium-137
- Cobalt-60
- Europium-152
- Europium-154
- Europium-155
- Nickel-63
- Plutonium-238
- Plutonium-239/240
- Strontium-90
- Uranium-234
- Uranium-235
- Uranium-238
- Arsenic
- Barium
- Cadmium
- Total chromium
- Hexavalent chromium
- Lead
- Lithium
- Mercury
- Selenium
- Silver
- Sodium.

Lithium and sodium were selected and included as COCs because they are identified as potential contaminants for the LSFF TSD unit. Note that semivolatile organic compounds (SVOCs) were initially identified as site COCs in the referenced addendum (BHI 2003a). No SVOC constituents were detected at levels requiring evaluation.

Low levels of polycyclic aromatic hydrocarbon compounds detected in some of the samples are most likely from wood products or asphalt. Therefore, the SVOCs have been eliminated as site COCs. The SVOC results are included in Appendix A.

E2.0 RESULTS

Site excavation and waste disposal are complete, and the exposed surfaces have been sampled and analyzed to verify attainment of the RAGs. At the completion of the remedial action, the total excavation was approximately 1,010 m^2 (10,872 ft^2) in area with an approximate depth of 5 m (16.4 ft). Approximately 14,011 metric tons (15,412 tons) of material from the site were disposed of at the Environmental Restoration Disposal Facility.

Results of the sampling, laboratory analyses, and data evaluations for the 117-DR facilities 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).

E2.1 DIRECT EXPOSURE SOIL CLEANUP STANDARDS

E2.1.1 Radionuclides

The Action Memorandum (EPA et al. 1998), the Remaining Sites ROD (EPA 1999), the Phase III SAP (DOE-RL 2000), and the RDR/RAWP (DOE-RL 2002a), developed in compliance with the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 *Code of Federal Regulations* 300), express the RAG for direct exposure to radionuclides in terms of an allowable radiation dose rate above background (i.e., 15 mrem/yr). The total dose rate above background, considering all radionuclide COCs and pathways, was predicted from the RESidual RADioactivity (RESRAD) dose assessment model (ANL 2002). The results indicate that the maximum dose rate above background from the site is 1.20 mrem/yr and would occur at present (2003);

this dose rate decreases to 1.26×10^{-2} mrem/yr in 1,000 years. The estimated total dose rate in 2018 is 2.72×10^{-1} mrem/yr. The 2018 date corresponds to the 30-year site cleanup schedule of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1998). Total dose rate estimates never exceed the direct exposure RAG of 15 mrem/yr above background.

Although the RAG for radionuclides is expressed in terms of radiation dose, the CVP also includes radionuclide excess lifetime cancer risk estimates as additional information. 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}. The RESRAD model calculated the total excess cancer risk for radionuclides using EPA's Health Effects Assessment Summary Tables (HEAST) (dated April 16, 2001, "Update of Radionuclide Carcinogenicity Slope Factors," available on the Internet at www.epa.gov/radiation/heast). Because of radioactive decay, the risk associated with radionuclides decreases over time. Based on RESRAD results, the excess lifetime cancer risk is largest (4.26×10^{-5}) at present (2003), and decreases to 2.73×10^{-8} in 1,000 years. The estimated excess cancer risk due to radionuclides in 2018 is 5.70×10^{-6}.

E2.1.2 Nonradionuclides

The nonradionuclide COCs for this site are arsenic, barium, cadmium, chromium, hexavalent chromium, lead, lithium, mercury, selenium, silver, and sodium. The concentrations of these COCs are below RAGs for direct exposure. There are no specific cleanup criteria for lithium, sodium, lithium carbonate, or sodium carbonate. The lithium and sodium concentrations (assumed to represent the concentration of lithium carbonate and sodium carbonate) in soil and of the remaining below-grade concrete tunnel structure are below the Washington State dangerous waste toxicity criteria of 100,000 mg/kg for lithium carbonate and 10,000 mg/kg for sodium carbonate (WAC 173-303-100). In addition, the lithium and sodium values detected in four

discrete soil samples collected beneath the LSFF RCRA TSD unit exhaust duct are consistent with background levels detected in Hanford soils (DOE-RL 1996).

With respect to noncarcinogenic risk, the individual and cumulative hazard quotients for COCs with noncarcinogenic effects are below the corresponding RAG (a hazard quotient of 1.0 in all cases). With respect to carcinogenic risk, the excess lifetime cancer risk estimate was not calculated for the individual carcinogenic COCs (arsenic, cadmium, and hexavalent chromium) because their residual soil concentrations were either below background or laboratory detection limits. The individual and total excess cancer risk limits (1×10^{-6} and 1×10^{-5}, respectively) are met.

E2.2 PROTECTION OF GROUNDWATER AND THE RIVER

E2.2.1 Radionuclides

All radionuclide RAGs for protection of groundwater and the Columbia River have been met. The estimated radionuclide dose rate via the groundwater and river pathways is below the RAG of 4 mrem/yr for beta and gamma emitters. Because the RESRAD model predicts that the nonuranium alpha emitters will not reach groundwater within 1,000 years, the drinking water standards for alpha emitters have been met based on the more stringent of the maximum contaminant level or 1/25th of the derived concentration guidelines from DOE Order 5400.5.

E2.2.2 Nonradionuclides

Based on comparison with groundwater and river protection RAGs, cleanup verification results indicate that the residual concentrations of the nonradionuclides are protective of groundwater and the Columbia River. The lithium and sodium concentrations (assumed to represent the concentration of lithium carbonate and sodium carbonate) in soil and of the remaining below-grade concrete tunnel structure are below the Washington State dangerous waste toxicity criteria of 100,000 mg/kg for lithium carbonate and

10,000 mg/kg for sodium carbonate (WAC 173-303-100). In addition, the lithium and sodium concentrations detected in soil are consistent with background levels detected in Hanford soils (DOE-RL 1996).

E3.0 WASTE SITE RECLASSIFICATION

The 117-DR facilities 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. 1998) and the Waste Site Reclassification Guideline TPA-MP-14 (RL-TPA-90-0001) (DOE-RL 1998c). A copy of the waste site reclassification form is included as Attachment ES-1.

Attachment ES-1. Waste Site Reclassification Form.

Date Submitted: 01/27/04 **Originator:** K. J. Koegler **Phone:** 373-1628	**Operable Unit(s):** 100-DR-2 **Waste Site ID:** 100-D-53 (122-DR-1:2, 122-DR-1:4), 132-DR-2 (122-DR-1:5), 100-D-64, 100-D-23, 100-D-54 **Type of Reclassification Action:** Rejected ☐ Closed Out ☐ Interim Closed Out ☒ No Action ☐	**Control Number:** 2003-053 **Lead Agency:** Ecology

This form documents agreement among the parties listed below authorizing classification of the subject unit as rejected, interim closed out, closed out, or no action and authorizing backfill of the site, if appropriate. Final removal from the National Priorities List 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 U.S. Department of Energy, Richland Operations Office, in concurrence with the Washington State Department of Ecology (Ecology). 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 Area of the Hanford Site, and (3) backfilling the site with clean soil to adjacent grade elevations. An additional objective applicable to structures is removal to a minimum of 0.9 m (3 ft) below surrounding grade. The CERCLA excavation and disposal activities have been completed.

A Certification of Closure shall be prepared for the Large Sodium Fire Facility (LSFF) treatment, storage, and disposal (TSD) unit (TSD No. T-1-1) by an independent professional engineer and submitted to Ecology. A Certification of Closure Acceptance Letter, signed by Ecology, shall be issued for the reclassification control number for this waste site to document completion of the RCRA TSD closure.

Basis for reclassification: The 117-DR Exhaust Filter Building and exhaust tunnels (100-D-53/122-DR-1:2 and 122-DR-1:4), the 116-DR Exhaust Stack (132-DR-2/122-DR-1:5), the 119-DR Exhaust Stack Sampling Building (100-D-64), and the 100-D-23 and 100-D-54 Dry Wells waste sites have been remediated to meet the cleanup standards/removal action goals/remedial action goals/performance standards specified by the *Action Memorandum, USDOE Hanford 100 Area National Priorities List (NPL) 105-F and 105-DR Reactor Buildings and Ancillary Facilities, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10 Seattle, Washington; and the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington. Remedial actions were performed so as to allow rural-residential land use and to protect groundwater and the Columbia River. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 105-DR Large Sodium Fire Facility (122-DR-1:2, 100-D-53/122-DR-1:4, 132-DR-2/122-DR-1:5)*, the *119-DR Exhaust Stack Sampling Building (100-D-64), and the 100-D-23 and 100-D-54 Dry Wells* (CVP-2003-00018), Bechtel Hanford, Inc., Richland, Washington.

The cleanup verification package/closure report does not demonstrate the acceptability of unrestricted access to deep zone soils (i.e., below 4.6 m [15 ft]); therefore, institutional controls to prevent uncontrolled drilling or excavation into deep zone soils are required.

H. E. Bilson RL Manager	Signature	3/4/04 Date
F. W. Bond Ecology Project Manager	Signature	3/4/04 Date
NA EPA Project Manager	Signature	Date

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ACRONYMS AND ABBREVIATIONS

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
COC	contaminant of concern
CVP	cleanup verification package
D&D	decontamination and decommissioning
DQA	data quality assessment
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
HEAST	Health Effects Assessment Summary Tables
ISS	interim safe storage
LSFF	Large Sodium Fire Facility
MDA	minimum detectable activity
MS	matrix spike
PARCC	precision, accuracy, representativeness, completeness, and comparability
PQL	practical quantitation limit
QA	quality assurance
QC	quality control
RAG	remedial action goal
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RDL	required detection limit
RDR/RAWP	Remedial Design Report/Remedial Action Work Plan
RESRAD	RESidual RADioactivity (dose assessment model)
ROD	Record of Decision
RPD	relative percent difference
SAP	sampling and analysis plan
SDG	sample delivery group
SVOC	semivolatile organic compound
TSD	treatment, storage, and disposal
UCL	upper confidence limit
WAC	*Washington Administrative Code*

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this cleanup verification package (CVP) is to document that the former 105-DR Large Sodium Fire Facility (LSFF) (122-DR-1:2, 100-D-53/122-DR-1:4, 132-DR-2/122-DR-1:5), the 119-DR Exhaust Stack Sampling Building (100-D-64), and the 100-D-23 and 100-D-54 Dry Wells (herein referred to as the 117-DR facilities site) were remediated in accordance with the applicable regulatory documents. Remedial action objectives and goals applicable to the sites included in this CVP are obtained from a combination of regulatory documents. Objectives and goals for the 100-D-23 Dry Well are obtained from the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units* (Remaining Sites ROD) (EPA 1999). The 100-D-54 Dry Well is in the process of being included in the Remaining Sites ROD through a draft Explanation of Significant Differences. Objectives and goals for the components of the LSFF treatment, storage, and disposal (TSD) unit (117-DR Filter Exhaust Building [100-D-53/122-DR-1:4], 116-DR Reactor Exhaust Stack [132-DR-2/122-DR-1:5], the pre-filter exhaust tunnel [122-DR-1:2]), as well as the 119-DR Exhaust Stack Sampling Building (100-D-64) are obtained from the *Action Memorandum, USDOE Hanford 100 Area National Priorities List (NPL) 105-F and 105-DR Reactor Buildings and Ancillary Facilities* (Action Memorandum) (EPA et al. 1998).

These documents provide the U.S. Department of Energy, Richland Operations Office the authority, guidance, and objectives to conduct this remedial/removal action. The preferred remedy specified in the Remaining Sites ROD (EPA 1999) and the Action Memorandum (EPA et al. 1998) and conducted for the 117-DR facilities site was excavation and treatment, as necessary, and disposal of contaminated materials at the Environmental Restoration Disposal Facility (ERDF). The action includes removal of structures to a minimum of 0.9 m (3 ft) beneath surrounding grade.

1.2 DOCUMENT ORGANIZATION

The cleanup verification evaluation is presented in the following sections:

- Section 2.0 Site Description and Supporting Information
- Section 3.0 Summary of Remedial Action Objectives and Goals
- Section 4.0 Remedial Action Field Activities
- Section 5.0 Cleanup Verification Data Evaluation
- Section 6.0 Evaluation of Remedial Action Goal Attainment
- Section 7.0 Radionuclide Risk Information
- Section 8.0 Statement of Protectiveness
- Section 9.0 References
- Section 10.0 Bibliography.

The main text is supported by the following appendices:

- Appendix A Summary of Verification Soil Sampling and Analytical Results
- Appendix B Data Quality Assessment
- Appendix C RESRAD Input Parameters and Calculation Brief Excerpts.

2.0 SITE DESCRIPTION AND SUPPORTING INFORMATION

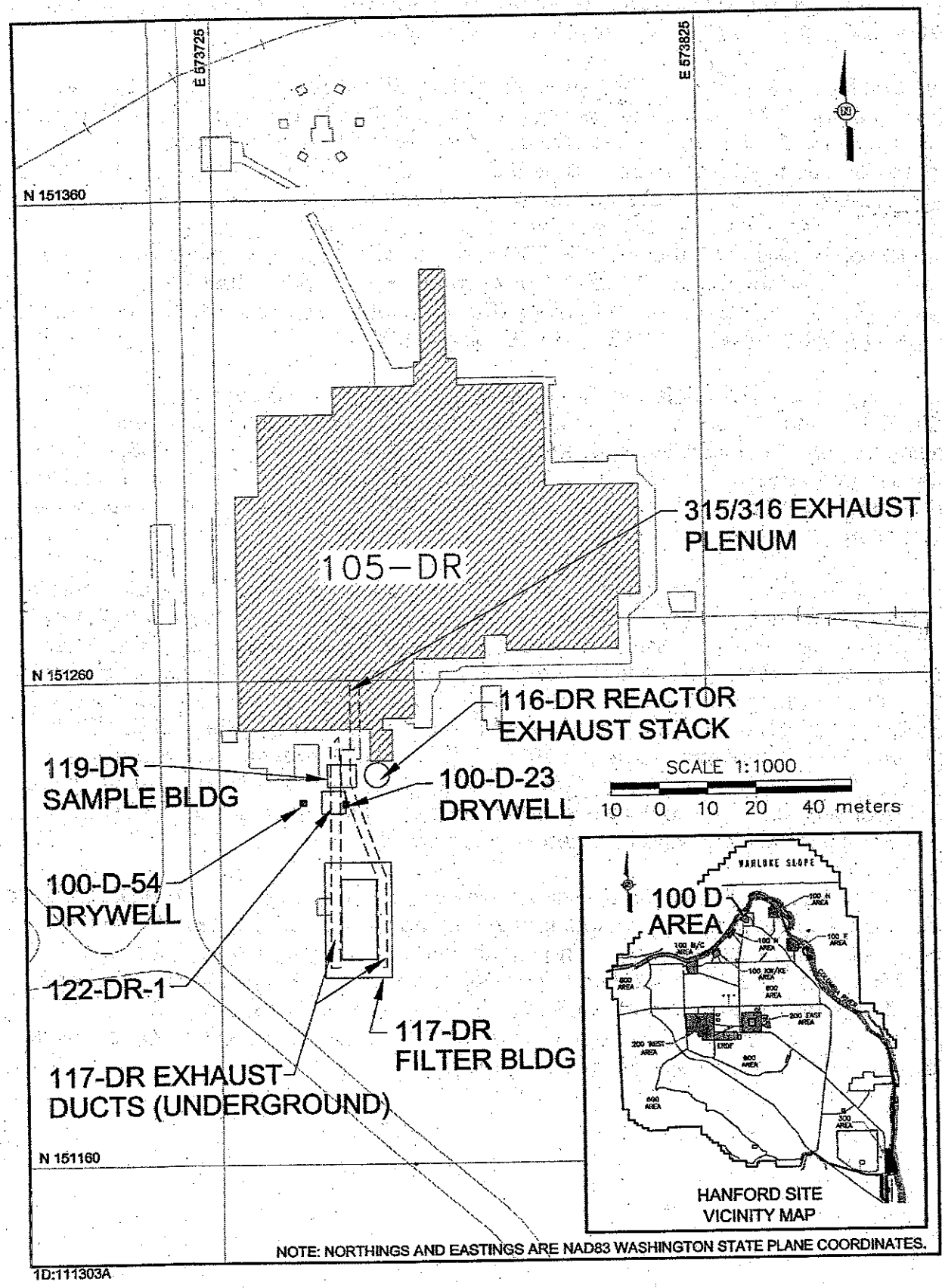
2.1 SITE HISTORY

The LSFF is located at the south end of the 105-DR Reactor Building in the 100-DR-2 Operable Unit in the 100-D Area of the Hanford Site in southeastern Washington State (Figure 1). The components of the LSFF included in this CVP are referred to as the 117-DR facilities site, and consist of the soil column and below-grade structures of the 105-DR LSFF (122-DR-1:2, 100-D-53/122-DR-1:4, 132-DR-2/ 122-DR-1:5), the 119-DR Exhaust Stack Sampling Building (100-D-64), and the 100-D-23 and 100-D-54 Dry Wells.

The LSFF is a *Resource Conservation and Recovery Act of 1976* (RCRA)-permitted waste TSD unit, which was operated from 1972 to 1986 under RCRA TSD Permit No. T-1-1. The LSFF was used to study the fire and safety aspects associated with sodium and other alkali metal fires for application to liquid metal reactors. The LSFF occupied the former supply/exhaust fan room of the 105-DR Reactor Building and used the 105-DR Reactor Building exhaust system, which includes the 117-DR Filter Building, exhaust tunnels, exhaust stack, exhaust sack sampling building, and exhaust stack sampling building drywell. The 105-DR Reactor began plutonium production operations in 1950 and ceased operation in 1964. The 105-DR Reactor Building exhaust system began operations in 1960, and ceased operations in 1964 in conjunction with the 105-DR Reactor. The exhaust system was reactivated in 1972 for the LSFF.

Portions of the permitted LSFF TSD unit included in this CVP (referred to as the 117-DR facilities site) are the 117-DR Exhaust Filter Building (100-D-53/122-DR-1:4), which also includes the downstream (post-filter) tunnel between the filter building and the exhaust stack and the underground exhaust tunnel between the 105-DR Building and the 117-DR Building (100-DR-1:2), and the 116-DR Exhaust Stack (132-DR-2/ 122-DR-1:5). In July 2003, remedial/removal action activities removed the 117-DR Exhaust Filter Building (100-D-53/122-DR-1:4), the downstream (post-filter) tunnel, and the upper 0.9 m (3 ft) of the 116-DR Reactor Exhaust Stack (132-DR-2/ 122-D-1:5). With regards to LSFF subunit 122-D-1:2, the underground tunnel between the 105-DR Building and the 117-DR Exhaust Filter Building was removed in its entirety. The 315 and 316 exhaust plenums, commonly referred to as the upper and lower exhaust tunnels, are also associated with the 122-D-1:2 subunit. Of these, the upper exhaust tunnel and approximately the top 0.9 m (3 ft) of the lower exhaust tunnel were removed.

Figure 1. Hanford Site Map and 117-DR Site Plan.



The 119-DR Exhaust Stack Sampling Building (100-D-64), and two stack sampling building dry wells (100-D-23 and 100-D-54) were also demolished and excavated as part of remedial/removal action activities in July 2003.

Note that four of the seven RCRA subunits of the LSFF (122-DR-1) were previously closed out under the *105-DR Large Sodium Fire Facility Closure Plan* (LSFF Closure Plan) (DOE-RL 1995a) and are not discussed in this CVP. These subunits include the exhaust fan room, small fire room, large fire room, sodium handling room, and an office area (122-DR-1:1); the gravel scrubber (122-DR-1:3); the 116-DR-8 Crib and associated piping (122-DR-1:6); and the outdoor storage area (122-DR-1:7). Certification of closure of these LSFF TSD subunits is documented in the *105-DR Large Sodium Fire Facility Soil Sampling Data Evaluation Report* (WHC 1996) and in a Washington State Department of Ecology (Ecology) letter regarding closure certification for the 122-DR-1 subsites 1, 3, 6, and 7 (Ecology 1996).

The LSFF Closure Plan deferred the remaining three LSFF TSD subunits (122-DR-1:2, 122-DR-1:4, and 122-DR-1:5) to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) process (EPA et al. 1998). Closure of these three subunits under CERCLA is addressed in this CVP. The RCRA closure of these subunits will be addressed in a separate RCRA closure document based on the information in this CVP.

The 117-DR Exhaust Filter Building (100-D-53/122-DR-1:4) was a reinforced-concrete structure 20.7 m (68 ft) long, 11.9 m (39 ft) wide, and 10.4 m (34 ft) deep, with 2.4 m (8 ft) of the building above grade. The facility was connected to the 105-DR Reactor Building and the 116-DR Reactor Exhaust Stack by underground reinforced-concrete exhaust ducts (the post-filter duct is included in 122-DR-1:4 and the pre-filter duct is included in 122-DR-1:2). The aboveground portion of the 116-DR Stack (132-DR-2/ 122-DR-1:5) was decommissioned in 1999. The 119-DR Exhaust Stack Sampling Building (100-D-64) was a 33.4 m^2 (360 ft^2) single-story, pre-fabricated metal structure on a concrete slab. The two dry wells (100-D-23 and 100-D-54) and the 119-DR Exhaust Stack Sampling Building were included in the removal action.

The 100-D-23 Dry Well is shown on historical drawings to the south of the 119-DR Exhaust Stack Sampling Building, but was not located during walkdown or excavation activities. The dry well was likely removed during construction of the nearby gravel scrubber (122-DR-1:3) in 1982. The 100-D-54 Dry Well was a 56-cm (22-in.)-diameter concrete pipe with a depth of approximately 1.5 m (4.9 ft) and was likely constructed as a replacement to the 100-D-23 Dry Well. The 100-D-54 Dry Well was located southwest of the 119-DR Exhaust Stack Sampling Building.

2.2 SUBSURFACE CONDITIONS

The soil column underlying the waste site and extending to groundwater consists of materials belonging to the Hanford and Ringold Formations. The shallower Hanford formation consists predominantly of medium-dense to dense sand and gravel, with varying amounts of silt and cobbles. The underlying Ringold Formation consists of dense, well-cemented gravels with sand and silt interbeds. The Hanford-Ringold contact is approximately 13.1 to 16.8 m (50 to 55 ft) below the surface grade level. The long-term groundwater level beneath the site is estimated at North American Vertical Datum 1988 (NAVD88) El. 118.6 m (389.1 ft) for analysis purposes, based on historical and current information from adjacent groundwater wells. The depth to groundwater is estimated to be 19.9 m (65.3 ft) beneath the floor of the excavation and 24.5 m (80.4 ft) beneath surface grade level. Groundwater elevations in adjacent wells are influenced by the nearby Columbia River and other factors such as atmospheric pressure.

2.3 CONTAMINANTS OF CONCERN

For the respective points of compliance, remedial action goals (RAGs) were established to identify radionuclide and nonradionuclide contaminants of concern (COCs) and contaminants of potential concern. Waste site COCs for the 117-DR facilities site were identified through process knowledge and are specified in the *Sampling and Analysis Plan for the 105-F and 105-DR Phase III Below-Grade Structures and Underlying Soils* (Phase III SAP) (DOE-RL 2000). The COC list was further refined and amended with the *117-DR Exhaust Filter Building Proposed Additional Soil Sampling and 1720-HA Arsenal Removal/Disposal Summary* (BHI 2003a). The COCs consist of the following:

- Americium-241
- Carbon-14
- Cesium-137
- Cobalt-60
- Europium-152
- Europium-154
- Europium-155
- Nickel-63
- Plutonium-238
- Plutonium-239/240
- Strontium-90
- Uranium-234
- Uranium-235
- Uranium-238
- Arsenic
- Barium
- Cadmium
- Total chromium
- Hexavalent chromium
- Lead
- Lithium
- Mercury
- Selenium
- Silver
- Sodium.

The COCs specified in the Phase III SAP for the LSFF are lithium carbonate and sodium carbonate. There are no specific analytical methods for lithium carbonate and sodium carbonate. Lithium and sodium were analyzed as metals and assumed to represent the lithium carbonate and sodium carbonate concentrations.

Note that semivolatile organic compounds (SVOCs) were initially identified as site COCs in the referenced addendum (BHI 2003a). No SVOC constituents were detected at levels requiring evaluation. Low levels of polycyclic aromatic hydrocarbon compounds detected in some of the samples are most likely from wood products or asphalt. Therefore, the SVOCs have been eliminated as site COCs. The SVOC results are included in Appendix A.

3.0 SUMMARY OF REMEDIAL ACTION OBJECTIVES AND GOALS

3.1 REMEDIAL ACTION OBJECTIVES

Remedial/removal action or closure objectives were established in multiple documents for the sites included in this CVP. Objectives for the 100-D-23 Dry Well are from the Remaining Sites ROD (EPA 1999). The 100-D-54 Dry Well is in the process to be included in the Remaining Sites ROD through a draft Explanation of Significant Differences. Objectives and goals for the components of the LSFF TSD unit (117-DR Filter Exhaust Building [100-D-53/122-DR-1:4], 116-DR Reactor Exhaust Stack [132-DR-2/122-DR-1:5], and the pre-filter exhaust tunnel [122-DR-1:2]), as well as the 119-DR Exhaust Stack Sampling Building (100-D-64) are from the Action Memorandum (EPA et al. 1998). The objectives and goals are also included in the Phase III SAP (DOE-RL 2000) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2002a), which are defined in the Action Memorandum.

The remedial or removal action goals and objectives were established by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy, Richland Operations Office, in concurrence with Ecology. For ease of discussion, the terminology of remedial action goals and objectives are used throughout this CVP. For a detailed discussion of the remedial action objectives (RAOs), see the documents referenced above.

3.2 REMEDIAL ACTION GOALS

RAGs are the specific numeric goals against which the cleanup verification data are evaluated in order to demonstrate attainment of the RAOs. The RAGs were developed to support a rural-residential exposure scenario. This scenario only involves exposures to soils less than 4.6 m (15 ft) deep. In the rural-residential scenario, an individual is assumed to live for 30 years in a residence built on the waste site and to spend 60% of his or her time indoors, 20% outdoors, and 20% offsite.

The scenario assumes a portion of the resident's time is spent in the basement of the home. It further assumes that he or she consumes crops, meat, and milk from plants and animals raised on the waste site, and consumes fish from a pond downgradient from the waste site.

Residual (post-cleanup) contaminant concentrations in the shallow zone (i.e., less than 4.6 m [15 ft]) are assumed for the soils in which crops are raised and on which animals providing meat and milk are raised. Water used by the resident for drinking, showering, watering livestock, and for fish production is assumed to be taken from groundwater derived from surface water that has infiltrated through the soil column at the site. The scenario for sites with residual contamination in the deep zone (i.e., greater than 4.6 m [15 ft]) assumes institutional controls against uncontrolled drilling or digging into deep zone soils. A more detailed description of the rural-residential scenario and how it is applied is provided in the RDR/RAWP (DOE-RL 2002a).

The contaminant-specific RAGs applicable to the 117-DR facilities site are listed in Table 1.

3.2.1 Direct Exposure RAGs

Under the rural-residential scenario, direct exposure RAGs are applicable to soils that are less than 4.6 m (15 ft) below ground surface (shallow zone soils). Direct exposure RAGs are listed in Table 1 and summarized below.

- **Radionuclide COCs:** For radionuclide COCs in the shallow zone (all pathways) and in the deep zone (water-dependent pathways), meet a 15 mrem/yr above background total dose rate (this RAG must be met for 1,000 years).

- **Nonradionuclide COCs:**

  - Hazard quotient of less than 1.0 for noncarcinogenic contaminants.

  - Excess cancer risk of less than 1×10^{-6} for individual carcinogenic contaminants.

  - Cumulative excess cancer risk of less than 1×10^{-5}.

  - Cleanup verification sample results pass the *Washington Administrative Code* (WAC) 173-340-740(7)(e) (*Model Toxics Control Act Cleanup Regulation*) three-part test.

Table 1. Summary of Remedial Action Goals.

COCs	Direct Exposure RAG	Groundwater Protection RAG (pCi/L)[a]	Columbia River Protection RAG (pCi/L)[a]
Radionuclides			
Carbon-14	15 mrem/yr (cumulative)[b]	4 mrem/yr (cumulative)[a]	4 mrem/yr (cumulative)[a]
Cesium-137			
Cobalt-60			
Europium-152			
Europium-154			
Europium-155			
Nickel-63			
Americium-241		1.2[a]	1.2[a]
Plutonium-238		1.6[a]	1.6[a]
Plutonium-239/240		1.2[a]	1.2[a]
Strontium-90[c]		8[d]	8[d]
Uranium-234		21.2[e]	21.2[e]
Uranium-235			
Uranium-238			
COCs	**Direct Exposure RAG (mg/kg)**	**Soil RAG for Groundwater Protection (mg/kg)**	**Soil RAG for Columbia River Protection (mg/kg)**
Nonradionuclides			
Arsenic	20[f]	20[f]	20[f]
Barium	5,600[g]	132[f]	224[h]
Cadmium	80[g], 13.9[f]	0.81[f]	0.81[f]
Chromium (total)	80,000[g]	18.5[f]	18.5[f]
Hexavalent chromium	2.1[i,j], 400[g]	8[k]	2[h]
Lead	353[l]	10.2[f]	10.2[f]
Lithium	NA	NA	NA
Mercury	24[g]	0.33[f]	0.33[f]
Selenium	400[g]	5[k]	0.78[f]
Silver	400[g]	8[k]	0.73[f]
Sodium	NA	NA	NA

[a]Lookup values based on individual radionuclide 4 mrem/yr dose rate equivalents for beta and gamma emitters per National Drinking Water Standards are presented in the RDR/RAWP (DOE-RL 2002a). Nonuranium alpha emitters must meet drinking water standards for alpha emitters based on the more conservative of the 15 pCi/L maximum contaminant level (MCL) or 1/25th of the derived concentration guidelines from DOE Order 5400.5.
[b]Individual radionuclide lookup values corresponding to a 15 mrem/yr dose rate are presented in the RDR/RAWP (DOE-RL 2002a).
[c]Strontium-90 also contributes to the 4 mrem/yr (cumulative) for groundwater and river protection.
[d]Promulgated groundwater protection standard.
[e]Since the time of Remaining Sites ROD (EPA 1999) signature, the EPA has promulgated an MCL of 30 µg/L for total uranium (65 *Federal Register* 76708). Based on the isotopic distribution of uranium in the 100 Areas, the 30 µg/L MCL corresponds to 21.2 pCi/L (BHI 2001).
[f]The *Washington Administrative Code* (WAC) 173-340-740(3) Method B direct exposure soil value, "100 times groundwater cleanup," and/or 100 times dilution attenuation factor (DAF) times surface water protection soil values are less than Washington State or Hanford Site soil background concentrations; therefore, background values are used as the soil RAG.
[g]WAC 173-340-740(3) Method B noncarcinogenic cleanup limit.
[h]Soil RAG based on 100 times DAF times surface water quality standard (DOE-RL 2002a).
[i]WAC 173-340-750(3) Method B carcinogenic cleanup limit based on inhalation exposure pathway.
[j]*Calculation of Hexavalent Chromium Carcinogenic Risk*, 0100X-CA-V0031 (BHI 2000).
[k]Soil RAG based on "100 times groundwater cleanup" rule (DOE-RL 2002a).
[l]Value is based on EPA's Integrated Exposure Uptake Biokinetic Model for lead in children (EPA 1994).
NA = not applicable. Remedial action goals for these constituents are not available.

3.2.2 Groundwater and River Protection

Groundwater and river protection RAGs are applicable to all vadose zone soils (shallow and deep zone soils). For this CVP, river protection and surface water protection are synonymous, since the Columbia River is the only surface water in proximity to the Hanford Site. The term river protection is used throughout this CVP. The groundwater and river protection RAGs are listed in Table 1 and summarized below.

- **Beta- and gamma-emitting radionuclide COCs:** Meet "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* [CFR] 141.66) dose rate standards (4 mrem/yr total body or organ dose rate) for a period of 1,000 years starting from site cleanup. Meet individual COC RAGs, as applicable.

- **Alpha-emitting radionuclide COCs:** Meet drinking water standards for nonuranium alpha-emitting radionuclides based on a limit of 15 pCi/L or 1/25th of the derived concentration guide per DOE Order 5400.5. For the 117-DR facilities site, there are three nonuranium alpha-emitting COCs (americium-241, plutonium-238, and plutonium-239/240). The maximum total contaminant level for uranium is 30 μg/L as promulgated by the EPA on December 7, 2000 (65 *Federal Register* 76708).

- **Nonradionuclide COCs:** Meet the individual RAGs listed in Table 1 (calculated using the WAC 173-340-740[3][a][ii] "100 times rule") and pass the WAC 173-340-740(7)(e) three-part test, or demonstrate by site-specific modeling that residual contaminant levels do not pose an unacceptable threat to groundwater or the river for 1,000 years (i.e., residual soil levels do not have the potential to exceed groundwater or river water RAGs).

4.0 REMEDIAL ACTION FIELD ACTIVITIES

Remediation and sampling requirements for the sites included in this CVP are obtained from a combination of Decontamination and Decommissioning (D&D) Project documents. The requirements were obtained from the *Engineering Evaluation/Cost Analysis for the 105-DR and 105-F Reactor Facilities and Ancillary Facilities* (DOE-RL 1998b), *Removal Action Work Plan for 105-DR and 105-F Building Interim Safe Storage Projects and Ancillary Buildings* (DOE-RL 2002b), *105-F/-DR Phase II Sampling and Analysis Plan* (DOE-RL 1998a), Phase III SAP (DOE-RL 2000), and two addenda to the Phase III SAP. The addenda are the *Approved Decommissioning Projects Discussion Papers* (BHI 2003b) and the *117-DR Exhaust Filter Building Proposed Additional Soil Sampling and 1720-HA Arsenal Removal/Disposal Summary* (BHI 2003a).

4.1 EXCAVATION AND DISPOSAL

Remedial action at the 117-DR facilities site was conducted in July 2003, as D&D activities removed the 117-DR Exhaust Filter Building and exhaust tunnel structures. Excavation of the site involved removal of the structure and slab floor, and removal of underlying soil to a depth of approximately 4.6 m (15 ft) in an area of approximately 1,010 m^2 (10,872 ft^2). The elevation of the bottom of the excavation was approximately 138.5 m (454.4 ft). Approximately 14,011 metric tons (15,412 tons) of contaminated materials were transported and disposed of at ERDF.

In addition, the upper 0.9 m (3 ft) of the 116-DR Reactor Exhaust Stack (132-DR-2/ 122-D-1:5) foundation and approximately the top 0.9 m (3 ft) of the lower exhaust tunnel (122-D-1:2) were removed.

The pre- and post-remediation site plans presented in Figure 2 show the site before D&D activities and after D&D and excavation. The sample design boundary in the post-remediation drawing reflects the shape of the excavation footprint. Note that the removal activities associated with the upper and lower exhaust tunnels (315 and 316 plenums) were conducted as part of the 105-F Interim Safe Storage (ISS)/removal action and were not included in the boundary of the sample design shown in Figure 2. Cleanup verification of the radionuclide and other CERCLA contaminants associated with the remaining lower exhaust tunnel is included in *Cleanup Verification Package for the 118-DR-2:2, 105-DR Reactor Below-Grade Structures and Underlying Soils, and the 100-D-49:4 Reactor Cooling Water Effluent Underground Pipeline* (BHI 2004a). The remaining portion of the lower exhaust tunnel is included in this CVP to demonstrate cleanup verification (based on historical data) for the RCRA contaminants (i.e., sodium and lithium).

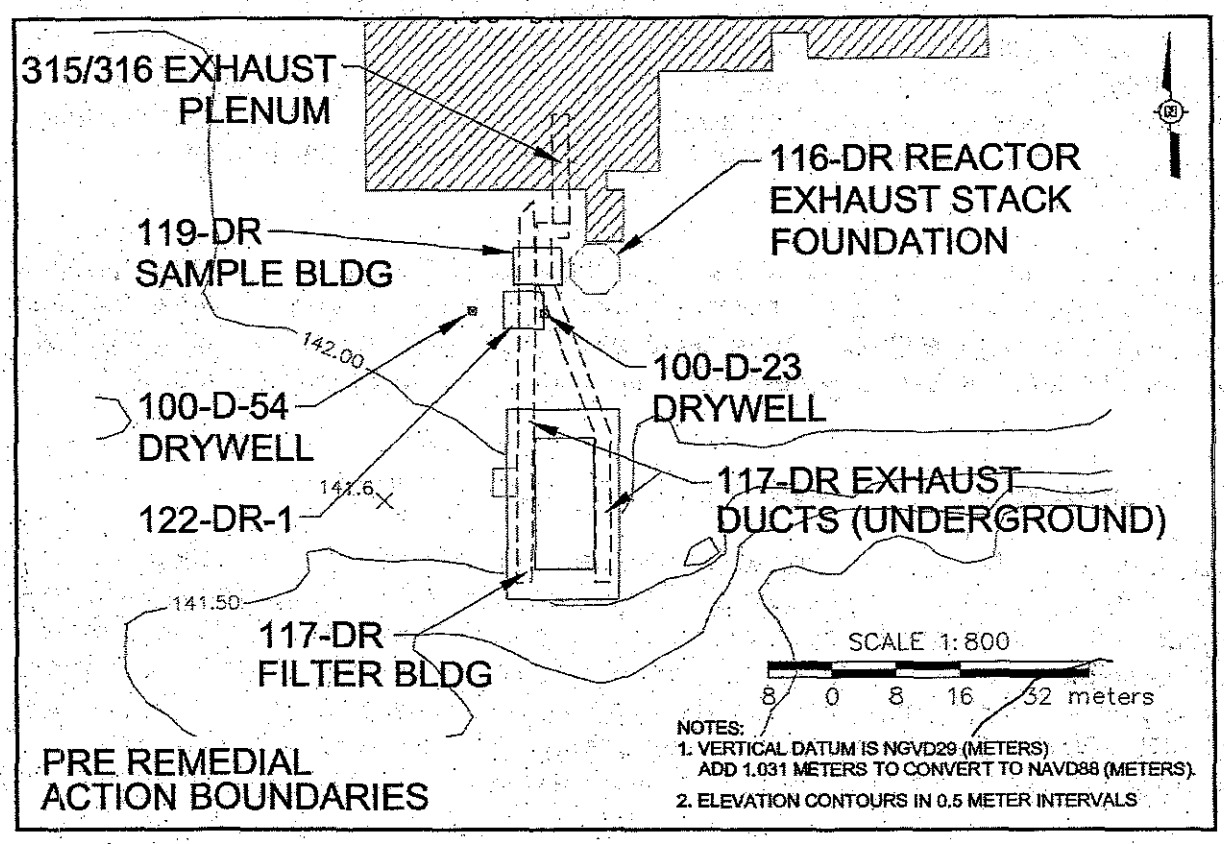
4.2 FIELD SCREENING

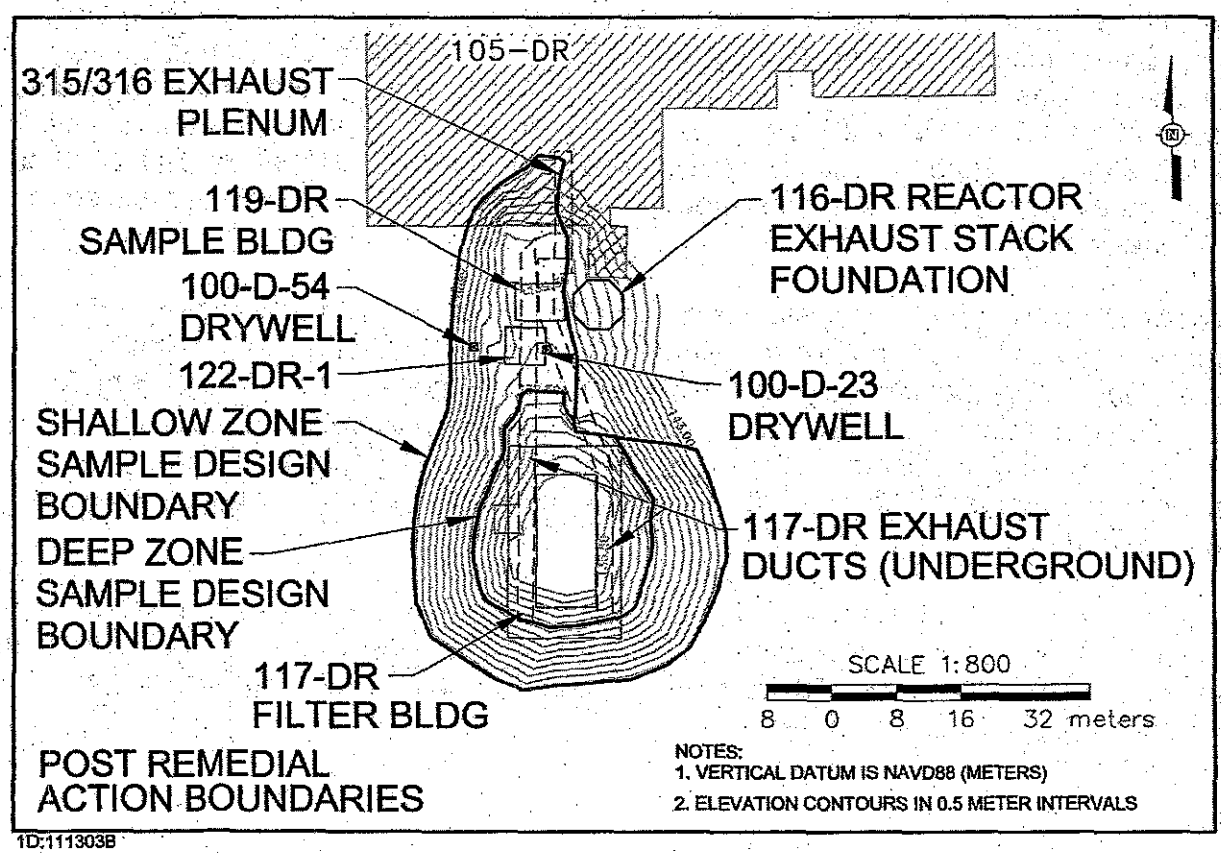
Field screening was used to guide the excavation and quickly assess the presence and level of radiological contamination. Field screening for the 117-DR facilities site included using a radiological data mapping system survey. The radiological mapping survey was performed on more than 50% of the site excavation surface area. All survey measurements were less than two times the background value.

4.3 VARIANCE SAMPLING AND ANALYSIS

Variance analysis was performed following field screening. The variance analysis quantifies the variability of residual contamination. This information was used to determine the site-specific number of final cleanup verification samples to be collected.

Figure 2. Pre- and Post-Remediation Site Plans.





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Variance sampling and testing was performed in August 2003 for the 117-DR facilities site using the *100 Area Remedial Action Sampling and Analysis Plan* (100 Area SAP) (DOE-RL 2001) and the *Instruction Guide for Remediation of the 100 Areas Waste Sites* (BHI 2003c). Variance analysis was performed for the shallow zone unit. A total of 24 variance samples were collected from the 117-DR facilities site. Variance samples were collected from the locations shown in the sample design calculation brief (Appendix C).

The results of the variance analysis indicated that the number of verification samples to be taken was less than the default number of four; therefore, four final verification samples were collected from the shallow zone decision unit. In addition, the default number of three final verification samples were collected from the deep zone decision unit.

4.4 CLEANUP VERIFICATION SAMPLING AND ANALYSIS

Final cleanup verification samples were collected following variance sampling. Cleanup verification sampling was conducted on August 8, 2003. Each verification sample was a composite formed by combining soil collected at four randomly selected nodes within each sampling area. The final verification samples were submitted to offsite laboratories for analysis using EPA-approved analytical methods, as required per the 100 Area SAP (DOE-RL 2001). The sample design methodology and sample location figure is presented in the calculation briefs for variance analysis and sample design in Appendix C.

The 117-DR facilities site excavation decision units, as shown on the sample design figure, are a function of the applicable RAGs (Section 3.2, "Remedial Action Goals"). 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 117-DR facilities site consisted of one shallow zone decision unit and one deep zone decision unit. The shallow zone decision unit was divided into four sampling areas. One composite cleanup verification sample was collected from each sample area. The deep zone decision unit was divided into three sampling areas. One composite cleanup verification sample was collected from each sample area. The sample area and location for this site is documented in the sample design calculation brief included in Appendix C.

As described in Section 4.3, the required number of composite samples for each decision subunit in the shallow zone was less than the default number of four composite samples, as specified in the 100 Area SAP (DOE-RL 2001) (excluding the quality assurance/quality control samples).

During these recent sampling activities for the LSFF, verification samples were not collected from the remaining portions of the lower exhaust tunnel (122-D-1:2) or 116 DR Exhaust Stack (132-DR-2/122-DR-1:5). The 116-DR Exhaust Stack foundation was removed to a minimum of 0.9 m (3 ft) below the surrounding grade and, based on process history, was determined to be uncontaminated. A radiological mapping survey was performed for the shallow zone soil surface around the 116-DR Exhaust Stack foundation. Additional discussion is included in Section 5.3.

Verification samples were, however, collected from the remaining lower exhaust tunnel (122-D-1:2) during the 105-DR Reactor ISS/removal action activities. These samples were analyzed for the CERCLA contaminants, including radionuclides and some metals, but were not analyzed for the RCRA contaminants (i.e., sodium and lithium). The data indicated low levels of CERCLA contaminants. Cleanup verification of the remaining portion of the lower exhaust tunnel for the CERCLA contaminants is included in BHI (2004a). Cleanup verification of the remaining portion of the lower exhaust tunnel for sodium and lithium is based on historical data using the summarization in Section 5.3, and detailed in *Proposed Closure Path for the Remaining Portion of the 105-DR/LSFF Exhaust Tunnel* (BHI 2004b). A copy of this document is included in Appendix D.

4.5 TSD VERIFICATION SAMPLING AND ANALYSIS

In addition to the cleanup verification samples described above, four discrete soil samples were collected from well-spaced locations along the footprint of the former LSFF exhaust duct. The sample design figure is shown on page C-73 of Appendix C. As directed in the Phase III SAP (DOE-RL 2000), these soil samples were analyzed for lithium and sodium only and are intended for closure of the RCRA TSD unit. There are no specific analytical methods for lithium carbonate and sodium carbonate. Lithium and sodium were analyzed as metals and assumed to represent the lithium carbonate and sodium carbonate concentrations. A split sample was collected from location 1 for separate analysis by Ecology.

As described in the Phase III SAP, these four samples were collected from biased sample locations and are not a part of the verification sample design prescribed by the 100 Area SAP (DOE-RL 2001). The results of the four discrete samples will be discussed separately from the verification samples.

5.0 CLEANUP VERIFICATION DATA EVALUATION

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

5.1 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 117-DR facilities 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 and closure of the RCRA TSD unit. The cleanup verification sample analytical data are stored in the Hanford Environmental Information System and are summarized in Appendix A. The detailed DQA is presented in Appendix B.

5.2 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 and deep zones, as appropriate). Prior to calculating the 95% UCL, the individual sample results are reviewed and, as appropriate, adjusted per the 100 Area SAP (DOE-RL 2001). This process is summarized below. Verification sampling summary statistics (95% UCL values) are listed in Table 2. Individual sample cleanup verification results are presented in Appendix A. Statistical calculations are presented in the cleanup verification 95% UCL calculation brief (Appendix C).

- **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 Ecology regulations (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).

Table 2. Cleanup Verification Data.

COCs	95% UCL Statistical Values	95% UCL Statistical Values	Hanford Site Background[a]	Cleanup Verification Data Set	Cleanup Verification Data Set
	Shallow Zone	Deep Zone		Shallow Zone	Deep Zone
Radionuclides (pCi/g)[b]					
Americium-241	0.0331[c]	0.00908[c]	[d]	0.0331	0.00908
Carbon-14	0.927[c]	1.12[c]	[d]	0.927	1.12
Cesium-137	0.0518	0.0459	1.1	0.0518	0.0459
Cobalt-60	0.0146[c]	0.0219[c]	0.008	0.0146	0.0219
Europium-152	0.0326[c]	0.0446[c]	[d]	0.0326	0.0446
Europium-154	0.0472[c]	0.0711[c]	0.033	0.0472	0.0711
Europium-155	0.0427[c]	0.0542[c]	0.054	0.0427	0.0542
Nickel-63	1.08[c]	1.63[c]	[d]	1.08	1.63
Plutonium-238	0.0240[c]	0.0759[c]	0.004	0.0240	0.0759
Plutonium-239/240	0.0245[c]	0.0234[c]	0.025	0.0245	0.0234
Strontium-90	-0.00300[c,e]	0.000610[c]	0.18	-0.00300	0.000610
Uranium-233/234	0.608	0.612	1.1	0 (<BG)[f]	0 (<BG)[f]
Uranium-235	0.0551[c]	0.0499[c]	0.1	0 (<BG)[f]	0 (<BG)[f]
Uranium-238	0.573	0.612	1.1	0 (<BG)[f]	0 (<BG)[f]
Nonradionuclides (mg/kg)[b]					
Arsenic	2.9	2.4	20[g]	2.9	2.4
Barium	65	58	132	65	58
Cadmium	0.19	0.21	0.81[h]	0.19	0.21
Total chromium	11	10	18.5	11	10
Hexavalent chromium	0.42[c]	0.42[c]	[d]	0.42	0.42
Lead	6.5	4.1	10.2	6.5	4.1
Lithium	12	9.9	33.5	12	9.9
Mercury	0.020[c]	0.020[c]	0.33	0.020	0.020
Selenium	0.30[c]	0.33[c]	0.78[h]	0.30	0.33
Silver	0.080[c]	0.080[c]	0.73	0.080	0.080
Sodium	400	390	690	400	390

[a]Hanford Site background is represented by the 90th percentile of the lognormal distribution for the site-wide background data set (DOE-RL 1995b, 1996).
[b]Laboratory data, including the minimum detectable activity (MDA) or practical quantitation limit (PQL) for the individual cleanup verification samples, are included in Appendix A and the 95% UCL calculation brief in Appendix C.
[c]Constituent was not detected in cleanup verification samples above the analytical method MDA or PQL. For radionuclides, the statistical value generally corresponds with the analytical method MDA. For nonradionuclides, the statistical value is the PQL.
[d]A background value for this analyte has not been established.
[e]Statistical calculations for radiochemical analyses can yield negative values
[f]The statistical value above background is used as the input value for RESidual RADioactivity modeling. Refer to Appendix C for additional details on determination of statistical values.
[g]Washington State soil background (WAC 173-340-740, Table 2).
[h]*Background Soil Metals Concentration in Washington State* (Ecology 1994).
BG = background

The columns on the left side of Table 2 are the 95% statistical values before subtraction of background. The columns on the right side of the table present statistical values adjusted for background, if appropriate. Hanford Site background concentration values are only subtracted for isotopic uranium. The radionuclide activities in the last column of Table 2 summarize the cleanup verification data set used for RESidual RADioactivity (RESRAD) modeling.

5.3 SITE-SPECIFIC CLEANUP VERIFICATION MODEL

The statistical values summarized in Table 2 were evaluated and used to develop a site-specific cleanup verification model for soil. The 117-DR facilities site-specific cleanup verification model assumes the worst case described in the RDR/RAWP (DOE-RL 2002a), where the deep zone verification concentrations continue at the same concentrations to groundwater. A schematic cross section of this site-specific cleanup verification model is included in the RESRAD calculation in Appendix C.

For the remaining concrete foundation of the 116-DR Exhaust Stack (132-DR-2/ 122-DR-1:5), the verification model assumes that the remaining concrete is uncontaminated. The exhaust stack concrete foundation was removed to a minimum of 0.9 m (3 ft) below the surrounding grade. Demolition of the upper portion of the exhaust stack foundation (the stack was removed in 1999) is considered sufficient to remove potential nonradioactive contamination. A radiological mapping survey performed for the shallow zone soil surface around the 116-DR Exhaust Stack foundation confirmed that the area was not radiologically contaminated above background levels. On this basis, it was determined that the remaining concrete of the exhaust stack concrete foundation is not contaminated and is adequately represented by the surrounding soil verification data.

The upper portion and approximately 0.9 m (3 ft) of the lower portion of the exhaust tunnel (122-D-1:2) was removed and disposed. Radiological sample data collected as a part of the 105-DR Reactor ISS/removal action show the remaining structure meets the applicable RAGs (BHI 2004a). Historical sample data from the remaining lower portion of the exhaust tunnel were used to verify that the below-grade concrete structure was below levels of concern for sodium and lithium. A discussion of the historical sample data and verification that the remaining structures meet the applicable sodium and lithium standards is documented in a white paper that has been approved by RL and Ecology (BHI 2004b). A copy of this document is included in Appendix D.

5.4 RESRAD MODELING

The individual radionuclide cleanup verification statistical values (Table 2) were entered into the RESRAD computer code, Version 6.21 (ANL 2002), 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) 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). The drinking water dose rate calculations based on the RESRAD estimated groundwater radionuclide concentrations are shown in the comparison to drinking water standards calculation brief (Appendix C). Specific results from the calculations are discussed in the RAG evaluation section (Section 6.0).

6.0 EVALUATION OF REMEDIAL ACTION GOAL ATTAINMENT

This section demonstrates that remedial actions at the 117-DR facilities site have achieved the applicable RAGs. Sections 6.1, 6.2, and 6.3 address attainment of direct exposure RAGs, groundwater protection RAGs, and Columbia River protection RAGs, respectively. Section 6.4 documents the application of the WAC 173-340-740(7)(e) three-part test. This test is only required for nonradionuclide COCs and is based on the most restrictive applicable RAG.

6.1 DIRECT EXPOSURE SOIL REMEDIAL ACTION GOALS ATTAINED

6.1.1 Radionuclides

The results of the RESRAD dose rate estimates for the site all-pathways scenarios are presented in Figure 3. This dose rate represents the dose contributions from soils at relevant time periods. The dose rate is largest at present (2003), 1.20 mrem/yr, and decreases to 1.26×10^{-2} mrem/yr in 1,000 years. The estimated dose rate in 2018 is 2.72×10^{-1} mrem/yr. The 2018 date corresponds to the 30-year site cleanup schedule of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1998). All dose rate estimates are less than the 15 mrem/yr RAG. The RESRAD computations are presented in detail in the RESRAD calculation brief summarized in Appendix C.

6.1.2 Nonradionuclides

6.1.2.1 Direct Comparison to RAGs. Table 3 compares the cleanup verification data set values presented in Table 2 to the direct exposure RAGs presented in Table 1.

Figure 3. RESRAD Analysis – All-Radionuclides, All-Pathways Dose Rate Estimate.

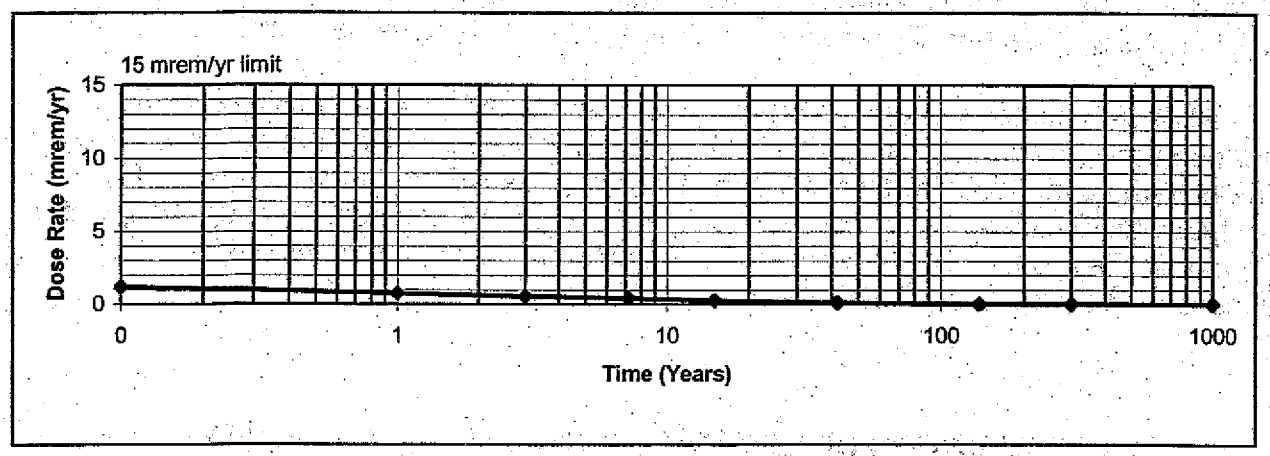


Table 3. Attainment of Nonradionuclide Direct Exposure Standards.

Nonradionuclides	Direct Exposure RAG (mg/kg)	Shallow Zone Cleanup Verification Value (mg/kg)	Direct Exposure RAGs Attained?
Arsenic	20[a]	2.9	Yes
Barium	5,600[b]	65	Yes
Cadmium	13.9[c], 80[b]	0.19	Yes
Total chromium	80,000[b]	11	Yes
Hexavalent chromium	2.1[c,d], 400[b]	0.42[e]	Yes
Lead	353[f]	6.5	Yes
Lithium	NA	12	Yes
Mercury	24[b]	0.020[e]	Yes
Selenium	400[b]	0.30[e]	Yes
Silver	400[b]	0.080[e]	Yes
Sodium	NA	400	Yes

[a]The WAC 173-340-740(3) Method B direct exposure soil value, "100 times groundwater cleanup," and/or the "100 times dilution attenuation factor times surface water protection" soil values were less than Washington State soil background concentrations; therefore, background values are used as the soil RAG.
[b]WAC 173-340-740(3) Method B noncarcinogenic cleanup limit.
[c]WAC 173-340-750(3) Method B carcinogenic cleanup limit based on inhalation exposure pathway.
[d]*Calculation of Hexavalent Chromium Carcinogenic Risk*, 0100X-CA-V0031 (BHI 2000).
[e]Constituent was not detected in cleanup verification samples above the analytical practical quantitation limit (PQL). The value is the PQL.
[f]Value is based on EPA's Integrated Exposure Uptake Biokinetic Model for lead in children (EPA 1994).
NA = not applicable. There are no direct exposure criteria for lithium and sodium; however, the cleanup verification data are below the Hanford Site background action level criteria from the LSFF Closure Plan (DOE-RL 1995a). Hanford Site background concentrations for lithium and sodium are 33.5 mg/kg and 690 mg/kg, respectively.

The analytical results for the four soil samples collected beneath the exhaust duct from the LSFF RCRA TSD unit are shown in Table A-3 in Appendix A. The sodium and lithium historical data for the lower exhaust tunnel are included in BHI (2004b) and Appendix D of this CVP. There are no applicable direct exposure criteria for lithium, sodium, lithium carbonate, or sodium carbonate. The lithium and sodium concentrations (assumed to represent the concentration of lithium carbonate and sodium carbonate) in soil and of the remaining below-grade concrete exhaust tunnel are below the Washington State dangerous waste toxicity criteria of 100,000 mg/kg for lithium carbonate and 10,000 mg/kg for sodium carbonate (WAC 173-303-100). In addition, the lithium and sodium values detected in the soil samples are consistent with background levels detected in Hanford soils (DOE-RL 1996).

6.1.2.2 Noncarcinogenic Hazard Quotient RAG Attained. For noncarcinogenic COCs, WAC 173-340-740(5)(a) and (b) specify the evaluation of the hazard quotient, which is given as daily intake divided by a reference dose. For cleanup actions under the Remaining Sites ROD (EPA 1999), a comparable conservative approach is used to demonstrate attainment of the noncarcinogenic risk requirements. Calculation of the hazard quotient is presented in the 95% UCL calculation brief (Appendix C).

With the exceptions of lithium and sodium, all nonradionuclide COCs for this site (arsenic, barium, cadmium, chromium, hexavalent chromium, lead, mercury, selenium, and silver) exhibit noncarcinogenic health effects. Again, there are no risk-based cleanup criteria for lithium and sodium. The hazard quotient was not calculated because all concentrations were below background; therefore, the noncarcinogenic risk requirements have been attained.

6.1.2.3 Carcinogenic Risk RAG Attained. For individual nonradionuclide carcinogenic COCs, the WAC 173-340-740(3) 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} per WAC 173-340-740(3)(b).

The nonradionuclide carcinogenic COCs at this site are hexavalent chromium, cadmium, and arsenic. The cancer risk from these COCs was not calculated because hexavalent chromium was not found at concentrations above laboratory detection limits in verification samples, and concentrations of arsenic and cadmium in the verification samples were all below background. The carcinogenic risk standards have, therefore, been attained for both individual and total excess cancer risk. This calculation is documented in the 95% UCL calculation brief (Appendix C).

6.2 GROUNDWATER REMEDIAL ACTION GOALS ATTAINED

6.2.1 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 each radionuclide COC and provides the individual RAGs for comparison. No COC is predicted to exceed the RAGs; therefore, the RAGs are attained.

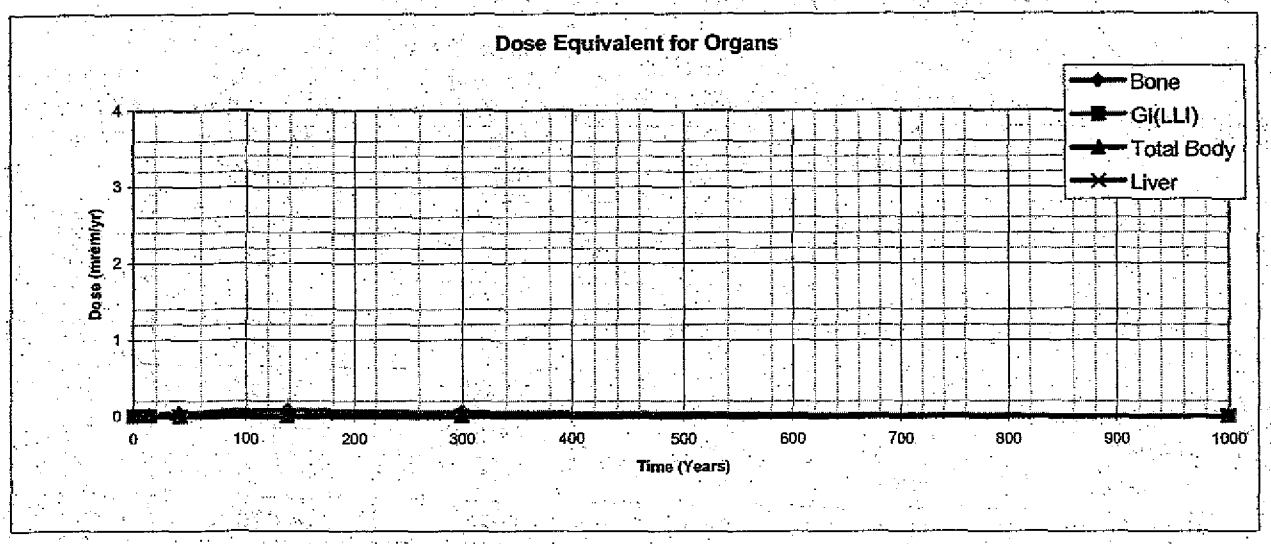
Table 4. Estimated Peak Radionuclide Groundwater Concentrations (Shallow Zone Impacts) Compared to RAGs.

Radionuclide	Peak Concentration (pCi/L)	RAG (pCi/L)	RAGS Attained? (Yes/No)
Americium-241	NA[a]	1.2[b]	Yes
Carbon-14	NA[a]	2,000[c]	Yes
Cesium-137	0.00188	60[c]	Yes
Cobalt-60	0.000158	100[c]	Yes
Europium-152	NA[a]	200[c]	Yes
Europium-154	NA[a]	60[c]	Yes
Europium-155	NA[a]	600[c]	Yes
Nickel-63	0.984	50[c]	Yes
Plutonium-238	NA[a]	1.6[b]	Yes
Plutonium-239/240	NA[a]	1.2[b]	Yes
Strontium-90	0.000177	8[d]	Yes
Uranium-234	NA[e]	21.2[f]	Yes
Uranium-235	NA[e]		Yes
Uranium-238	NA[e]		Yes

[a]These radionuclides do not reach groundwater within 1,000 years.
[b]Value corresponding to 1/25th of the derived concentration guide from DOE Order 5400.5.
[c]Lookup value corresponding to a dose rate of 4 mrem/yr.
[d]EPA drinking water promulgated maximum contaminant level (MCL) (40 CFR 141.66).
[e]Soil concentrations for these radionuclides are below Hanford Site background or laboratory detection limits and, therefore, were not assessed using RESRAD.
[f]Since the time of Remaining Sites ROD (EPA 1999) signature, the EPA has promulgated an MCL of 30 µg/L for total uranium (65 *Federal Register* 76708). Based on the isotopic distribution of uranium in the 100 Areas, the 30 µg/L MCL corresponds to 21.2 pCi/L (BHI 2001).
NA = not applicable

In addition, none of the individual organ doses for beta- and gamma-emitting radionuclides are predicted to exceed the 4 mrem/yr standard within the 1,000-year time frame of the evaluation. The individual organ dose rates for beta- and gamma-emitting radionuclides predicted over a 1,000-year period are presented in Figure 4 and in the comparison to drinking water standards calculation brief (Appendix C).

Figure 4. Dose Rates to Organs from Groundwater.



6.2.2 Nonradionuclides

Table 5 illustrates the comparison of cleanup verification values to the groundwater protection RAGs. The table shows that the residual concentrations (cleanup verification values) of all nonradionuclide COCs are less than the listed groundwater protection soil RAGs. The results of meeting the listed RAGs demonstrate that the RAGs have been attained.

As noted in Table 5, there are no applicable groundwater protection RAGs for lithium, sodium, lithium carbonate, or sodium carbonate. The lithium and sodium concentrations (assumed to represent the concentration of lithium carbonate and sodium carbonate) in soil (samples results in Table A-3) and the remaining below-grade exhaust tunnel (BHI 2004b) are below the Washington State dangerous waste toxicity criteria of 100,000 mg/kg for lithium carbonate and 10,000 mg/kg for sodium carbonate (WAC 173-303-100). In addition, the lithium and sodium concentrations detected in the soil samples are consistent with background levels detected in Hanford soils (DOE-RL 1996).

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

Nonradionuclides	Soil RAG for Groundwater Protection (mg/kg)	Soil RAG for Columbia River Protection (mg/kg)	Shallow Zone Cleanup Verification Data Value (mg/kg)	Deep Zone Cleanup Verification Data Value (mg/kg)	RAGs Attained? (Yes/No)
Arsenic	20	20	2.9	2.4	Yes
Barium	132	224	65	58	Yes
Cadmium	0.81	0.81	0.19	0.21	Yes
Total chromium	18.5	18.5	11	10	Yes
Hexavalent chromium	8	2	0.42[a]	0.42[a]	Yes
Lead	10.2	10.2	6.5	4.1	Yes
Lithium	NA	NA	12	9.9	Yes
Mercury	0.33	0.33	0.020[a]	0.020[a]	Yes
Selenium	5	0.78	0.30[a]	0.33[a]	Yes
Silver	8	0.73	0.080[a]	0.080[a]	Yes
Sodium	NA	NA	400	390	Yes

[a]Constituent was not detected in cleanup verification samples above the analytical practical quantitation limit (PQL). The value is the PQL.
NA = not applicable. There are no criteria for groundwater or river protection for lithium and sodium; however, the cleanup verification data are below the Hanford Site background action level criteria from the LSFF Closure Plan (DOE-RL 1995a). Hanford Site background concentrations for lithium and sodium are 33.5 mg/kg and 690 mg/kg, respectively.

6.3 COLUMBIA RIVER REMEDIAL ACTION GOALS ATTAINED

6.3.1 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.

6.3.2 Nonradionuclides

Table 5 illustrates the comparison of cleanup verification values to the river protection RAGs. The table shows the residual concentrations (cleanup verification values) of nonradionuclides are less than the listed river protection soil RAGs. The results of meeting the listed RAGs demonstrate that the RAGs have been attained.

As noted previously, there are no applicable river protection RAGs for lithium, sodium, lithium carbonate, or sodium carbonate. The lithium and sodium concentrations (assumed to represent the concentration of lithium carbonate and sodium carbonate)

detected in soil (sample results in Table A-3) and the remaining below-grade exhaust tunnel (BHI 2004b) are below the Washington State dangerous waste toxicity criteria of 100,000 mg/kg for lithium carbonate and 10,000 mg/kg for sodium carbonate (WAC 173-303-100). In addition, the lithium and sodium values detected in the soil samples are consistent with background levels detected in Hanford soils (DOE-RL 1996).

6.4 WAC 173-340-740 THREE-PART TEST FOR NONRADIONUCLIDES

Sections 6.1, 6.2, and 6.3 looked separately at compliance with direct exposure RAGs, groundwater protection RAGs, and Columbia River protection RAGs. Section 6.4 documents application of the WAC 173-340-740(7)(e) three-part test for nonradionuclides using the most restrictive RAGs applicable to each decision unit (i.e., shallow zone and deep zone). 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 117-DR facilities site verification data set. The WAC 173-340-740(7)(e) 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 173-340-740(7)(e) three-part test. 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 for each nonradionuclide COC. The final column of the table describes the result of applying the three criteria using the values listed in the preceding columns.

Table 6 shows the residual concentrations (cleanup verification values) of all nonradionuclide COCs pass the WAC 173-340-740(7)(e) three-part test. Therefore, the cleanup verification sample data set meets the three-part test criteria when compared to the most stringent applicable RAGs.

As noted previously, there are no applicable RAGs for lithium, sodium, lithium carbonate, or sodium carbonate. The lithium and sodium values (assumed to represent the concentration of lithium carbonate and sodium carbonate) for soil and remaining concrete are below the Washington State dangerous waste toxicity criteria of 100,000 mg/kg for lithium carbonate and 10,000 mg/kg for sodium carbonate (WAC 173-303-100). In addition, the lithium and sodium values detected in the four soil samples collected beneath the LSFF exhaust duct (Table A-3) are consistent with background levels detected in Hanford soils (DOE-RL 1996).

Table 6. Application of the WAC 173-340-740 Three-Part Test.

Nonradionuclides	Most Stringent Applicable RAG (mg/kg)	Cleanup Verification Value (mg/kg)[a]	Maximum Detected (mg/kg)[b]	Total Number of Samples[c]	Number Exceeding Criteria[d]	RAGs Attained? (Yes/No)
Shallow Zone						
Arsenic	20	2.9	3.1	5	0	Yes
Barium	132	65	67	5	0	Yes
Cadmium	0.81	0.19	0.19	5	0	Yes
Total chromium	18.5	11	12	5	0	Yes
Hexavalent chromium	2	0.42[e]	0.42	5	0	Yes
Lead	10.2	6.5	7.4	5	0	Yes
Lithium	NA	12[f]	13[f]	5	0	Yes
Mercury	0.33	0.020[e]	0.020	5	0	Yes
Selenium	0.78	0.30[e]	0.30	5	0	Yes
Silver	0.73	0.080[e]	0.080	5	0	Yes
Sodium	NA	400[g]	450[g]	5	0	Yes
Deep Zone						
Arsenic	20	2.4	2.6	4	0	Yes
Barium	132	58	59	4	0	Yes
Cadmium	0.81	0.21	0.21	4	0	Yes
Total chromium	18.5	10	12	4	0	Yes
Hexavalent chromium	2	0.42[e]	0.42	4	0	Yes
Lead	10.2	4.1	4.2	4	0	Yes
Lithium	NA	9.9[f]	10[f]	4	0	Yes
Mercury	0.33	0.020[e]	0.020	4	0	Yes
Selenium	0.78	0.33[e]	0.33	4	0	Yes
Silver	0.73	0.080[e]	0.080	4	0	Yes
Sodium	NA	390[g]	400[g]	4	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 include 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]Constituent was not detected in cleanup verification samples above the analytical practical quantitation limit (PQL). The value is the PQL.
[f]Values were below the Hanford Site background value of 33.5 mg/kg.
[g]Values were below the Hanford Site background value of 690 mg/kg.
NA = not applicable. There are no specific cleanup criteria for lithium and sodium; however, the cleanup verification data meet the three-part test when the Hanford Site background action level criteria from the LSFF Closure Plan (DOE-RL 1995a) is used. Hanford Site background concentrations for lithium and sodium are 33.5 mg/kg and 690 mg/kg, respectively.

7.0 RADIONUCLIDE RISK INFORMATION

The radionuclide RAG for direct exposure is derived from the Action Memorandum (EPA et al. 1998) and the Remaining Sites ROD (EPA 1999), 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 (HEAST) (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 CFR 300) presents a target range for residual risk of 10^{-4} to 10^{-6}. Figure 5 illustrates excess lifetime cancer risk as estimated using the RESRAD model. Because of radioactive decay, the risk decreases over time. The estimated site risk is largest (4.26×10^{-5}) at present (2003), and decreases to 2.73×10^{-8} in 1,000 years. The estimated excess cancer risk due to radionuclides in 2018 is 5.70×10^{-6}. Figure 6 plots the radiation dose rate above background for the shallow zone similar to Figure 3, and shows the corresponding radionuclide risk at present and in 2018.

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

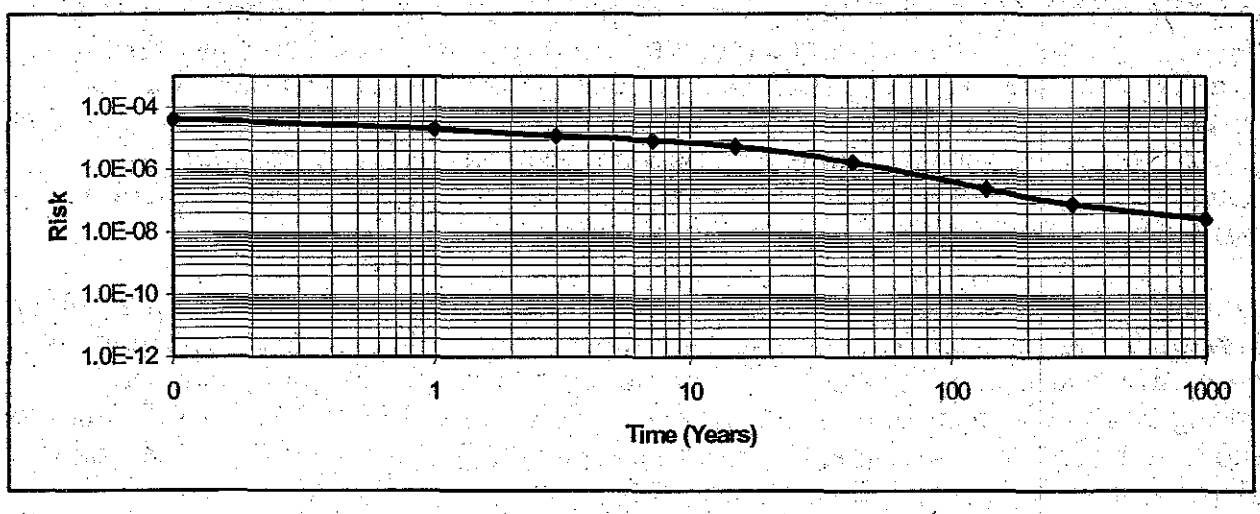
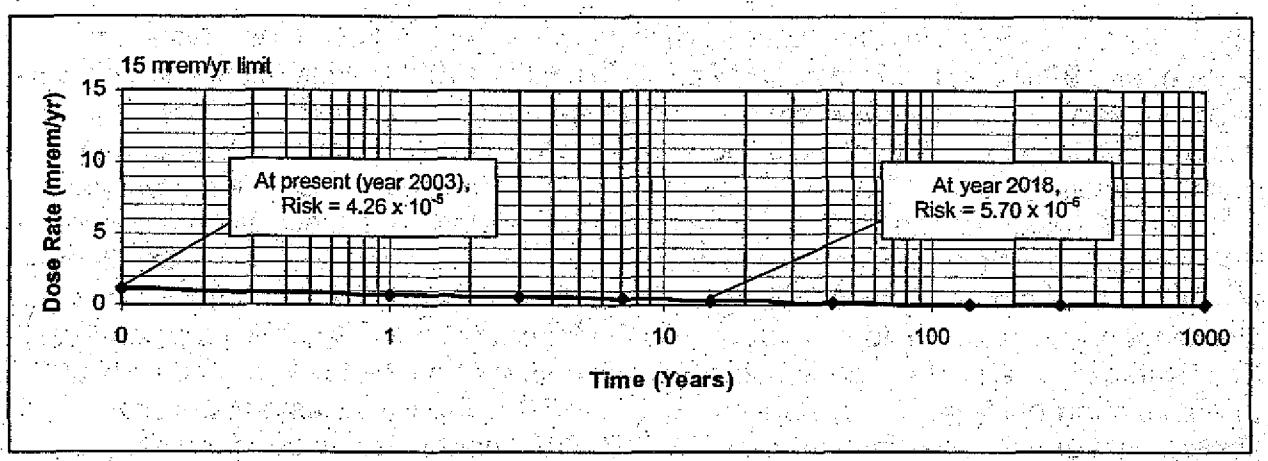


Figure 6. RESRAD Analysis – Radionuclide Dose Rate, All Pathways, With Corresponding Risk Values.



8.0 STATEMENT OF PROTECTIVENESS

This CVP demonstrates that remedial action at the 117-DR facilities site has achieved the RAOs and corresponding RAGs established in the Action Memorandum (EPA et al. 1998), the Remaining Sites ROD (EPA 1999), the Phase III SAP (DOE-RL 2000), and the RDR/RAWP (DOE-RL 2002a). The remaining soils at the 117-DR facilities site have been sampled, analyzed, and modeled. The results of this effort indicate that the materials from the 117-DR facilities site containing COCs at concentrations exceeding RAGs have been excavated and disposed of 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 are protective of groundwater and the Columbia River.

However, the deep zone data are not typically assessed against direct exposure criteria. Therefore, the acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated, and institutional controls are required to prevent uncontrolled drilling or excavation into the deep zone (i.e., below 4.6 m [15 ft]). The 117-DR facilities site is verified to be remediated in accordance with the RAOs and RAGs of the Action Memorandum and the Remaining Sites ROD and may be backfilled.

In addition, demonstration that remedial action at the 117-DR facilities site has achieved the RAOs and corresponding RAGs established in the Action Memorandum and the Remaining Sites ROD meets the RCRA closure requirements for the underlying soils. Final RCRA TSD certification of closure is pending.

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APPENDIX A

SUMMARY OF VERIFICATION SOIL SAMPLING AND ANALYTICAL RESULTS

Table A-1. 117-DR Shallow Zone Radionuclide and Inorganics Cleanup Verification Data, August 8, 2003. (3 Pages)

Sampling Area	HEIS Number	Am-241			C-14			Cs-137			Co-60			Eu-152			Eu-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J00WJ0	0.00E+00	U	1.70E-01	1.67E-01	U	3.10E+00	1.90E-02		1.90E-02	2.00E-02	U	2.00E-02	4.80E-02	U	4.80E-02	6.90E-02	U	6.90E-02
Duplicate of J00WJ0	J00WJ7	0.00E+00	U	2.10E-01	1.22E+00	U	2.80E+00	4.00E-02		3.00E-02	2.60E-02	U	2.60E-02	6.00E-02	U	6.00E-02	8.90E-02	U	8.90E-02
Split of J00WJ0	J00WJ9	-2.91E-03	U	1.22E-01	-1.16E-01	U	7.83E-01	1.90E-02	U	2.71E-02	-4.12E-04	U	2.73E-02	1.92E-02	U	6.05E-02	-2.30E-02	U	8.22E-02
A2	J00WJ1	5.00E-02	U	1.90E-01	9.54E-01	U	2.60E+00	6.30E-02		1.70E-02	1.50E-02	U	1.50E-02	3.50E-02	U	3.50E-02	5.20E-02	U	5.20E-02
A3	J00WJ2	0.00E+00	U	2.00E-01	-2.92E-01	U	2.70E+00	5.10E-02	U	5.10E-02	3.10E-02	U	3.10E-02	6.80E-02	U	6.80E-02	9.80E-02	U	9.80E-02
A4	J00WJ3	0.00E+00	U	2.10E-01	5.75E-01	U	2.70E+00	3.30E-02		2.70E-02	2.60E-02	U	2.60E-02	5.80E-02	U	5.80E-02	8.50E-02	U	8.50E-02

Sampling Area	HEIS Number	Eu-155			Ni-63			Pu-238			Pu-239/240			Sr-90[a]			U-233/234		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J00WJ0	7.10E-02	U	7.10E-02	7.04E-01	U	2.50E+00	3.70E-02	U	2.80E-01	0.00E+00	U	2.80E-01	-1.90E-02	U	2.90E-01	4.94E-01		1.50E-01
Duplicate of J00WJ0	J00WJ7	5.40E-02	U	5.40E-02	1.12E+00	U	2.80E+00	-4.90E-02	U	3.70E-01	0.00E+00	U	3.70E-01	4.60E-02	U	2.80E-01	4.59E-01		1.80E-01
Split of J00WJ0	J00WJ9	2.34E-02	U	5.89E-02	2.56E+00	U	5.79E+00	0.00E+00	U	8.17E-02	0.00E+00	U	8.17E-02	5.68E-02	U	1.44E-01	6.86E-01		8.22E-02
A2	J00WJ1	3.70E-02	U	3.70E-02	1.21E+00	U	2.40E+00	0.00E+00	U	2.20E-01	0.00E+00	U	2.20E-01	-3.10E-02	U	2.60E-01	3.67E-01		1.80E-01
A3	J00WJ2	1.00E-01	U	1.00E-01	7.36E-01	U	2.80E+00	0.00E+00	U	2.70E-01	0.00E+00	U	2.70E-01	-6.80E-02	U	2.70E-01	5.25E-01		1.60E-01
A4	J00WJ3	5.50E-02	U	5.50E-02	6.00E-01	U	2.40E+00	3.70E-02	U	2.80E-01	3.70E-02	U	2.80E-01	-3.70E-02	U	2.90E-01	6.62E-01		1.60E-01

[a]Strontium-90 is the contaminant of concern identified in the *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. The values reported here are for total radioactive strontium.
HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
Q = qualifier
U = The constituent was not detected. The associated value is the laboratory detection limit or MDA.

Table A-1. 117-DR Shallow Zone Radionuclide and Inorganics Cleanup Verification Data, August 8, 2003. (3 Pages)

Sampling Area	HEIS Number	U-235			U-238			Arsenic			Barium			Cadmium		
		pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
A1	J00WJ0	2.40E-02	U	1.80E-01	6.52E-01		1.50E-01	2.7E+00		3.8E-01	6.7E+01		2.0E-02	7.0E-02		4.0E-02
Duplicate of J00WJ0	J00WJ7	0.00E+00	U	2.20E-01	5.08E-01		1.80E-01	3.1E+00		4.4E-01	6.7E+01		2.0E-02	1.9E-01		4.0E-02
Split of J00WJ0	J00WJ9	9.83E-02		5.33E-02	9.18E-01		1.03E-01	2.50E+00		2.30E-01	6.80E+01		4.30E-01	3.80E-02	U	3.80E-02
A2	J00WJ1	0.00E+00	U	2.10E-01	2.98E-01		1.80E-01	2.7E+00		4.1E-01	6.2E+01		2.0E-02	4.0E-02	U	4.0E-02
A3	J00WJ2	2.50E-02	U	1.90E-01	3.15E-01		1.60E-01	2.4E+00		3.9E-01	5.9E+01		2.0E-02	4.0E-02	U	4.0E-02
A4	J00WJ3	7.50E-02	U	1.90E-01	5.79E-01		1.60E-01	2.9E+00		4.2E-01	6.0E+01		2.0E-02	4.0E-02	U	4.0E-02

Sampling Area	HEIS Number	Chromium (total)			Hexavalent Chromium			Lead			Lithium			Mercury		
		mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
A1	J00WJ0	1.2E+01		9.0E-02	4.2E-01	U	4.2E-01	5.0E+00		1.7E-01	1.0E+01		2.0E-02	1.0E-02	U	1.0E-02
Duplicate of J00WJ0	J00WJ7	1.2E+01		1.0E-01	4.2E-01	U	4.2E-01	5.0E+00		2.0E-01	9.9E+00		2.0E-02	2.0E-02	U	2.0E-02
Split of J00WJ0	J00WJ9	1.09E+01		5.80E-02	3.50E-01	U	3.50E-01	5.10E+00		1.40E-01	1.26E+01		7.20E-01	1.70E-02	U	1.70E-02
A2	J00WJ1	1.1E+01		1.0E-01	4.1E-01	U	4.1E-01	4.5E+00		1.8E-01	1.1E+01		2.0E-02	2.0E-02	U	2.0E-02
A3	J00WJ2	8.4E+00		9.0E-02	4.1E-01	U	4.1E-01	7.4E+00		1.8E-01	1.3E+01		2.0E-02	2.0E-02	U	2.0E-02
A4	J00WJ3	9.3E+00		1.0E-01	4.2E-01	U	4.2E-01	4.3E+00		1.9E-01	7.8E+00		2.0E-02	2.0E-02	U	2.0E-02

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
PQL = practical quantitation limit
Q = qualifier
U = The constituent was not detected. The associated value is the laboratory detection limit or MDA.

Table A-1. 117-DR Shallow Zone Radionuclide and Inorganics Cleanup Verification Data, August 8, 2003. (3 Pages)

Sampling Area	HEIS Number	Selenium			Silver			Sodium		
		mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
A1	J00WJ0	2.6E-01	U	2.6E-01	7.0E-02	U	7.0E-02	3.3E+02		6.4E-01
Duplicate of J00WJ0	J00WJ7	3.0E-01	U	3.0E-01	8.0E-02	U	8.0E-02	2.9E+02		7.4E-01
Split of J00WJ0	J00WJ9	2.20E-01	U	2.20E-01	5.70E-02	U	5.70E-02	2.71E+02		1.45E+01
A2	J00WJ1	2.8E-01	U	2.8E-01	8.0E-02	U	8.0E-02	4.5E+02		6.9E-01
A3	J00WJ2	2.7E-01	U	2.7E-01	7.0E-02	U	7.0E-02	3.4E+02		6.6E-01
A4	J00WJ3	2.9E-01	U	2.9E-01	8.0E-02	U	8.0E-02	2.9E+02		7.1E-01

HEIS = Hanford Environmental Information System
PQL = practical quantitation limit
Q = qualifier
U = The constituent was not detected. The associated value is the laboratory detection limit or MDA.

Table A-2. 117-DR Deep Zone Radionuclide and Inorganics Cleanup Verification Data, August 8, 2003. (3 Pages)

Sampling Area	HEIS Number	Am-241			C-14			Cs-137			Co-60			Eu-152			Eu-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J00WJ4	-7.00E-02	U	1.80E-01	7.64E-01	U	2.40E+00	4.50E-02	U	4.50E-02	4.30E-02	U	4.30E-02	8.80E-02	U	8.80E-02	1.50E-01	U	1.50E-01
Duplicate of J00WJ4	J00WJ8	8.20E-02	U	2.10E-01	1.66E+00	U	2.90E+00	5.00E-02	U	5.00E-02	4.50E-02	U	4.50E-02	9.20E-02	U	9.20E-02	1.40E-01	U	1.40E-01
Split of J00WJ4	J00WK0	5.12E-02	U	6.94E-02	4.16E-02	U	7.82E-01	3.69E-02		1.71E-02	3.56E-03	U	1.67E-02	-1.52E-02	U	3.62E-02	-3.00E-02	U	4.87E-02
A2	J00WJ5	-2.40E-02	U	1.80E-01	4.27E-01	U	2.40E+00	3.90E-02	U	3.90E-02	3.70E-02	U	3.70E-02	7.80E-02	U	7.80E-02	1.20E-01	U	1.20E-01
A3	J00WJ6	0.00E+00	U	1.80E-01	4.06E-01	U	2.50E+00	4.90E-02		3.20E-02	2.90E-02	U	2.90E-02	6.70E-02	U	6.70E-02	1.10E-01	U	1.10E-01

Sampling Area	HEIS Number	Eu-155			Ni-63			Pu-238			Pu-239/240			Sr-90[a]			U-233/234		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J00WJ4	9.70E-02	U	9.70E-02	4.46E-01	U	2.50E+00	1.06E-01	U	4.10E-01	5.30E-02	U	4.10E-01	-6.50E-02	U	2.90E-01	5.36E-01		1.70E-01
Duplicate of J00WJ4	J00WJ8	9.80E-02	U	9.80E-02	1.72E+00	U	3.60E+00	4.70E-02	U	3.60E-01	0.00E+00	U	3.60E-01	-2.80E-02	U	3.00E-01	4.94E-01		1.60E-01
Split of J00WJ4	J00WK0	4.62E-02	U	4.67E-02	4.34E+00	U	6.17E+00	0.00E+00	U	7.11E-02	-5.25E-03	U	1.26E-01	2.00E-02	U	1.37E-01	6.68E-01		7.18E-02
A2	J00WJ5	9.40E-02	U	9.40E-02	1.59E+00	U	3.10E+00	0.00E+00	U	3.70E-01	0.00E+00	U	3.70E-01	6.00E-03	U	2.80E-01	4.23E-01		1.60E-01
A3	J00WJ6	1.10E-01	U	1.10E-01	1.96E-01	U	3.00E+00	4.20E-02	U	3.20E-01	0.00E+00	U	3.20E-01	-7.60E-02	U	2.90E-01	6.19E-01		1.60E-01

[a]Strontium-90 is the contaminant of concern identified in the *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. The values reported here are for total radioactive strontium.
HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
Q = qualifier
U = The constituent was not detected. The associated value is the laboratory detection limit or MDA.

Table A-2. 117-DR Deep Zone Radionuclide and Inorganics Cleanup Verification Data, August 8, 2003. (3 Pages)

Sampling Area	HEIS Number	U-235			U-238			Arsenic			Barium			Cadmium		
		pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
A1	J00WJ4	0.00E+00	U	2.10E-01	6.47E-01		1.70E-01	2.3E+00		3.9E-01	5.3E+01		2.0E-02	4.0E-02	U	4.0E-02
Duplicate of J00WJ4	J00WJ8	5.20E-02	U	2.00E-01	6.01E-01		1.60E-01	2.6E+00		4.3E-01	5.9E+01		2.0E-02	1.7E-01		4.0E-02
Split of J00WJ4	J00WK0	5.15E-02	U	4.66E-02	8.57E-01		7.18E-02	2.4E+00		2.4E-01	6.5E+01		4.4E-01	3.9E-02	U	3.9E-02
A2	J00WJ5	5.10E-02	U	2.00E-01	5.29E-01		1.60E-01	2.0E+00		4.2E-01	5.6E+01		2.0E-02	1.7E-01		4.0E-02
A3	J00WJ6	0.00E+00	U	1.90E-01	5.16E-01		1.60E-01	2.2E+00		4.2E-01	5.8E+01		2.0E-02	2.1E-01		4.0E-02

Sampling Area	HEIS Number	Chromium (total)			Hexavalent Chromium			Lead			Lithium			Mercury		
		mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
A1	J00WJ4	8.7E+00		9.0E-02	4.2E-01	U	4.2E-01	3.9E+00		1.8E-01	8.7E+00		2.0E-02	2.0E-02	U	2.0E-02
Duplicate of J00WJ4	J00WJ8	1.2E+01		1.0E-01	4.2E-01	U	4.2E-01	4.2E+00		2.0E-01	8.9E+00		2.0E-02	1.0E-02	U	1.0E-02
Split of J00WJ4	J00WK0	1.0E+01		5.9E-02	3.5E-01	U	3.5E-01	4.1E+00		1.4E-01	1.4E+01		7.3E-01	1.7E-02	U	1.7E-02
A2	J00WJ5	8.2E+00		1.0E-01	4.2E-01	U	4.2E-01	3.7E+00		1.9E-01	1.0E+01		2.0E-02	1.0E-02	U	1.0E-02
A3	J00WJ6	9.9E+00		1.0E-01	4.1E-01	U	4.1E-01	3.9E+00		1.9E-01	8.2E+00		2.0E-02	1.0E-02	U	1.0E-02

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
PQL = practical quantitation limit
Q = qualifier
U = The constituent was not detected. The associated value is the laboratory detection limit or MDA.

Table A-2. 117-DR Deep Zone Radionuclide and Inorganics Cleanup Verification Data, August 8, 2003. (3 Pages)

Sampling Area	HEIS Number	Selenium			Silver			Sodium		
		mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
A1	J00WJ4	2.7E-01	U	2.7E-01	7.0E-02	U	7.0E-02	3.0E+02		6.6E-01
Duplicate of J00WJ4	J00WJ8	3.0E-01	U	3.0E-01	8.0E-02	U	8.0E-02	2.8E+02		7.3E-01
Split of J00WJ4	J00WK0	2.2E-01	U	2.2E-01	8.5E-02	U	8.5E-02	2.8E+02		1.5E+01
A2	J00WJ5	2.9E-01	U	2.9E-01	8.0E-02	U	8.0E-02	4.0E+02		7.0E-01
A3	J00WJ6	3.3E-01	U	3.3E-01	8.0E-02	U	8.0E-02	3.0E+02		7.1E-01

HEIS = Hanford Environmental Information System
PQL = practical quantitation limit
Q = qualifier
U = The constituent was not detected. The associated value is the laboratory detection limit or MDA.

Table A-3. Large Sodium Fire Facility Exhaust Tunnel RCRA Verification Data, August 8, 2003.

Sampling Location	Northing	Easting	HEIS Number	Lithium[a, b]			Sodium[a, b]		
				mg/kg	Q	PQL	mg/kg	Q	PQL
Tunnel 1	151237.83	573749.16	J00WM1	1.1E+01		9.4E-01	3.9E+02		2.1E+00
Duplicate of J00MW1	151237.83	573749.16	J00WM5	1.1E+01		1.0E+00	4.0E+02		2.3E+00
Equipment Blank for J00WM1	151237.83	573749.16	J00WM6	9.7E-01	U	9.7E-01	9.6E+00		2.2E+00
Ecology Split of J00WM1	151237.83	573749.16	ECO117D5 (non-HEIS)	1.1E+01		1.1E+00	NA		NA
Tunnel 2	151228.49	573749.04	J00WM2	4.2E+00		9.7E-01	4.3E+02		2.2E+00
Tunnel 3	151219.15	573748.92	J00WM3	1.4E+01		8.9E-01	4.6E+02		2.0E+00
Tunnel 4	151209.81	573748.79	J00WM3	4.0E+01		1.0E+00	1.0E+03		2.3E+00

[a]Dangerous waste criteria concentrations for lithium carbonate and sodium carbonate are 100,000 mg/kg and 10,000 mg/kg, respectively (WAC 173-303-100, "Dangerous Waste Regulations").
[b]Hanford Site background concentrations for lithium and sodium are 33.5 mg/kg and 690 mg/kg, respectively.
HEIS = Hanford Environmental Information System
NA = not analyzed
PQL = practical quantitation limit
Q = qualifier
U = The constituent was not detected. The associated value is the laboratory detection limit or MDA.

Table A-4. 117-DR Shallow Zone Organics Cleanup Verification Data, August 8, 2003. (3 Pages)

Sample Location		J00WJ0			J00WJ7			J00WJ9			J00WJ1			J00WJ2			J00WJ3		
		Sample Area A1			Duplicate of J00WJ0			Split of J00WJ0			Sample Area A2			Sample Area A3			Sample Area A4		
Constituent	Class	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
1,2,4-Trichlorobenzene	SVOA	350	U	350	350	U	350	18	U	340	340	U	340	340	U	340	350	U	350
1,2-Dichlorobenzene	SVOA	350	U	350	350	U	350	12	U	340	340	U	340	340	U	340	350	U	350
1,3-Dichlorobenzene	SVOA	350	U	350	350	U	350	12	U	340	340	U	340	340	U	340	350	U	350
1,4-Dichlorobenzene	SVOA	350	U	350	350	U	350	14	U	340	340	U	340	340	U	340	350	U	350
2,4,5-Trichlorophenol	SVOA	870	U	870	870	U	870	31	U	340	860	U	860	860	U	860	880	U	880
2,4,6-Trichlorophenol	SVOA	350	U	350	350	U	350	32	U	340	340	U	340	340	U	340	350	U	350
2,4-Dichlorophenol	SVOA	350	U	350	350	U	350	26	U	340	340	U	340	340	U	340	350	U	350
2,4-Dimethylphenol	SVOA	350	U	350	350	U	350	29	U	340	340	U	340	340	U	340	350	U	350
2,4-Dinitrophenol	SVOA	870	U	870	870	U	870	66	U	1700	860	U	860	860	U	860	880	U	880
2,4-Dinitrotoluene	SVOA	350	U	350	350	U	350	18	U	340	340	U	340	340	U	340	350	U	350
2,6-Dinitrotoluene	SVOA	350	U	350	350	U	350	21	U	340	340	U	340	340	U	340	350	U	350
2-Chloronaphthalene	SVOA	350	U	350	350	U	350	16	U	340	340	U	340	340	U	340	350	U	350
2-Chlorophenol	SVOA	350	U	350	350	U	350	14	U	340	340	U	340	340	U	340	350	U	350
2-Methylnaphthalene	SVOA	350	U	350	350	U	350	15	U	340	340	U	340	340	U	340	350	U	350
2-Methylphenol (cresol, o-)	SVOA	350	U	350	350	U	350	20	U	340	340	U	340	340	U	340	350	U	350
2-Nitroaniline	SVOA	870	U	870	870	U	870	39	U	1700	860	U	860	860	U	860	880	U	880
2-Nitrophenol	SVOA	350	U	350	350	U	350	20	U	340	340	U	340	340	U	340	350	U	350
3,3'-Dichlorobenzidine	SVOA	350	U	350	350	U	350	24	U	340	340	U	340	340	U	340	350	U	350
3-Nitroaniline	SVOA	870	U	870	870	U	870	27	U	1700	860	U	860	860	U	860	880	U	880
4,6-Dinitro-2-methylphenol	SVOA	870	U	870	870	U	870	64	U	1700	860	U	860	860	U	860	880	U	880
4-Bromophenylphenyl ether	SVOA	350	U	350	350	U	350	23	U	340	340	U	340	340	U	340	350	U	350
4-Chloro-3-methylphenol	SVOA	350	U	350	350	U	350	27	U	340	340	U	340	340	U	340	350	U	350
4-Chloroaniline	SVOA	350	U	350	350	U	350	32	U	340	340	U	340	340	U	340	350	U	350
4-Chlorophenylphenyl ether	SVOA	350	U	350	350	U	350	19	U	340	340	U	340	340	U	340	350	U	350
4-Methylphenol (cresol, p-)	SVOA	350	U	350	350	U	350	52	U	340	340	U	340	340	U	340	350	U	350
4-Nitroaniline	SVOA	870	U	870	870	U	870	23	U	1700	860	U	860	860	U	860	880	U	880
4-Nitrophenol	SVOA	870	U	870	870	U	870	44	U	1700	860	U	860	860	U	860	880	U	880
Acenaphthene	SVOA	350	U	350	350	U	350	17	U	340	340	U	340	340	U	340	350	U	350
Acenaphthylene	SVOA	350	U	350	350	U	350	17	U	340	340	U	340	340	U	340	350	U	350
Anthracene	SVOA	350	U	350	350	U	350	18	U	340	340	U	340	340	U	340	350	U	350

PQL = practical quantitation limit
Q = qualifier
SVOA = semivolatile organic analyses
U = The constituent was not detected. The associated value is the analytical method PQL.

Table A-4. 117-DR Shallow Zone Organics Cleanup Verification Data, August 8, 2003. (3 Pages)

Sample Location		J00WJ0			J00WJ7			J00WJ9			J00WJ1			J00WJ2			J00WJ3		
		Sample Area A1			Duplicate of J00WJ0			Split of J00WJ0			Sample Area A2			Sample Area A3			Sample Area A4		
Constituent	Class	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
Benzo(a)anthracene	SVOA	350	U	350	24	J	350	24	U	340	66	J	340	18	J	340	350	U	350
Benzo(a)pyrene	SVOA	350	U	350	20	J	350	20	U	340	30	J	340	340	U	340	350	U	350
Benzo(b)fluoranthene	SVOA	350	U	350	350	U	350	40	U	340	36	J	340	340	U	340	350	U	350
Benzo(ghi)perylene	SVOA	350	U	350	350	U	350	100	U	340	340	U	340	340	U	340	350	U	350
Benzo(k)fluoranthene	SVOA	350	U	350	19	J	350	20	U	340	25	J	340	340	U	340	350	U	350
Bis(2-chloro-1-methylethyl)ether	SVOA	350	U	350	350	U	350	16	U	340	340	U	340	340	U	340	350	U	350
Bis(2-Chloroethoxy)methane	SVOA	350	U	350	350	U	350	21	U	340	340	U	340	340	U	340	350	U	350
Bis(2-chloroethyl) ether	SVOA	350	U	350	350	U	350	14	U	340	340	U	340	340	U	340	350	U	350
Bis(2-ethylhexyl) phthalate	SVOA	81	B	350	130	B	350	35	U	340	340	U	340	53	B	340	350	U	350
Butylbenzylphthalate	SVOA	350	U	350	350	U	350	27	U	340	340	U	340	340	U	340	350	U	350
Carbazole	SVOA	350	U	350	350	U	350	21	U	340	340	U	340	340	U	340	350	U	350
Chrysene	SVOA	350	U	350	27	J	350	15	U	340	55	J	340	340	U	340	350	U	350
Dibenz[a,h]anthracene	SVOA	350	U	350	350	U	350	84	U	340	340	U	340	340	U	340	350	U	350
Dibenzofuran	SVOA	350	U	350	350	U	350	23	U	340	340	U	340	340	U	340	350	U	350
Diethylphthalate	SVOA	350	U	350	350	U	350	42	U	340	340	U	340	340	U	340	350	U	350
Dimethyl phthalate	SVOA	350	U	350	350	U	350	20	U	340	340	U	340	340	U	340	350	U	350
Di-n-butylphthalate	SVOA	350	U	350	19	J	350	29	U	340	340	U	340	340	U	340	350	U	350
Di-n-octylphthalate	SVOA	350	U	350	350	U	350	150	U	340	340	U	340	340	U	340	350	U	350
Fluoranthene	SVOA	23	J	350	30	J	350	24	U	340	110	J	340	22	J	340	350	U	350
Fluorene	SVOA	350	U	350	350	U	350	20	U	340	340	U	340	340	U	340	350	U	350
Hexachlorobenzene	SVOA	350	U	350	350	U	350	18	U	340	340	U	340	340	U	340	350	U	350
Hexachlorobutadiene	SVOA	350	U	350	350	U	350	13	U	340	340	U	340	340	U	340	350	U	350
Hexachlorocyclopentadiene	SVOA	350	U	350	350	U	350	74	U	340	340	U	340	340	U	340	350	U	350
Hexachloroethane	SVOA	350	U	350	350	U	350	17	U	340	340	U	340	340	U	340	350	U	350
Indeno(1,2,3-cd)pyrene	SVOA	350	U	350	350	U	350	18	U	340	340	U	340	340	U	340	350	U	350
Isophorone	SVOA	350	U	350	350	U	350	19	U	340	340	U	340	340	U	340	350	U	350
Naphthalene	SVOA	350	U	350	350	U	350	15	U	340	340	U	340	340	U	340	350	U	350
Nitrobenzene	SVOA	350	U	350	350	U	350	19	U	340	340	U	340	340	U	340	350	U	350
N-Nitroso-di-n-dipropylamine	SVOA	350	U	350	350	U	350	20	U	340	340	U	340	340	U	340	350	U	350
N-Nitrosodiphenylamine	SVOA	350	U	350	350	U	350	21	U	340	340	U	340	340	U	340	350	U	350

B = The constituent was detected in the laboratory blank sample.
J = The constituent was detected and value estimated below the associated PQL value.
PQL = practical quantitation limit
Q = qualifier
SVOA = semivolatile organic analyses
U = The constituent was not detected. The associated value is the analytical method PQL.

Table A-4. 117-DR Shallow Zone Organics Cleanup Verification Data, August 8, 2003. (3 Pages)

Sample Location		J00WJ0			J00WJ7			J00WJ9			J00WJ1			J00WJ2			J00WJ3		
		Sample Area A1			Duplicate of J00WJ0			Split of J00WJ0			Sample Area A2			Sample Area A3			Sample Area A4		
Constituent	Class	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
Pentachlorophenol	SVOA	870	U	870	870	U	870	120	U	1700	860	U	860	860	U	860	880	U	880
Phenanthrene	SVOA	350	U	350	350	U	350	17	U	340	20	J	340	340	U	340	350	U	350
Phenol	SVOA	350	U	350	350	U	350	90	U	340	340	U	340	340	U	340	350	U	350
Pyrene	SVOA	24	J	350	36	J	350	23	U	340	100	J	340	20	J	340	350	U	350

J = The constituent was detected and value estimated below the associated PQL value.
PQL = practical quantitation limit
Q = qualifier
SVOA = semivolatile organic analyses
U = The constituent was not detected. The associated value is the analytical method PQL.

Table A-5. 117-DR Deep Zone Organics Cleanup Verification Data, August 8, 2003. (3 Pages)

Sample Location		J00WJ4			J00WJ8			J00WK0			J00WJ5			J00WJ6		
		Sample Area A1			Duplicate of J00WJ4			Split of J00WJ4			Sample Area A2			Sample Area A3		
Constituent	Class	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
1,2,4-Trichlorobenzene	SVOA	350	U	350	350	U	350	18	U	340	350	U	350	350	U	350
1,2-Dichlorobenzene	SVOA	350	U	350	350	U	350	13	U	340	350	U	350	350	U	350
1,3-Dichlorobenzene	SVOA	350	U	350	350	U	350	12	U	340	350	U	350	350	U	350
1,4-Dichlorobenzene	SVOA	350	U	350	350	U	350	14	U	340	350	U	350	350	U	350
2,4,5-Trichlorophenol	SVOA	870	U	870	870	U	870	32	U	340	870	U	870	860	U	860
2,4,6-Trichlorophenol	SVOA	350	U	350	350	U	350	33	U	340	350	U	350	350	U	350
2,4-Dichlorophenol	SVOA	350	U	350	350	U	350	27	U	340	350	U	350	350	U	350
2,4-Dimethylphenol	SVOA	350	U	350	350	U	350	30	U	340	350	U	350	350	U	350
2,4-Dinitrophenol	SVOA	870	U	870	870	U	870	67	U	1700	870	U	870	860	U	860
2,4-Dinitrotoluene	SVOA	350	U	350	350	U	350	19	U	340	350	U	350	350	U	350
2,6-Dinitrotoluene	SVOA	350	U	350	350	U	350	21	U	340	350	U	350	350	U	350
2-Chloronaphthalene	SVOA	350	U	350	350	U	350	16	U	340	350	U	350	350	U	350
2-Chlorophenol	SVOA	350	U	350	350	U	350	14	U	340	350	U	350	350	U	350
2-Methylnaphthalene	SVOA	350	U	350	350	U	350	16	U	340	350	U	350	350	U	350
2-Methylphenol (cresol, o-)	SVOA	350	U	350	350	U	350	20	U	340	350	U	350	350	U	350
2-Nitroaniline	SVOA	870	U	870	870	U	870	39	U	1700	870	U	870	860	U	860
2-Nitrophenol	SVOA	350	U	350	350	U	350	20	U	340	350	U	350	350	U	350
3,3'-Dichlorobenzidine	SVOA	350	U	350	350	U	350	24	U	340	350	U	350	350	U	350
3-Nitroaniline	SVOA	870	U	870	870	U	870	27	U	1700	870	U	870	860	U	860
4,6-Dinitro-2-methylphenol	SVOA	870	U	870	870	U	870	65	U	1700	870	U	870	860	U	860
4-Bromophenylphenyl ether	SVOA	350	U	350	350	U	350	23	U	340	350	U	350	350	U	350
4-Chloro-3-methylphenol	SVOA	350	U	350	350	U	350	28	U	340	350	U	350	350	U	350
4-Chloroaniline	SVOA	350	U	350	350	U	350	32	U	340	350	U	350	350	U	350
4-Chlorophenylphenyl ether	SVOA	350	U	350	350	U	350	19	U	340	350	U	350	350	U	350
4-Methylphenol (cresol, p-)	SVOA	350	U	350	350	U	350	53	U	340	350	U	350	350	U	350
4-Nitroaniline	SVOA	870	U	870	870	U	870	23	U	1700	870	U	870	860	U	860
4-Nitrophenol	SVOA	870	U	870	870	U	870	44	U	1700	870	U	870	860	U	860
Acenaphthene	SVOA	350	U	350	350	U	350	17	U	340	350	U	350	350	U	350
Acenaphthylene	SVOA	350	U	350	350	U	350	17	U	340	350	U	350	350	U	350
Anthracene	SVOA	350	U	350	350	U	350	19	U	340	350	U	350	350	U	350

PQL = practical quantitation limit
Q = qualifier
SVOA = semivolatile organic analyses
U = The constituent was not detected. The associated value is the analytical method PQL.

Table A-5. 117-DR Deep Zone Organics Cleanup Verification Data, August 8, 2003. (3 Pages)

Sample Location		J00WJ4			J00WJ8			J00WK0			J00WJ5			J00WJ6		
		Sample Area A1			Duplicate of J00WJ4			Split of J00WJ4			Sample Area A2			Sample Area A3		
Constituent	Class	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
Benzo(a)anthracene	SVOA	350	U	350	23	J	350	24	U	340	350	U	350	350	U	350
Benzo(a)pyrene	SVOA	350	U	350	350	U	350	20	U	340	350	U	350	350	U	350
Benzo(b)fluoranthene	SVOA	350	U	350	350	U	350	40	U	340	350	U	350	350	U	350
Benzo(ghi)perylene	SVOA	350	U	350	350	U	350	110	U	340	350	U	350	350	U	350
Benzo(k)fluoranthene	SVOA	350	U	350	350	U	350	20	U	340	350	U	350	350	U	350
Bis(2-chloro-1-methylethyl)ether	SVOA	350	U	350	350	U	350	16	U	340	350	U	350	350	U	350
Bis(2-Chloroethoxy)methane	SVOA	350	U	350	350	U	350	21	U	340	350	U	350	350	U	350
Bis(2-chloroethyl) ether	SVOA	350	U	350	350	U	350	14	U	340	350	U	350	350	U	350
Bis(2-ethylhexyl) phthalate	SVOA	49	B	350	64	B	350	150	J	340	68	B	350	150	B	350
Butylbenzylphthalate	SVOA	350	U	350	350	U	350	27	U	340	350	U	350	350	U	350
Carbazole	SVOA	350	U	350	350	U	350	21	U	340	350	U	350	350	U	350
Chrysene	SVOA	350	U	350	22	J	350	15	U	340	350	U	350	350	U	350
Dibenz[a,h]anthracene	SVOA	350	U	350	350	U	350	85	U	340	350	U	350	350	U	350
Dibenzofuran	SVOA	350	U	350	350	U	350	23	U	340	350	U	350	350	U	350
Diethylphthalate	SVOA	350	U	350	350	U	350	43	U	340	350	U	350	350	U	350
Dimethyl phthalate	SVOA	350	U	350	350	U	350	21	U	340	350	U	350	350	U	350
Di-n-butylphthalate	SVOA	350	U	350	350	U	350	29	U	340	350	U	350	350	U	350
Di-n-octylphthalate	SVOA	350	U	350	350	U	350	150	U	340	350	U	350	350	U	350
Fluoranthene	SVOA	26	J	350	49	J	350	89	J	340	350	U	350	27	J	350
Fluorene	SVOA	350	U	350	350	U	350	20	U	340	350	U	350	350	U	350
Hexachlorobenzene	SVOA	350	U	350	350	U	350	19	U	340	350	U	350	350	U	350
Hexachlorobutadiene	SVOA	350	U	350	350	U	350	13	U	340	350	U	350	350	U	350
Hexachlorocyclopentadiene	SVOA	350	U	350	350	U	350	74	U	340	350	U	350	350	U	350
Hexachloroethane	SVOA	350	U	350	350	U	350	17	U	340	350	U	350	350	U	350
Indeno(1,2,3-cd)pyrene	SVOA	350	U	350	350	U	350	18	U	340	350	U	350	350	U	350
Isophorone	SVOA	350	U	350	350	U	350	19	U	340	350	U	350	350	U	350
Naphthalene	SVOA	350	U	350	350	U	350	15	U	340	350	U	350	350	U	350
Nitrobenzene	SVOA	350	U	350	350	U	350	19	U	340	350	U	350	350	U	350
N-Nitroso-di-n-dipropylamine	SVOA	350	U	350	350	U	350	21	U	340	350	U	350	350	U	350
N-Nitrosodiphenylamine	SVOA	350	U	350	350	U	350	22	U	340	350	U	350	350	U	350

B = The constituent was detected in the laboratory blank sample.
J = The constituent was detected and value estimated below the associated PQL value.
PQL = practical quantitation limit
Q = qualifier
SVOA = semivolatile organic analyses
U = The constituent was not detected. The associated value is the analytical method PQL.

Table A-5. 117-DR Deep Zone Organics Cleanup Verification Data, August 8, 2003. (3 Pages)

Sample Location		J00WJ4			J00WJ8			J00WK0			J00WJ5			J00WJ6		
		Sample Area A1			Duplicate of J00WJ4			Split of J00WJ4			Sample Area A2			Sample Area A3		
Constituent	Class	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
Pentachlorophenol	SVOA	870	U	870	870	U	870	120	U	1700	870	U	870	860	U	860
Phenanthrene	SVOA	350	U	350	18	J	350	17	U	340	350	U	350	350	U	350
Phenol	SVOA	350	U	350	350	U	350	91	U	340	350	U	350	350	U	350
Pyrene	SVOA	26	J	350	51	J	350	85	J	340	350	U	350	24	J	350

J = The constituent was detected and value estimated below the associated PQL value.
PQL = practical quantitation limit
Q = qualifier
SVOA = semivolatile organic analyses
U = The constituent was not detected. The associated value is the analytical method PQL.

APPENDIX B

DATA QUALITY ASSESSMENT

B1.0 DATA QUALITY ASSESSMENT FOR THE 117-DR 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 the project objectives and performance specifications. The DQA involves the 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 [EPA 2000]). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives (DQO) process.

This DQA was performed in accordance with BHI-EE-01, *Environmental Investigations Procedures.* Specific DQOs for the site are found in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001) and the *Data Quality Objectives Summary Report for 100/300 Area Remaining Sites Analytical Sampling Effort* (DQO Summary Report) (BHI 2003). The DQA is based on the guidelines presented in *Guidance for Data Quality Assessment* (EPA 2000). Statistical tests used in this DQA were performed as specified in the SAP and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2002).

Prior to performing statistical tests, all of the analytical data are evaluated and a portion are validated for compliance with quality assurance (QA) project plan requirements (DOE-RL 2001, BHI 2003). Data evaluation is performed to determine if the laboratory carried out all steps required by the SAP, DQO Summary Report, and the laboratory contract governing the conduct of analysis and reporting of the data. This evaluation also examines the available laboratory data to determine if an analyte is present or absent in a sample, and the degree of overall uncertainty associated with that determination. Data validation is done in accordance with validation procedures (BHI 2000a, 2000b) as part of data evaluation. After data evaluation and validation, the appropriate statistical test is performed on the adjusted raw analytical data (see the 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. In addition to the waste verification samples, data from four discrete samples collected for the *Resource Conservation and Recovery Act of 1976* treatment, storage, and disposal unit (122-DR-1) closure were also validated. These samples include Hanford Environmental Information System numbers J00WM1, J00WM2, J00WM3, J00WM4, J00WM5, and J00WM6 that are contained in data package H2316 (Tech Law 2003).

The DQA for the 117-DR facilities 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 to be 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 Hanford Environmental Information System and are summarized in Appendix A.

The following subsections describe the DQA results for the 117-DR facilities 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 DATA VALIDATION

B1.2.1 Laboratory QA/QC 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]) is added to a separate aliquot of a sample from the analytical batch. The recovery percentage of the added MS is used to evaluate analytical accuracy. For analyses not amenable to MS techniques (e.g., gamma energy analysis) or where analytical recovery is corrected via internal standards (e.g., alpha spectral analyses), accuracy is evaluated from recovery of the QC reference sample (e.g., laboratory control spike or blank spike sample).

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

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

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 Environmental Restoration Contractor QA group to ensure that the laboratories are performing to meet laboratory contract requirements.

B1.2.2 Data Validation Results

After sampling was completed, all of the fixed-base laboratory data from one SDG, H2316, were validated to Level C per BHI-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). Validation was performed by Tech Law, Inc. (Tech Law 2003). 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
- MS/matrix spike duplicate results
- Sample replicates
- Associated batch laboratory control sample results
- Data package completeness
- Achievement of target (or contractual) required detection limits (RDLs).

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 practical quantitation limit (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 to be accurate within the standard errors associated with the methods.

The adequacy of laboratory QA/QC was evaluated for precision, accuracy, completeness, and the specified detection limits pursuant to the SAP (DOE-RL 2001) and DQO Summary Report (BHI 2003). The organization performing the data validation reported that, of the data given formal validation, the laboratory met the standards for performance for accuracy (±30%) and completeness (>90%).

A summary of deficiencies noted during validation follows.

Radionuclides. There were no radionuclides included in the validated data package.

Nonradionuclides. No major deficiencies were noted for nonradionuclides.

Minor deficiencies noted during validation include the following: due to laboratory blank contamination, the sodium result in sample J00WM6 was qualified as undetected and flagged as "U."

B1.3 DATA EVALUATION

The formal data validation described in the previous section included evaluation of only one SDG; however, DQA is required for all SDGs. Therefore, supplementary data evaluation was performed on the remaining SDGs (H2309 and W04100). The following paragraphs include the results of the data evaluation of all SDGs.

To ensure adequate data quality, DQA investigators reviewed the study objectives in the SAP (DOE-RL 2001) and DQO Summary Report (BHI 2003) to determine the context for assessing the data. The context for assessing the data includes evaluating the sample data using the statistical methodology of the SAP (included in the calculation brief excerpts in Appendix C) and a comparison of analytical results to the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters as specified in the SAP and DQO Summary Report. This section summarizes the results of the PARCC parameter comparison and presents an evaluation of the affected data.

Detection Limit Comparison: Reported analytical detection levels for nondetected analytes were compared to the specified detection limits in the SAP (DOE-RL 2001). When detected results are obtained, evaluation of detection limits is not performed. The data validation and supplemental data evaluation noted any analyses in which the detection limit (MDA or PQL) was above the specified detection limits for nondetected analytes.

Reported radionuclide analytical detection levels for undetected analytes are compared against the SAP-specified detection limits to ensure that laboratory detection levels meet the required criteria.

For the nonradionuclides, the PQLs in nearly all of the semivolatile organic compound (SVOC) analyses exceeded the specified detection limits of 330 µg/kg. The RDLs are based on generic conditions where analysis would be performed on 100% solids (0% moisture). The laboratory is required to report results on a dry weight basis, and samples containing moisture (e.g., soil samples) could result in slightly elevated detection limits. The nondetect result values, although higher than the contractual detection limit goals, are within a range that indicate that the laboratory methodologies are close to optimal. Although these samples did not meet the specified SVOC detection limits "as reported" (dry weight basis), the actual "as received" (soil containing moisture) detection limits met the RDL. The information presented above indicates that the data are suitable for making cleanup decisions.

All laboratory reported detection levels for metals and radionuclides meet the required detection limits specified in the SAP.

Precision and Accuracy Evaluation: Analytical accuracy and precision were evaluated by examination of the percent recovery and RPD between the main and duplicate samples. Only the contaminants of concern (COCs) detected at five times the detection limit (or greater) are used for data analysis with respect to accuracy and precision. All precision and accuracy parameters met acceptance criteria except for uranium-238 in sample J00WJ9. The RPD for this sample (30.2%) was slightly above the QC limit.

Difficulty in producing truly homogeneous soil mixtures containing actinide contamination is well known. Actinides are typically present as alpha-emitting particles that have a natural tendency to accumulate in discrete portions of the matrix. Even distribution of the contaminants throughout the matrix is not likely to occur in nature and is difficult to achieve in prepared standard materials. The possibility of getting an actinide hot spot in a subfraction of a sample is significant, even in prepared standard materials. The RPDs for actinides in the duplicate samples are most likely due to sample heterogeneity. Based on guidance from Environmental Restoration Contractor radiochemists, this does not affect the usefulness of the data. In addition, the reported values are sufficiently below Hanford Site background for uranium-238 and the remedial action goals (RAGs) so as not to compromise the usability of the associated cleanup verification data (DOE-RL 2001).

Other Evaluations: Barium, total chromium, lithium, and sodium were detected in laboratory blank samples. Possible causes and usability of the data is discussed in Section B1.4.

RAGs for lithium and sodium have not been established; however, all results were consistent with background values.

B1.4 FIELD QA/QC

Field QA/QC measures were used to assess potential sources of error and cross-contamination of soil samples that could bias results. Field QA/QC samples included two field duplicate samples, one each for the shallow and deep zone (samples J00WJ7 and J00WJ8, shallow and deep zones, respectively), which were duplicates of samples J00WJ0 and J00WJ4, shallow and deep zones, respectively; and two field split samples, one each for the shallow and deep zone (samples J00WJ9 and J00WK0, shallow and deep zones, respectively), which were splits of samples J00WJ0 and J00WJ4, shallow and deep zones, respectively. The main and QA/QC sample results are presented in Appendix A.

B1.4.1 Equipment Blank Samples

One equipment blank sample (J00WM6) was collected as part of the QA/QC measures. Sodium was detected in the equipment blank sample (9.6 mg/kg). Although a specific RAG has not been established for sodium, the reported value is sufficiently below background so as not to compromise the usability of the associated cleanup verification data (DOE-RL 2001).

B1.4.2 Field Duplicate Samples

Duplicate samples were collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicate is evaluated by computing the RPD of the duplicate samples for each COC. Only analytes with values above five times the detection limits for both the main and duplicate samples are compared.

The RPDs for the following shallow zone constituents were outside QC limits for precision (±30%): cesium-137 (71%) and cadmium (92%). The high RPDs are likely due to sample heterogeneity. Since both the main and the field duplicate samples are sufficiently below the cleanup criteria, the RPD results do not affect the usability of the data for decision-making purposes.

B1.4.3 Field Split Samples

A split sample was collected to provide a relative measure of the degree of variability in the sampling, sample handling, and analytical techniques used by commercial laboratories. The field main and split samples are evaluated by computing the RPD of the split samples for each COC to determine the usability of the verification data. The U.S. Environmental Protection Agency Contract Laboratory Program duplicate sample comparison methodology, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 1994), is used as an initial test of the data from the splits. Only analytes that had values above five times the specified detection limit or contract required detection limit for both the main and split sample were compared.

The RPDs for the following constituents were outside QC limits for precision (±30%): uranium-233/234 (33%) and uranium-238 (34%) in the shallow zone, and lithium (49%) in the deep zone. The high RPDs are likely due to sample heterogeneity. Since both the main and the field duplicate samples are sufficiently below the cleanup criteria, the RPD results do not affect the usability of the data for decision-making purposes.

B1.5 SUITABILITY OF DATA

Variance analysis (Appendix C) indicates that the number of samples taken is sufficient for site verification. The use of statistical values described in Section 5.0 is used to compensate for COC variance at the site and ensure that decisions are made within acceptable error tolerance. As all values were below the RAGs by a larger amount than the potential heterogeneity in the samples, the usability of the data is not affected.

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 to be 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 SHALLOW ZONE RADIONUCLIDES

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Summary : 117-DR Cleanup Verification - Shallow Zone File: 117dr_s.rad

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

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Am-241	4.440E-01	4.440E-01	DCF2(2)
B-1	C-14	2.090E-06	2.090E-06	DCF2(3)
B-1	Co-60	2.190E-04	2.190E-04	DCF2(4)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(5)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(6)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(8)
B-1	Eu-155	4.140E-05	4.140E-05	DCF2(9)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(10)
B-1	Ni-63	6.290E-06	6.290E-06	DCF2(11)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(12)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(13)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(14)
B-1	Pu-238	3.920E-01	3.920E-01	DCF2(15)
B-1	Pu-239	4.290E-01	4.290E-01	DCF2(16)
B-1	Pu-240	4.290E-01	4.290E-01	DCF2(17)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(18)
B-1	Ra-228+D	5.080E-03	5.080E-03	DCF2(19)
B-1	Th-228+D	3.450E-01	3.450E-01	DCF2(20)
B-1	Th-229+D	2.160E+00	2.160E+00	DCF2(21)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(22)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(23)
B-1	U-233	1.350E-01	1.350E-01	DCF2(24)
B-1	U-234	1.320E-01	1.320E-01	DCF2(25)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(26)
B-1	U-236	1.250E-01	1.250E-01	DCF2(27)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Am-241	3.640E-03	3.640E-03	DCF3(2)
D-1	C-14	2.090E-06	2.090E-06	DCF3(3)
D-1	Co-60	2.690E-05	2.690E-05	DCF3(4)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(5)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(6)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(8)
D-1	Eu-155	1.530E-06	1.530E-06	DCF3(9)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(10)
D-1	Ni-63	5.770E-07	5.770E-07	DCF3(11)
D-1	Np-237+D	4.440E-03	4.440E-03	DCF3(12)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(13)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(14)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(15)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(16)
D-1	Pu-240	3.540E-03	3.540E-03	DCF3(17)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(18)
D-1	Ra-228+D	1.440E-03	1.440E-03	DCF3(19)
D-1	Th-228+D	8.080E-04	8.080E-04	DCF3(20)
D-1	Th-229+D	4.030E-03	4.030E-03	DCF3(21)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(22)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(23)

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Summary : 117-DR Cleanup Verification - Shallow Zone File: 117dr_s.rad

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

0 Menu	Parameter	Current Value	Default	Parameter Name
D-1	U-233	2.890E-04	2.890E-04	DCF3(24)
D-1	U-234	2.830E-04	2.830E-04	DCF3(25)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(26)
D-1	U-236	2.690E-04	2.690E-04	DCF3(27)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(2,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(2,3)
D-34				
D-34	C-14 , plant/soil concentration ratio, dimensionless	5.500E+00	5.500E+00	RTF(3,1)
D-34	C-14 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.100E-02	3.100E-02	RTF(3,2)
D-34	C-14 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.200E-02	1.200E-02	RTF(3,3)
D-34				
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(4,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(4,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(5,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(5,3)
D-34				
D-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(6,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(6,3)
D-34				
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(8,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(8,3)
D-34				
D-34	Eu-155 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	Eu-155 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(9,2)
D-34	Eu-155 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(9,3)
D-34				
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(10,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(10,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(10,3)
D-34				
D-34	Ni-63 , plant/soil concentration ratio, dimensionless	5.000E-02	5.000E-02	RTF(11,1)
D-34	Ni-63 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(11,2)
D-34	Ni-63 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-02	2.000E-02	RTF(11,3)
D-34				
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(12,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(12,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(12,3)
D-34				

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

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(13,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(13,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(13,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(14,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(14,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(14,3)
D-34				
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(15,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(15,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(15,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(16,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(16,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(16,3)
D-34				
D-34	Pu-240 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(17,1)
D-34	Pu-240 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(17,2)
D-34	Pu-240 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(17,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(18,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(18,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(18,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(19,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(19,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(19,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(20,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(20,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(20,3)
D-34				
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(21,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(21,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(21,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(22,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(22,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(22,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(23,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(23,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(23,3)
D-34				
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(24,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(24,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(24,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(25,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(25,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(25,3)

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

Menu	Parameter	Current Value	Default	Parameter Name
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(26,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(26,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(26,3)
D-34				
D-34	U-236 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(27,1)
D-34	U-236 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(27,2)
D-34	U-236 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(27,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Am-241 , fish	3.000E+01	3.000E+01	BIOFAC(2,1)
D-5	Am-241 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5				
D-5	C-14 , fish	5.000E+04	5.000E+04	BIOFAC(3,1)
D-5	C-14 , crustacea and mollusks	9.100E+03	9.100E+03	BIOFAC(3,2)
D-5				
D-5	Co-60 , fish	3.000E+02	3.000E+02	BIOFAC(4,1)
D-5	Co-60 , crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(4,2)
D-5				
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(5,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(5,2)
D-5				
D-5	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(6,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(6,2)
D-5				
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(8,1)
D-5	Eu-154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(8,2)
D-5				
D-5	Eu-155 , fish	5.000E+01	5.000E+01	BIOFAC(9,1)
D-5	Eu-155 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(9,2)
D-5				
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(10,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(10,2)
D-5				
D-5	Ni-63 , fish	1.000E+02	1.000E+02	BIOFAC(11,1)
D-5	Ni-63 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(11,2)
D-5				
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(12,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(12,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(13,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(13,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(14,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(14,2)
D-5				
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(15,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(15,2)
D-5				

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Summary : 117-DR Cleanup Verification - Shallow Zone File: 117dr_s.rad

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

Menu	Parameter	Current Value	Default	Parameter Name
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(16,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(16,2)
D-5				
D-5	Pu-240 , fish	3.000E+01	3.000E+01	BIOFAC(17,1)
D-5	Pu-240 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(17,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(18,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(18,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(19,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(19,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(20,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(20,2)
D-5				
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(21,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(21,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(22,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(22,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(23,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(23,2)
D-5				
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(24,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(24,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(25,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(25,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(26,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(26,2)
D-5				
D-5	U-236 , fish	1.000E+01	1.000E+01	BIOFAC(27,1)
D-5	U-236 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(27,2)

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Summary : 117-DR Cleanup Verification - Shallow Zone File: 117dr_s.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)	4.750E+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)	5.200E+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)	7.200E+00	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.500E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	4.200E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.380E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	3.000E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+03	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Am-241	3.310E-02	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): C-14	9.270E-01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Co-60	1.460E-02	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Cs-137	5.180E-02	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Eu-152	3.260E-02	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): Eu-154	4.720E-02	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g): Eu-155	4.270E-02	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): Ni-63	1.080E+00	0.000E+00	---	S1(11)
R012	Initial principal radionuclide (pCi/g): Pu-238	2.400E-02	0.000E+00	---	S1(15)
R012	Initial principal radionuclide (pCi/g): Pu-239	1.980E-02	0.000E+00	---	S1(16)
R012	Initial principal radionuclide (pCi/g): Pu-240	4.730E-03	0.000E+00	---	S1(17)
R012	Concentration in groundwater (pCi/L): Am-241	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): C-14	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Co-60	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Eu-152	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): Eu-154	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): Eu-155	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): Ni-63	not used	0.000E+00	---	W1(11)
R012	Concentration in groundwater (pCi/L): Pu-238	not used	0.000E+00	---	W1(15)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(16)
R012	Concentration in groundwater (pCi/L): Pu-240	not used	0.000E+00	---	W1(17)
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)	1.000E-03	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)	not used	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

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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
R015	Unsat. zone 1, thickness (m)	1.990E+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 Am-241				
R016	Contaminated zone (cm**3/g)	2.000E+02	2.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	2.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	2.000E+02	2.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for C-14				
R016	Contaminated zone (cm**3/g)	2.000E+02	0.000E+00	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	0.000E+00	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	2.000E+02	0.000E+00	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.166E-04	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.166E-04	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for Eu-155				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for Ni-63				
R016	Contaminated zone (cm**3/g)	3.000E+01	1.000E+03	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+01	1.000E+03	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	3.000E+01	1.000E+03	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.605E-04	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCC(15)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCU(15,1)
R016	Saturated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCS(15)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(15)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(15)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCC(16)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCU(16,1)
R016	Saturated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCS(16)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(16)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(16)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Pu-240				
R016	Contaminated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCC(17)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCU(17,1)
R016	Saturated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCS(17)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(17)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(17)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.397E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.316E-05	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCC(12)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCU(12,1)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCS(12)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.216E-05	ALEACH(12)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(12)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(13)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(13,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(13)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.166E-04	ALEACH(13)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(13)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	3.000E+01	1.000E+02	---	DCNUCC(14)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+01	1.000E+02	---	DCNUCU(14,1)
R016	Saturated zone (cm**3/g)	3.000E+01	1.000E+02	---	DCNUCS(14)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.605E-04	ALEACH(14)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(14)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	2.000E+02	7.000E+01	---	DCNUCC(18)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	7.000E+01	---	DCNUCU(18,1)
R016	Saturated zone (cm**3/g)	2.000E+02	7.000E+01	---	DCNUCS(18)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(18)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(18)

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	2.000E+02	7.000E+01	---	DCNUCC(19)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	7.000E+01	---	DCNUCU(19,1)
R016	Saturated zone (cm**3/g)	2.000E+02	7.000E+01	---	DCNUCS(19)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(19)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(19)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCC(20)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCU(20,1)
R016	Saturated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCS(20)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(20)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(20)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCC(21)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCU(21,1)
R016	Saturated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCS(21)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(21)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(21)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCC(22)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCU(22,1)
R016	Saturated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCS(22)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(22)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(22)
R016	Distribution coefficients for daughter Th-232				
R016	Contaminated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCC(23)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCU(23,1)
R016	Saturated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCS(23)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(23)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(23)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCC(24)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCU(24,1)
R016	Saturated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCS(24)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.119E-03	ALEACH(24)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(24)
R016	Distribution coefficients for daughter U-234				
R016	Contaminated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCC(25)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCU(25,1)
R016	Saturated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCS(25)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.119E-03	ALEACH(25)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(25)

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCC(26)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCU(26,1)
R016	Saturated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCS(26)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.119E-03	ALEACH(26)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(26)
R016	Distribution coefficients for daughter U-236				
R016	Contaminated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCC(27)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCU(27,1)
R016	Saturated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCS(27)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.119E-03	ALEACH(27)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(27)
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)
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)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.237E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.237E+00	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)
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)	2.000E-05	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	3.000E-02	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	2.000E-02	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	9.800E-01	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	3.000E-01	3.000E-01	---	DMC

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	C-14 evasion flux rate from soil (1/sec)	7.000E-07	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	1.000E-10	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	8.000E-01	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	2.000E-01	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	8.894E+01	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	---	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)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	1	---	---	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

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Contaminated Zone Dimensions	
Area:	4750.00 square meters
Thickness:	4.60 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
Am-241	3.310E-02
C-14	9.270E-01
Co-60	1.460E-02
Cs-137	5.180E-02
Eu-152	3.260E-02
Eu-154	4.720E-02
Eu-155	4.270E-02
Ni-63	1.080E+00
Pu-238	2.400E-02
Pu-239	1.980E-02
Pu-240	4.730E-03

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
TDOSE(t):	1.204E+00	7.480E-01	5.469E-01	4.145E-01	2.713E-01	1.021E-01	3.139E-02	2.069E-02	1.242E-02
M(t):	8.025E-02	4.987E-02	3.646E-02	2.763E-02	1.808E-02	6.809E-03	2.093E-03	1.380E-03	8.282E-04

0Maximum TDOSE(t): 1.204E+00 mrem/yr at t = 0.000E+00 years

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Summary : 117-DR Cleanup Verification - Shallow Zone File: 117dr_s.rad

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	9.376E-04	0.0008	5.488E-04	0.0005	0.000E+00	0.0000	6.788E-03	0.0056	2.924E-05	0.0000	3.175E-06	0.0000	7.030E-03	0.0058
C-14	4.311E-06	0.0000	1.147E-04	0.0001	0.000E+00	0.0000	4.543E-01	0.3774	4.932E-02	0.0410	3.767E-02	0.0313	5.989E-05	0.0000
Co-60	1.395E-01	0.1159	1.120E-07	0.0000	0.000E+00	0.0000	1.659E-03	0.0014	3.738E-04	0.0003	8.565E-05	0.0001	2.149E-05	0.0000
Cs-137	1.092E-01	0.0907	6.105E-08	0.0000	0.000E+00	0.0000	5.770E-03	0.0048	2.115E-03	0.0018	1.313E-03	0.0011	1.495E-04	0.0001
Eu-152	1.400E-01	0.1163	2.624E-07	0.0000	0.000E+00	0.0000	2.901E-05	0.0000	2.359E-06	0.0000	6.235E-08	0.0000	1.202E-05	0.0000
Eu-154	2.195E-01	0.1824	4.852E-07	0.0000	0.000E+00	0.0000	6.108E-05	0.0001	4.968E-06	0.0000	1.313E-07	0.0000	2.531E-05	0.0000
Eu-155	4.683E-03	0.0039	6.166E-08	0.0000	0.000E+00	0.0000	8.592E-06	0.0000	6.988E-07	0.0000	1.847E-08	0.0000	3.561E-06	0.0000
Ni-63	0.000E+00	0.0000	2.529E-07	0.0000	0.000E+00	0.0000	1.749E-03	0.0015	1.035E-04	0.0001	9.585E-04	0.0008	3.625E-05	0.0000
Pu-238	2.417E-06	0.0000	3.502E-04	0.0003	0.000E+00	0.0000	4.314E-03	0.0036	3.716E-05	0.0000	1.009E-06	0.0000	4.467E-03	0.0037
Pu-239	3.768E-06	0.0000	3.175E-04	0.0003	0.000E+00	0.0000	3.952E-03	0.0033	3.405E-05	0.0000	9.242E-07	0.0000	4.093E-03	0.0034
Pu-240	4.646E-07	0.0000	7.584E-05	0.0001	0.000E+00	0.0000	9.441E-04	0.0008	8.134E-06	0.0000	2.208E-07	0.0000	9.778E-04	0.0008
Total	6.139E-01	0.5099	1.408E-03	0.0012	0.000E+00	0.0000	4.796E-01	0.3984	5.203E-02	0.0432	4.003E-02	0.0333	1.688E-02	0.0140

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.534E-02	0.0127
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.415E-01	0.4498
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.416E-01	0.1176
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.185E-01	0.0984
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.401E-01	0.1164
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.196E-01	0.1825
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.696E-03	0.0039
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.848E-03	0.0024
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.172E-03	0.0076
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.402E-03	0.0070
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.007E-03	0.0017
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.204E+00	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	9.361E-04	0.0013	5.479E-04	0.0007	0.000E+00	0.0000	6.777E-03	0.0091	2.920E-05	0.0000	3.169E-06	0.0000	7.019E-03	0.0094
C-14	1.018E-06	0.0000	2.709E-05	0.0000	0.000E+00	0.0000	1.088E-01	0.1454	1.235E-02	0.0165	9.279E-03	0.0124	1.414E-05	0.0000
Co-60	1.223E-01	0.1634	9.815E-08	0.0000	0.000E+00	0.0000	1.454E-03	0.0019	3.277E-04	0.0004	7.508E-05	0.0001	1.884E-05	0.0000
Cs-137	1.066E-01	0.1426	5.964E-08	0.0000	0.000E+00	0.0000	5.637E-03	0.0075	2.066E-03	0.0028	1.283E-03	0.0017	1.461E-04	0.0002
Eu-152	1.329E-01	0.1777	2.491E-07	0.0000	0.000E+00	0.0000	2.754E-05	0.0000	2.240E-06	0.0000	5.919E-08	0.0000	1.141E-05	0.0000
Eu-154	2.029E-01	0.2713	4.484E-07	0.0000	0.000E+00	0.0000	5.645E-05	0.0001	4.591E-06	0.0000	1.213E-07	0.0000	2.340E-05	0.0000
Eu-155	4.072E-03	0.0054	5.362E-08	0.0000	0.000E+00	0.0000	7.471E-06	0.0000	6.076E-07	0.0000	1.606E-08	0.0000	3.096E-06	0.0000
Ni-63	0.000E+00	0.0000	2.510E-07	0.0000	0.000E+00	0.0000	1.736E-03	0.0023	1.027E-04	0.0001	9.512E-04	0.0013	3.598E-05	0.0000
Pu-238	2.398E-06	0.0000	3.475E-04	0.0005	0.000E+00	0.0000	4.279E-03	0.0057	3.687E-05	0.0000	1.001E-06	0.0000	4.432E-03	0.0059
Pu-239	3.768E-06	0.0000	3.174E-04	0.0004	0.000E+00	0.0000	3.952E-03	0.0053	3.405E-05	0.0000	9.241E-07	0.0000	4.093E-03	0.0055
Pu-240	4.646E-07	0.0000	7.582E-05	0.0001	0.000E+00	0.0000	9.440E-04	0.0013	8.133E-06	0.0000	2.207E-07	0.0000	9.776E-04	0.0013
Total	5.698E-01	0.7617	1.317E-03	0.0018	0.000E+00	0.0000	1.336E-01	0.1786	1.496E-02	0.0200	1.159E-02	0.0155	1.677E-02	0.0224

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.531E-02	0.0205
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.304E-01	0.1744
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.241E-01	0.1659
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.158E-01	0.1548
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.330E-01	0.1778
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.030E-01	0.2714
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.083E-03	0.0055
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.826E-03	0.0038
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.099E-03	0.0122
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.401E-03	0.0112
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.006E-03	0.0027
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.480E-01	1.0000

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	9.330E-04	0.0017	5.461E-04	0.0010	0.000E+00	0.0000	6.755E-03	0.0124	2.910E-05	0.0001	3.159E-06	0.0000	6.996E-03	0.0128
C-14	5.666E-08	0.0000	1.508E-06	0.0000	0.000E+00	0.0000	6.053E-03	0.0111	6.872E-04	0.0013	5.165E-04	0.0009	7.872E-07	0.0000
Co-60	9.394E-02	0.1718	7.542E-08	0.0000	0.000E+00	0.0000	1.117E-03	0.0020	2.518E-04	0.0005	5.769E-05	0.0001	1.447E-05	0.0000
Cs-137	1.018E-01	0.1861	5.692E-08	0.0000	0.000E+00	0.0000	5.381E-03	0.0098	1.972E-03	0.0036	1.225E-03	0.0022	1.394E-04	0.0003
Eu-152	1.198E-01	0.2191	2.245E-07	0.0000	0.000E+00	0.0000	2.481E-05	0.0000	2.018E-06	0.0000	5.334E-08	0.0000	1.028E-05	0.0000
Eu-154	1.733E-01	0.3169	3.830E-07	0.0000	0.000E+00	0.0000	4.822E-05	0.0001	3.922E-06	0.0000	1.036E-07	0.0000	1.998E-05	0.0000
Eu-155	3.079E-03	0.0056	4.054E-08	0.0000	0.000E+00	0.0000	5.648E-06	0.0000	4.594E-07	0.0000	1.214E-08	0.0000	2.341E-06	0.0000
Ni-63	0.000E+00	0.0000	2.473E-07	0.0000	0.000E+00	0.0000	1.710E-03	0.0031	1.012E-04	0.0002	9.369E-04	0.0017	3.544E-05	0.0001
Pu-238	2.360E-06	0.0000	3.420E-04	0.0006	0.000E+00	0.0000	4.212E-03	0.0077	3.629E-05	0.0001	9.854E-07	0.0000	4.362E-03	0.0080
Pu-239	3.768E-06	0.0000	3.174E-04	0.0006	0.000E+00	0.0000	3.951E-03	0.0072	3.404E-05	0.0001	9.239E-07	0.0000	4.092E-03	0.0075
Pu-240	4.644E-07	0.0000	7.580E-05	0.0001	0.000E+00	0.0000	9.437E-04	0.0017	8.130E-06	0.0000	2.207E-07	0.0000	9.773E-04	0.0018
Total	4.929E-01	0.9013	1.284E-03	0.0023	0.000E+00	0.0000	3.020E-02	0.0552	3.126E-03	0.0057	2.741E-03	0.0050	1.665E-02	0.0304

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.526E-02	0.0279
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.259E-03	0.0133
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.539E-02	0.1744
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.105E-01	0.2021
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.198E-01	0.2191
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.734E-01	0.3171
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.087E-03	0.0056
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.784E-03	0.0051
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.955E-03	0.0164
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.400E-03	0.0154
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.006E-03	0.0037
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.469E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 7.200E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	9.265E-04	0.0022	5.423E-04	0.0013	0.000E+00	0.0000	6.708E-03	0.0162	2.890E-05	0.0001	3.137E-06	0.0000	6.947E-03	0.0168
C-14	1.304E-10	0.0000	3.470E-09	0.0000	0.000E+00	0.0000	1.393E-05	0.0000	1.582E-06	0.0000	1.189E-06	0.0000	1.812E-09	0.0000
Co-60	5.403E-02	0.1303	4.337E-08	0.0000	0.000E+00	0.0000	6.426E-04	0.0016	1.448E-04	0.0003	3.318E-05	0.0001	8.324E-06	0.0000
Cs-137	9.229E-02	0.2226	5.161E-08	0.0000	0.000E+00	0.0000	4.878E-03	0.0118	1.788E-03	0.0043	1.110E-03	0.0027	1.264E-04	0.0003
Eu-152	9.627E-02	0.2322	1.804E-07	0.0000	0.000E+00	0.0000	1.994E-05	0.0000	1.622E-06	0.0000	4.286E-08	0.0000	8.264E-06	0.0000
Eu-154	1.245E-01	0.3003	2.751E-07	0.0000	0.000E+00	0.0000	3.463E-05	0.0001	2.816E-06	0.0000	7.443E-08	0.0000	1.435E-05	0.0000
Eu-155	1.711E-03	0.0041	2.254E-08	0.0000	0.000E+00	0.0000	3.140E-06	0.0000	2.554E-07	0.0000	6.749E-09	0.0000	1.301E-06	0.0000
Ni-63	0.000E+00	0.0000	2.395E-07	0.0000	0.000E+00	0.0000	1.656E-03	0.0040	9.802E-05	0.0002	9.075E-04	0.0022	3.433E-05	0.0001
Pu-238	2.283E-06	0.0000	3.307E-04	0.0008	0.000E+00	0.0000	4.073E-03	0.0098	3.510E-05	0.0001	9.538E-07	0.0000	4.219E-03	0.0102
Pu-239	3.766E-06	0.0000	3.173E-04	0.0008	0.000E+00	0.0000	3.950E-03	0.0095	3.403E-05	0.0001	9.236E-07	0.0000	4.091E-03	0.0099
Pu-240	4.641E-07	0.0000	7.575E-05	0.0002	0.000E+00	0.0000	9.430E-04	0.0023	8.125E-06	0.0000	2.205E-07	0.0000	9.767E-04	0.0024
Total	3.697E-01	0.8919	1.267E-03	0.0031	0.000E+00	0.0000	2.292E-02	0.0553	2.143E-03	0.0052	2.058E-03	0.0050	1.643E-02	0.0396

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 7.200E+00 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.516E-02	0.0366
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.671E-05	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.486E-02	0.1323
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.002E-01	0.2417
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.630E-02	0.2323
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.245E-01	0.3004
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.715E-03	0.0041
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.696E-03	0.0065
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.661E-03	0.0209
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.397E-03	0.0203
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.004E-03	0.0048
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.145E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.500E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	9.147E-04	0.0034	5.354E-04	0.0020	0.000E+00	0.0000	6.622E-03	0.0244	2.854E-05	0.0001	3.097E-06	0.0000	6.858E-03	0.0253
C-14	1.597E-15	0.0000	4.250E-14	0.0000	0.000E+00	0.0000	1.707E-10	0.0000	1.940E-11	0.0000	1.458E-11	0.0000	2.219E-14	0.0000
Co-60	1.934E-02	0.0713	1.552E-08	0.0000	0.000E+00	0.0000	2.300E-04	0.0008	5.183E-05	0.0002	1.188E-05	0.0000	2.980E-06	0.0000
Cs-137	7.694E-02	0.2836	4.303E-08	0.0000	0.000E+00	0.0000	4.067E-03	0.0150	1.490E-03	0.0055	9.257E-04	0.0034	1.054E-04	0.0004
Eu-152	6.414E-02	0.2365	1.202E-07	0.0000	0.000E+00	0.0000	1.329E-05	0.0000	1.081E-06	0.0000	2.856E-08	0.0000	5.506E-06	0.0000
Eu-154	6.731E-02	0.2481	1.487E-07	0.0000	0.000E+00	0.0000	1.873E-05	0.0001	1.523E-06	0.0000	4.025E-08	0.0000	7.760E-06	0.0000
Eu-155	5.752E-04	0.0021	7.573E-09	0.0000	0.000E+00	0.0000	1.055E-06	0.0000	8.582E-08	0.0000	2.268E-09	0.0000	4.373E-07	0.0000
Ni-63	0.000E+00	0.0000	2.258E-07	0.0000	0.000E+00	0.0000	1.561E-03	0.0058	9.239E-05	0.0003	8.554E-04	0.0032	3.236E-05	0.0001
Pu-238	2.146E-06	0.0000	3.108E-04	0.0011	0.000E+00	0.0000	3.828E-03	0.0141	3.298E-05	0.0001	8.976E-07	0.0000	3.965E-03	0.0146
Pu-239	3.764E-06	0.0000	3.171E-04	0.0012	0.000E+00	0.0000	3.947E-03	0.0146	3.401E-05	0.0001	9.230E-07	0.0000	4.088E-03	0.0151
Pu-240	4.635E-07	0.0000	7.565E-05	0.0003	0.000E+00	0.0000	9.418E-04	0.0035	8.115E-06	0.0000	2.202E-07	0.0000	9.754E-04	0.0036
Total	2.292E-01	0.8450	1.239E-03	0.0046	0.000E+00	0.0000	2.123E-02	0.0783	1.741E-03	0.0064	1.798E-03	0.0066	1.604E-02	0.0591

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.500E+01 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.496E-02	0.0552
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.047E-10	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.963E-02	0.0724
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.353E-02	0.3079
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.416E-02	0.2365
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.733E-02	0.2482
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.768E-04	0.0021
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.542E-03	0.0094
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.140E-03	0.0300
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.391E-03	0.0309
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.002E-03	0.0074
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.713E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 4.200E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	8.748E-04	0.0086	5.119E-04	0.0050	0.000E+00	0.0000	6.334E-03	0.0620	2.731E-05	0.0003	2.961E-06	0.0000	6.558E-03	0.0642
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.259E-27	0.0000	1.434E-28	0.0000	1.076E-28	0.0000	0.000E+00	0.0000
Co-60	5.519E-04	0.0054	4.431E-10	0.0000	0.000E+00	0.0000	6.565E-06	0.0001	1.479E-06	0.0000	3.390E-07	0.0000	8.504E-08	0.0000
Cs-137	4.099E-02	0.4013	2.292E-08	0.0000	0.000E+00	0.0000	2.167E-03	0.0212	7.940E-04	0.0078	4.932E-04	0.0048	5.614E-05	0.0005
Eu-152	1.573E-02	0.1540	2.948E-08	0.0000	0.000E+00	0.0000	3.259E-06	0.0000	2.650E-07	0.0000	7.004E-09	0.0000	1.350E-06	0.0000
Eu-154	8.013E-03	0.0785	1.791E-08	0.0000	0.000E+00	0.0000	2.229E-06	0.0000	1.813E-07	0.0000	4.792E-09	0.0000	9.239E-07	0.0000
Eu-155	1.320E-05	0.0001	1.738E-10	0.0000	0.000E+00	0.0000	2.421E-08	0.0000	1.969E-09	0.0000	5.205E-11	0.0000	1.003E-08	0.0000
Ni-63	0.000E+00	0.0000	1.840E-07	0.0000	0.000E+00	0.0000	1.272E-03	0.0125	7.529E-05	0.0007	6.971E-04	0.0068	2.637E-05	0.0003
Pu-238	1.731E-06	0.0000	2.508E-04	0.0025	0.000E+00	0.0000	3.089E-03	0.0302	2.661E-05	0.0003	7.278E-07	0.0000	3.199E-03	0.0313
Pu-239	3.756E-06	0.0000	3.164E-04	0.0031	0.000E+00	0.0000	3.938E-03	0.0386	3.393E-05	0.0003	9.210E-07	0.0000	4.079E-03	0.0399
Pu-240	4.615E-07	0.0000	7.533E-05	0.0007	0.000E+00	0.0000	9.378E-04	0.0092	8.080E-06	0.0001	2.193E-07	0.0000	9.712E-04	0.0095
Total	6.618E-02	0.6479	1.155E-03	0.0113	0.000E+00	0.0000	1.775E-02	0.1738	9.672E-04	0.0095	1.195E-03	0.0117	1.489E-02	0.1458

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 4.200E+01 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.431E-02	0.1401
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.510E-27	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.604E-04	0.0055
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.450E-02	0.4357
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.574E-02	0.1541
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.017E-03	0.0785
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.323E-05	0.0001
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.071E-03	0.0203
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.567E-03	0.0643
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.372E-03	0.0820
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.993E-03	0.0195
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.021E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.380E+02 years
0
Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	7.468E-04	0.0238	4.366E-04	0.0139	0.000E+00	0.0000	5.407E-03	0.1722	2.336E-05	0.0007	2.527E-06	0.0001	5.593E-03	0.1782
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	1.779E-09	0.0000	1.428E-15	0.0000	0.000E+00	0.0000	2.116E-11	0.0000	4.769E-12	0.0000	1.093E-12	0.0000	2.741E-13	0.0000
Cs-137	4.369E-03	0.1392	2.443E-09	0.0000	0.000E+00	0.0000	2.309E-04	0.0074	8.463E-05	0.0027	5.256E-05	0.0017	5.983E-06	0.0002
Eu-152	1.063E-04	0.0034	1.992E-10	0.0000	0.000E+00	0.0000	2.202E-08	0.0000	1.791E-09	0.0000	4.733E-11	0.0000	9.126E-09	0.0000
Eu-154	4.146E-06	0.0001	9.161E-12	0.0000	0.000E+00	0.0000	1.153E-09	0.0000	9.380E-11	0.0000	2.479E-12	0.0000	4.780E-10	0.0000
Eu-155	1.958E-11	0.0000	2.578E-16	0.0000	0.000E+00	0.0000	3.592E-14	0.0000	2.922E-15	0.0000	7.722E-17	0.0000	1.489E-14	0.0000
Ni-63	0.000E+00	0.0000	8.886E-08	0.0000	0.000E+00	0.0000	6.145E-04	0.0196	3.636E-05	0.0012	3.367E-04	0.0107	1.274E-05	0.0004
Pu-238	8.081E-07	0.0000	1.169E-04	0.0037	0.000E+00	0.0000	1.439E-03	0.0459	1.240E-05	0.0004	3.464E-07	0.0000	1.491E-03	0.0475
Pu-239	3.726E-06	0.0001	3.138E-04	0.0100	0.000E+00	0.0000	3.907E-03	0.1245	3.366E-05	0.0011	9.136E-07	0.0000	4.047E-03	0.1289
Pu-240	4.545E-07	0.0000	7.418E-05	0.0024	0.000E+00	0.0000	9.235E-04	0.0294	7.956E-06	0.0003	2.160E-07	0.0000	9.564E-04	0.0305
Total	5.231E-03	0.1666	9.416E-04	0.0300	0.000E+00	0.0000	1.252E-02	0.3989	1.984E-04	0.0063	3.933E-04	0.0125	1.211E-02	0.3856

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.380E+02 years
0
Water Dependent Pathways
0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.221E-02	0.3889
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.807E-09	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.743E-03	0.1511
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.063E-04	0.0034
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.147E-06	0.0001
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.964E-11	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.000E-03	0.0319
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.060E-03	0.0975
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.306E-03	0.2646
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.963E-03	0.0625
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.139E-02	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	5.719E-04	0.0276	3.338E-04	0.0161	0.000E+00	0.0000	4.141E-03	0.2001	1.796E-05	0.0009	1.933E-06	0.0001	4.276E-03	0.2066
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	9.618E-19	0.0000	7.721E-25	0.0000	0.000E+00	0.0000	1.144E-20	0.0000	2.578E-21	0.0000	5.906E-22	0.0000	1.482E-22	0.0000
Cs-137	9.990E-05	0.0048	5.586E-11	0.0000	0.000E+00	0.0000	5.281E-06	0.0003	1.935E-06	0.0001	1.202E-06	0.0001	1.368E-07	0.0000
Eu-152	2.314E-08	0.0000	4.336E-14	0.0000	0.000E+00	0.0000	4.792E-12	0.0000	3.898E-13	0.0000	1.030E-14	0.0000	1.986E-12	0.0000
Eu-154	1.181E-11	0.0000	2.609E-17	0.0000	0.000E+00	0.0000	3.284E-15	0.0000	2.671E-16	0.0000	7.060E-18	0.0000	1.361E-15	0.0000
Eu-155	2.858E-21	0.0000	3.763E-26	0.0000	0.000E+00	0.0000	5.243E-24	0.0000	4.264E-25	0.0000	1.127E-26	0.0000	2.173E-24	0.0000
Ni-63	0.000E+00	0.0000	2.602E-08	0.0000	0.000E+00	0.0000	1.799E-04	0.0087	1.065E-05	0.0005	9.860E-05	0.0048	3.730E-06	0.0002
Pu-238	2.265E-07	0.0000	3.223E-05	0.0016	0.000E+00	0.0000	3.968E-04	0.0192	3.420E-06	0.0002	1.004E-07	0.0000	4.109E-04	0.0199
Pu-239	3.677E-06	0.0002	3.097E-04	0.0150	0.000E+00	0.0000	3.855E-03	0.1863	3.321E-05	0.0016	9.014E-07	0.0000	3.992E-03	0.1929
Pu-240	4.428E-07	0.0000	7.228E-05	0.0035	0.000E+00	0.0000	8.998E-04	0.0435	7.752E-06	0.0004	2.105E-07	0.0000	9.319E-04	0.0450
Total	6.762E-04	0.0327	7.480E-04	0.0361	0.000E+00	0.0000	9.477E-03	0.4580	7.493E-05	0.0036	1.029E-04	0.0050	9.615E-03	0.4646

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.342E-03	0.4514
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.765E-19	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.084E-04	0.0052
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.314E-08	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.181E-11	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.865E-21	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.930E-04	0.0142
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.437E-04	0.0408
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.195E-03	0.3960
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.912E-03	0.0924
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.069E-02	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	1.822E-04	0.0147	1.047E-04	0.0084	0.000E+00	0.0000	1.319E-03	0.1062	5.931E-06	0.0005	6.091E-07	0.0000	1.341E-03	0.1079
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	8.122E-12	0.0000	4.542E-18	0.0000	0.000E+00	0.0000	4.293E-13	0.0000	1.573E-13	0.0000	9.772E-14	0.0000	1.112E-14	0.0000
Eu-152	3.466E-24	0.0000	1.006E-17	0.0000	0.000E+00	0.0000	2.513E-17	0.0000	2.044E-18	0.0000	5.403E-20	0.0000	1.042E-17	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	1.290E-10	0.0000	0.000E+00	0.0000	8.924E-07	0.0001	5.281E-08	0.0000	4.890E-07	0.0000	1.850E-08	0.0000
Pu-238	2.656E-08	0.0000	1.238E-07	0.0000	0.000E+00	0.0000	1.546E-06	0.0001	1.347E-08	0.0000	1.199E-09	0.0000	1.573E-06	0.0001
Pu-239	3.470E-06	0.0003	2.922E-04	0.0235	0.000E+00	0.0000	3.637E-03	0.2928	3.134E-05	0.0025	8.505E-07	0.0001	3.767E-03	0.3032
Pu-240	3.958E-07	0.0000	6.460E-05	0.0052	0.000E+00	0.0000	8.043E-04	0.0647	6.930E-06	0.0006	1.881E-07	0.0000	8.330E-04	0.0670
Total	1.861E-04	0.0150	4.616E-04	0.0372	0.000E+00	0.0000	5.763E-03	0.4639	4.426E-05	0.0036	2.138E-06	0.0002	5.942E-03	0.4783

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	2.234E-08	0.0000	1.427E-10	0.0000	0.000E+00	0.0000	2.470E-09	0.0000	4.606E-11	0.0000	2.345E-10	0.0000	2.953E-03	0.2377
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.817E-12	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.771E-17	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.453E-06	0.0001
Pu-238	2.100E-05	0.0017	1.344E-07	0.0000	0.000E+00	0.0000	2.322E-06	0.0002	4.347E-08	0.0000	2.210E-07	0.0000	2.701E-05	0.0022
Pu-239	3.888E-08	0.0000	2.749E-10	0.0000	0.000E+00	0.0000	4.299E-09	0.0000	8.980E-11	0.0000	3.911E-10	0.0000	7.732E-03	0.6224
Pu-240	2.624E-07	0.0000	1.640E-09	0.0000	0.000E+00	0.0000	2.901E-08	0.0000	5.421E-10	0.0000	2.762E-09	0.0000	1.710E-03	0.1376
Total	2.133E-05	0.0017	1.364E-07	0.0000	0.000E+00	0.0000	2.358E-06	0.0002	4.415E-08	0.0000	2.244E-07	0.0000	1.242E-02	1.0000

*Sum of all water independent and dependent pathways.

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Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0Parent (i)	Product (j)	Branch Fraction*	t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
			DSR(j,t) (mrem/yr)/(pCi/g)								
Am-241	Am-241	1.000E+00	4.634E-01	4.626E-01	4.611E-01	4.579E-01	4.520E-01	4.322E-01	3.686E-01	2.818E-01	8.828E-02
Am-241	Np-237	1.000E+00	9.277E-07	2.876E-06	6.781E-06	1.494E-05	2.993E-05	8.032E-05	2.418E-04	4.608E-04	9.320E-04
Am-241	U-233	1.000E+00	2.305E-14	1.335E-13	6.344E-13	2.882E-12	1.122E-11	7.826E-11	6.707E-10	2.266E-09	7.682E-07
Am-241	Th-229	1.000E+00	9.140E-18	1.326E-16	1.523E-15	1.577E-14	1.263E-13	2.481E-12	7.311E-11	5.789E-10	1.064E-08
Am-241	ãDSR(j)		4.634E-01	4.626E-01	4.611E-01	4.579E-01	4.520E-01	4.323E-01	3.688E-01	2.822E-01	8.921E-02
0C-14	C-14	1.000E+00	5.842E-01	1.407E-01	7.831E-03	1.803E-05	2.209E-10	1.629E-27	0.000E+00	0.000E+00	0.000E+00
0Co-60	Co-60	1.000E+00	9.699E+00	8.502E+00	6.533E+00	3.757E+00	1.345E+00	3.838E-02	1.237E-07	6.689E-17	0.000E+00
0Cs-137	Cs-137	1.000E+00	2.288E+00	2.235E+00	2.133E+00	1.934E+00	1.612E+00	8.591E-01	9.156E-02	2.094E-03	1.702E-10
0Eu-152	Eu-152	7.208E-01	3.097E+00	2.940E+00	2.650E+00	2.129E+00	1.419E+00	3.480E-01	2.351E-03	5.117E-07	7.665E-23
0Eu-152	Eu-152	2.792E-01	1.200E+00	1.139E+00	1.026E+00	8.247E-01	5.495E-01	1.348E-01	9.107E-04	1.982E-07	2.969E-23
Eu-152	Gd-152	2.792E-01	3.792E-17	1.112E-16	2.468E-16	4.894E-16	8.207E-16	1.320E-15	1.479E-15	1.477E-15	1.463E-15
Eu-152	ãDSR(j)		1.200E+00	1.139E+00	1.026E+00	8.247E-01	5.495E-01	1.348E-01	9.107E-04	1.982E-07	1.463E-15
0Eu-154	Eu-154	1.000E+00	4.653E+00	4.301E+00	3.673E+00	2.638E+00	1.427E+00	1.698E-01	8.787E-05	2.502E-10	2.731E-34
0Eu-155	Eu-155	1.000E+00	1.100E-01	9.563E-02	7.230E-02	4.019E-02	1.351E-02	3.099E-04	4.598E-10	6.711E-20	0.000E+00
0Ni-63	Ni-63	1.000E+00	2.637E-03	2.617E-03	2.577E-03	2.497E-03	2.353E-03	1.918E-03	9.262E-04	2.713E-04	1.345E-06
0Pu-238	Pu-238	1.000E+00	3.822E-01	3.791E-01	3.731E-01	3.609E-01	3.392E-01	2.736E-01	1.275E-01	3.515E-02	1.342E-04
Pu-238	U-234	1.000E+00	8.900E-08	2.697E-07	6.250E-07	1.341E-06	2.568E-06	5.909E-06	1.034E-05	7.966E-06	9.876E-04
Pu-238	Th-230	1.000E+00	3.438E-13	2.318E-12	1.196E-11	5.613E-11	2.190E-10	1.462E-09	1.043E-08	2.664E-08	1.857E-07
Pu-238	Ra-226	1.000E+00	4.504E-15	6.895E-14	8.088E-13	8.402E-12	6.670E-11	1.257E-09	3.197E-08	2.024E-07	1.584E-06
Pu-238	Pb-210	1.000E+00	1.891E-17	5.011E-16	1.121E-14	2.321E-13	3.448E-12	1.525E-10	8.427E-09	7.222E-08	1.763E-06
Pu-238	ãDSR(j)		3.822E-01	3.791E-01	3.731E-01	3.609E-01	3.392E-01	2.736E-01	1.275E-01	3.516E-02	1.125E-03
0Pu-239	Pu-239	1.000E+00	4.243E-01	4.243E-01	4.242E-01	4.241E-01	4.238E-01	4.228E-01	4.195E-01	4.139E-01	3.905E-01
Pu-239	U-235	1.000E+00	2.667E-10	7.996E-10	1.857E-09	4.043E-09	7.978E-09	2.043E-08	5.282E-08	8.093E-08	2.214E-06
Pu-239	Pa-231	1.000E+00	2.315E-14	1.701E-13	9.158E-13	4.417E-12	1.770E-11	1.271E-10	1.149E-09	4.216E-09	4.543E-08
Pu-239	Ac-227	1.000E+00	1.493E-16	2.029E-15	2.206E-14	2.167E-13	1.623E-12	2.639E-11	4.686E-10	2.160E-09	8.954E-08
Pu-239	ãDSR(j)		4.243E-01	4.243E-01	4.242E-01	4.241E-01	4.238E-01	4.228E-01	4.195E-01	4.139E-01	3.905E-01
0Pu-240	Pu-240	1.000E+00	4.242E-01	4.242E-01	4.240E-01	4.237E-01	4.232E-01	4.214E-01	4.149E-01	4.043E-01	3.614E-01
Pu-240	U-236	1.000E+00	8.838E-10	2.688E-09	6.276E-09	1.369E-08	2.702E-08	6.916E-08	1.781E-07	2.706E-07	6.297E-05
Pu-240	Th-232	1.000E+00	9.751E-20	6.588E-19	3.415E-18	1.620E-17	6.448E-17	4.616E-16	4.178E-15	1.543E-14	1.794E-13
Pu-240	Ra-228	1.000E+00	4.813E-20	7.292E-19	8.179E-18	7.671E-17	5.111E-16	6.102E-15	7.179E-14	2.827E-13	1.552E-12
Pu-240	Th-228	1.000E+00	3.363E-21	9.432E-20	1.981E-18	3.188E-17	3.039E-16	4.807E-15	6.303E-14	2.538E-13	1.392E-12
Pu-240	ãDSR(j)		4.242E-01	4.242E-01	4.240E-01	4.237E-01	4.232E-01	4.214E-01	4.149E-01	4.043E-01	3.615E-01

*Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ó 0.5 yr) daughters.

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Summary : 117-DR Cleanup Verification - Shallow Zone File: 117dr_s.rad

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

0Nuclide

(i)	t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
Am-241	3.237E+01	3.242E+01	3.253E+01	3.276E+01	3.318E+01	3.470E+01	4.067E+01	5.315E+01	1.681E+02
C-14	2.568E+01	1.066E+02	1.915E+03	8.321E+05	6.792E+10	*4.454E+12	*4.454E+12	*4.454E+12	*4.454E+12
Co-60	1.546E+00	1.764E+00	2.296E+00	3.992E+00	1.115E+01	3.908E+02	1.212E+08	*1.131E+15	*1.131E+15
Cs-137	6.556E+00	6.711E+00	7.032E+00	7.755E+00	9.302E+00	1.746E+01	1.638E+02	7.165E+03	8.812E+10
Eu-152	3.491E+00	3.677E+00	4.081E+00	5.078E+00	7.621E+00	3.107E+01	4.598E+03	2.113E+07	*1.765E+14
Eu-154	3.223E+00	3.488E+00	4.083E+00	5.686E+00	1.051E+01	8.832E+01	1.707E+05	5.995E+10	*2.639E+14
Eu-155	1.364E+02	1.569E+02	2.075E+02	3.732E+02	1.111E+03	4.840E+04	3.262E+10	*4.651E+14	*4.651E+14
Ni-63	5.689E+03	5.732E+03	5.820E+03	6.008E+03	6.374E+03	7.822E+03	1.619E+04	5.530E+04	1.115E+07
Pu-238	3.925E+01	3.956E+01	4.020E+01	4.156E+01	4.423E+01	5.482E+01	1.176E+02	4.267E+02	1.333E+04
Pu-239	3.535E+01	3.535E+01	3.536E+01	3.537E+01	3.539E+01	3.547E+01	3.576E+01	3.624E+01	3.841E+01
Pu-240	3.536E+01	3.536E+01	3.538E+01	3.540E+01	3.544E+01	3.560E+01	3.615E+01	3.710E+01	4.150E+01

*At specific activity limit

0

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

0Nuclide

(i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Am-241	3.310E-02	0.000E+00	4.634E-01	3.237E+01	4.634E-01	3.237E+01
C-14	9.270E-01	0.000E+00	5.842E-01	2.568E+01	5.842E-01	2.568E+01
Co-60	1.460E-02	0.000E+00	9.699E+00	1.546E+00	9.699E+00	1.546E+00
Cs-137	5.180E-02	0.000E+00	2.288E+00	6.556E+00	2.288E+00	6.556E+00
Eu-152	3.260E-02	0.000E+00	4.297E+00	3.491E+00	4.297E+00	3.491E+00
Eu-154	4.720E-02	0.000E+00	4.653E+00	3.223E+00	4.653E+00	3.223E+00
Eu-155	4.270E-02	0.000E+00	1.100E-01	1.364E+02	1.100E-01	1.364E+02
Ni-63	1.080E+00	0.000E+00	2.637E-03	5.689E+03	2.637E-03	5.689E+03
Pu-238	2.400E-02	0.000E+00	3.822E-01	3.925E+01	3.822E-01	3.925E+01
Pu-239	1.980E-02	0.000E+00	4.243E-01	3.535E+01	4.243E-01	3.535E+01
Pu-240	4.730E-03	0.000E+00	4.242E-01	3.536E+01	4.242E-01	3.536E+01

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Summary : 117-DR Cleanup Verification - Shallow Zone File: 117dr_s.rad

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	1.534E-02	1.531E-02	1.526E-02	1.516E-02	1.496E-02	1.431E-02	1.220E-02	9.327E-03	2.922E-03
0Np-237	Am-241	1.000E+00	3.071E-08	9.520E-08	2.244E-07	4.944E-07	9.907E-07	2.659E-06	8.004E-06	1.525E-05	3.085E-05
0U-233	Am-241	1.000E+00	7.629E-16	4.420E-15	2.100E-14	9.538E-14	3.713E-13	2.590E-12	2.220E-11	7.501E-11	2.543E-08
0Th-229	Am-241	1.000E+00	3.025E-19	4.388E-18	5.042E-17	5.221E-16	4.181E-15	8.212E-14	2.420E-12	1.916E-11	3.521E-10
0C-14	C-14	1.000E+00	5.415E-01	1.304E-01	7.259E-03	1.671E-05	2.047E-10	1.510E-27	0.000E+00	0.000E+00	0.000E+00
0Co-60	Co-60	1.000E+00	1.416E-01	1.241E-01	9.539E-02	5.486E-02	1.963E-02	5.604E-04	1.807E-09	9.765E-19	0.000E+00
0Cs-137	Cs-137	1.000E+00	1.185E-01	1.158E-01	1.105E-01	1.002E-01	8.353E-02	4.450E-02	4.743E-03	1.084E-04	8.817E-12
0Eu-152	Eu-152	7.208E-01	1.010E-01	9.585E-02	8.637E-02	6.941E-02	4.625E-02	1.134E-02	7.665E-05	1.668E-08	2.499E-24
Eu-152	Eu-152	2.792E-01	3.911E-02	3.713E-02	3.346E-02	2.689E-02	1.791E-02	4.394E-03	2.969E-05	6.462E-09	9.679E-25
Eu-152	ãDOSE(j)		1.401E-01	1.330E-01	1.198E-01	9.630E-02	6.416E-02	1.574E-02	1.063E-04	2.314E-08	3.467E-24
0Gd-152	Eu-152	2.792E-01	1.236E-18	3.625E-18	8.045E-18	1.596E-17	2.676E-17	4.302E-17	4.822E-17	4.815E-17	4.771E-17
0Eu-154	Eu-154	1.000E+00	2.196E-01	2.030E-01	1.734E-01	1.245E-01	6.733E-02	8.017E-03	4.147E-06	1.181E-11	0.000E+00
0Eu-155	Eu-155	1.000E+00	4.696E-03	4.083E-03	3.087E-03	1.716E-03	5.768E-04	1.323E-05	1.964E-11	2.865E-21	0.000E+00
0Ni-63	Ni-63	1.000E+00	2.848E-03	2.826E-03	2.784E-03	2.696E-03	2.542E-03	2.071E-03	1.000E-03	2.930E-04	1.453E-06
0Pu-238	Pu-238	1.000E+00	9.172E-03	9.099E-03	8.955E-03	8.661E-03	8.140E-03	6.567E-03	3.060E-03	8.435E-04	3.221E-06
0U-234	Pu-238	1.000E+00	2.136E-09	6.474E-09	1.500E-08	3.218E-08	6.163E-08	1.418E-07	2.482E-07	1.912E-07	2.370E-05
0Th-230	Pu-238	1.000E+00	8.252E-15	5.564E-14	2.870E-13	1.347E-12	5.255E-12	3.510E-11	2.504E-10	6.393E-10	4.456E-09
0Ra-226	Pu-238	1.000E+00	1.081E-16	1.655E-15	1.941E-14	2.016E-13	1.601E-12	3.017E-11	7.672E-10	4.858E-09	3.802E-08
0Pb-210	Pu-238	1.000E+00	4.539E-19	1.203E-17	2.691E-16	5.570E-15	8.276E-14	3.660E-12	2.022E-10	1.733E-09	4.231E-08
0Pu-239	Pu-239	1.000E+00	8.402E-03	8.401E-03	8.400E-03	8.397E-03	8.391E-03	8.372E-03	8.306E-03	8.195E-03	7.732E-03
0U-235	Pu-239	1.000E+00	5.280E-12	1.583E-11	3.678E-11	8.006E-11	1.580E-10	4.045E-10	1.046E-09	1.602E-09	4.385E-08
0Pa-231	Pu-239	1.000E+00	4.584E-16	3.367E-15	1.813E-14	8.746E-14	3.505E-13	2.517E-12	2.274E-11	8.348E-11	8.995E-10
0Ac-227	Pu-239	1.000E+00	2.956E-18	4.018E-17	4.367E-16	4.290E-15	3.214E-14	5.225E-13	9.278E-12	4.277E-11	1.773E-09
0Pu-240	Pu-240	1.000E+00	2.007E-03	2.006E-03	2.006E-03	2.004E-03	2.002E-03	1.993E-03	1.963E-03	1.912E-03	1.709E-03
0U-236	Pu-240	1.000E+00	4.180E-12	1.271E-11	2.968E-11	6.474E-11	1.278E-10	3.271E-10	8.423E-10	1.280E-09	2.978E-07
0Th-232	Pu-240	1.000E+00	4.612E-22	3.116E-21	1.615E-20	7.663E-20	3.050E-19	2.183E-18	1.976E-17	7.298E-17	8.486E-16

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Summary : 117-DR Cleanup Verification - Shallow Zone File: 117dr_s.rad

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
ÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ
Ra-228	Pu-240	1.000E+00	2.277E-22	3.449E-21	3.869E-20	3.628E-19	2.417E-18	2.886E-17	3.396E-16	1.337E-15	7.340E-15
0Th-228	Pu-240	1.000E+00	1.591E-23	4.461E-22	9.372E-21	1.508E-19	1.437E-18	2.273E-17	2.981E-16	1.201E-15	6.584E-15
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BRF(i) is the branch fraction of the parent nuclide.

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Summary : 117-DR Cleanup Verification - Shallow Zone File: 117dr_s.rad

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	3.310E-02	3.305E-02	3.294E-02	3.271E-02	3.229E-02	3.087E-02	2.633E-02	2.013E-02	6.306E-03
0Np-237	Am-241	1.000E+00	0.000E+00	1.071E-08	3.208E-08	7.672E-08	1.588E-07	4.346E-07	1.318E-06	2.517E-06	5.096E-06
0U-233	Am-241	1.000E+00	0.000E+00	2.339E-14	2.095E-13	1.196E-12	5.098E-12	3.762E-11	3.296E-10	1.119E-09	3.894E-09
0Th-229	Am-241	1.000E+00	0.000E+00	7.366E-19	1.982E-17	2.720E-16	2.426E-15	5.085E-14	1.537E-12	1.224E-11	1.819E-10
0C-14	C-14	1.000E+00	9.270E-01	2.190E-01	1.219E-02	2.809E-05	3.447E-10	2.557E-27	0.000E+00	0.000E+00	0.000E+00
0Co-60	Co-60	1.000E+00	1.460E-02	1.280E-02	9.834E-03	5.656E-03	2.024E-03	5.778E-05	1.863E-10	1.007E-19	0.000E+00
0Cs-137	Cs-137	1.000E+00	5.180E-02	5.061E-02	4.830E-02	4.379E-02	3.651E-02	1.945E-02	2.073E-03	4.740E-05	3.854E-12
0Eu-152	Eu-152	7.208E-01	2.350E-02	2.231E-02	2.010E-02	1.615E-02	1.076E-02	2.640E-03	1.784E-05	3.882E-09	5.815E-25
Eu-152	Eu-152	2.792E-01	9.102E-03	8.640E-03	7.786E-03	6.257E-03	4.169E-03	1.022E-03	6.909E-06	1.504E-09	2.253E-25
Eu-152	ãS(j):		3.260E-02	3.095E-02	2.789E-02	2.241E-02	1.493E-02	3.662E-03	2.475E-05	5.386E-09	8.068E-25
0Gd-152	Eu-152	2.792E-01	0.000E+00	5.692E-17	1.622E-16	3.508E-16	6.081E-16	9.958E-16	1.120E-15	1.118E-15	1.108E-15
0Eu-154	Eu-154	1.000E+00	4.720E-02	4.362E-02	3.726E-02	2.676E-02	1.447E-02	1.723E-03	8.912E-07	2.538E-12	2.770E-36
0Eu-155	Eu-155	1.000E+00	4.270E-02	3.713E-02	2.807E-02	1.561E-02	5.244E-03	1.203E-04	1.785E-10	2.606E-20	0.000E+00
0Ni-63	Ni-63	1.000E+00	1.080E+00	1.072E+00	1.056E+00	1.023E+00	9.639E-01	7.855E-01	3.794E-01	1.111E-01	5.510E-04
0Pu-238	Pu-238	1.000E+00	2.400E-02	2.381E-02	2.343E-02	2.266E-02	2.130E-02	1.718E-02	8.007E-03	2.207E-03	8.428E-06
0U-234	Pu-238	1.000E+00	0.000E+00	6.760E-08	2.002E-07	4.674E-07	9.253E-07	2.173E-06	3.833E-06	2.958E-06	1.348E-07
0Th-230	Pu-238	1.000E+00	0.000E+00	3.049E-13	2.720E-12	1.538E-11	6.454E-11	4.505E-10	3.270E-09	8.379E-09	1.416E-08
0Ra-226	Pu-238	1.000E+00	0.000E+00	4.407E-17	1.182E-15	1.611E-14	1.419E-13	2.845E-12	7.412E-11	4.720E-10	3.630E-09
0Pb-210	Pu-238	1.000E+00	0.000E+00	3.406E-19	2.710E-17	8.660E-16	1.523E-14	7.461E-13	4.287E-11	3.705E-10	3.450E-09
0Pu-239	Pu-239	1.000E+00	1.980E-02	1.980E-02	1.980E-02	1.979E-02	1.978E-02	1.973E-02	1.957E-02	1.931E-02	1.822E-02
0U-235	Pu-239	1.000E+00	0.000E+00	1.945E-11	5.805E-11	1.378E-10	2.814E-10	7.356E-10	1.917E-09	2.943E-09	3.540E-09
0Pa-231	Pu-239	1.000E+00	0.000E+00	2.059E-16	1.847E-15	1.056E-14	4.518E-14	3.376E-13	3.098E-12	1.141E-11	5.672E-11
0Ac-227	Pu-239	1.000E+00	0.000E+00	2.169E-18	5.746E-17	7.640E-16	6.437E-15	1.123E-13	2.048E-12	9.493E-12	5.389E-11
0Pu-240	Pu-240	1.000E+00	4.730E-03	4.729E-03	4.728E-03	4.725E-03	4.719E-03	4.698E-03	4.627E-03	4.508E-03	4.029E-03
0U-236	Pu-240	1.000E+00	0.000E+00	1.397E-10	4.168E-10	9.892E-10	2.019E-09	5.273E-09	1.369E-08	2.083E-08	2.388E-08
0Th-232	Pu-240	1.000E+00	0.000E+00	3.448E-21	3.092E-20	1.768E-19	7.568E-19	5.661E-18	5.213E-17	1.933E-16	9.930E-16

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Summary : 117-DR Cleanup Verification - Shallow Zone File: 117dr_s.rad

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
ÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃ
Ra-228	Pu-240	1.000E+00	0.000E+00	1.345E-22	3.417E-21	4.184E-20	3.083E-19	3.899E-18	4.677E-17	1.849E-16	9.832E-16
0Th-228	Pu-240	1.000E+00	0.000E+00	1.142E-23	7.704E-22	1.804E-20	1.972E-19	3.356E-18	4.501E-17	1.821E-16	9.800E-16
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ

BRF(i) is the branch fraction of the parent nuclide.
0RESCALC.EXE execution time = 6.97 seconds

RESRAD INPUT PARAMETERS FOR DEEP ZONE RADIONUCLIDES

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Dose Conversion Factor (and Related) Parameter Summary
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0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Am-241	4.440E-01	4.440E-01	DCF2(2)
B-1	C-14	2.090E-06	2.090E-06	DCF2(3)
B-1	Co-60	2.190E-04	2.190E-04	DCF2(4)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(5)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(6)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(8)
B-1	Eu-155	4.140E-05	4.140E-05	DCF2(9)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(10)
B-1	Ni-63	6.290E-06	6.290E-06	DCF2(11)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(12)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(13)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(14)
B-1	Pu-238	3.920E-01	3.920E-01	DCF2(15)
B-1	Pu-239	4.290E-01	4.290E-01	DCF2(16)
B-1	Pu-240	4.290E-01	4.290E-01	DCF2(17)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(18)
B-1	Ra-228+D	5.080E-03	5.080E-03	DCF2(19)
B-1	Sr-90+D	1.310E-03	1.310E-03	DCF2(20)
B-1	Th-228+D	3.450E-01	3.450E-01	DCF2(21)
B-1	Th-229+D	2.160E+00	2.160E+00	DCF2(22)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(23)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(24)
B-1	U-233	1.350E-01	1.350E-01	DCF2(25)
B-1	U-234	1.320E-01	1.320E-01	DCF2(26)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(27)
B-1	U-236	1.250E-01	1.250E-01	DCF2(28)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Am-241	3.640E-03	3.640E-03	DCF3(2)
D-1	C-14	2.090E-06	2.090E-06	DCF3(3)
D-1	Co-60	2.690E-05	2.690E-05	DCF3(4)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(5)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(6)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(8)
D-1	Eu-155	1.530E-06	1.530E-06	DCF3(9)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(10)
D-1	Ni-63	5.770E-07	5.770E-07	DCF3(11)
D-1	Np-237+D	4.440E-03	4.440E-03	DCF3(12)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(13)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(14)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(15)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(16)
D-1	Pu-240	3.540E-03	3.540E-03	DCF3(17)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(18)
D-1	Ra-228+D	1.440E-03	1.440E-03	DCF3(19)
D-1	Sr-90+D	1.530E-04	1.530E-04	DCF3(20)
D-1	Th-228+D	8.080E-04	8.080E-04	DCF3(21)
D-1	Th-229+D	4.030E-03	4.030E-03	DCF3(22)

Dose Conversion Factor (and Related) Parameter Summary (continued)
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Menu	Parameter	Current Value	Default	Parameter Name
D-1	Th-230	5.480E-04	5.480E-04	DCF3(23)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(24)
D-1	U-233	2.890E-04	2.890E-04	DCF3(25)
D-1	U-234	2.830E-04	2.830E-04	DCF3(26)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(27)
D-1	U-236	2.690E-04	2.690E-04	DCF3(28)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(2,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(2,3)
D-34				
D-34	C-14 , plant/soil concentration ratio, dimensionless	5.500E+00	5.500E+00	RTF(3,1)
D-34	C-14 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.100E-02	3.100E-02	RTF(3,2)
D-34	C-14 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.200E-02	1.200E-02	RTF(3,3)
D-34				
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(4,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(4,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(5,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(5,3)
D-34				
D-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(6,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(6,3)
D-34				
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(8,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(8,3)
D-34				
D-34	Eu-155 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	Eu-155 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(9,2)
D-34	Eu-155 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(9,3)
D-34				
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(10,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(10,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(10,3)
D-34				
D-34	Ni-63 , plant/soil concentration ratio, dimensionless	5.000E-02	5.000E-02	RTF(11,1)
D-34	Ni-63 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(11,2)
D-34	Ni-63 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-02	2.000E-02	RTF(11,3)
D-34				
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(12,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(12,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(12,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)
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0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(13,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(13,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(13,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(14,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(14,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(14,3)
D-34				
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(15,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(15,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(15,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(16,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(16,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(16,3)
D-34				
D-34	Pu-240 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(17,1)
D-34	Pu-240 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(17,2)
D-34	Pu-240 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(17,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(18,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(18,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(18,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(19,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(19,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(19,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(20,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(20,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(20,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(21,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(21,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(21,3)
D-34				
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(22,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(22,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(22,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(23,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(23,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(23,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(24,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(24,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(24,3)
D-34				
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(25,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(25,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(25,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)
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0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(26,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(26,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(26,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(27,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(27,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(27,3)
D-34				
D-34	U-236 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(28,1)
D-34	U-236 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(28,2)
D-34	U-236 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(28,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Am-241 , fish	3.000E+01	3.000E+01	BIOFAC(2,1)
D-5	Am-241 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5				
D-5	C-14 , fish	5.000E+04	5.000E+04	BIOFAC(3,1)
D-5	C-14 , crustacea and mollusks	9.100E+03	9.100E+03	BIOFAC(3,2)
D-5				
D-5	Co-60 , fish	3.000E+02	3.000E+02	BIOFAC(4,1)
D-5	Co-60 , crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(4,2)
D-5				
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(5,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(5,2)
D-5				
D-5	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(6,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(6,2)
D-5				
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(8,1)
D-5	Eu-154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(8,2)
D-5				
D-5	Eu-155 , fish	5.000E+01	5.000E+01	BIOFAC(9,1)
D-5	Eu-155 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(9,2)
D-5				
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(10,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(10,2)
D-5				
D-5	Ni-63 , fish	1.000E+02	1.000E+02	BIOFAC(11,1)
D-5	Ni-63 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(11,2)
D-5				
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(12,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(12,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(13,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(13,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(14,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(14,2)

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Dose Conversion Factor (and Related) Parameter Summary (continued)
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Menu	Parameter	Current Value	Default	Parameter Name
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(15,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(15,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(16,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(16,2)
D-5				
D-5	Pu-240 , fish	3.000E+01	3.000E+01	BIOFAC(17,1)
D-5	Pu-240 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(17,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(18,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(18,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(19,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(19,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(20,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(20,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(21,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(21,2)
D-5				
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(22,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(22,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(23,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(23,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(24,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(24,2)
D-5				
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(25,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(25,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(26,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(26,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(27,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(27,2)
D-5				
D-5	U-236 , fish	1.000E+01	1.000E+01	BIOFAC(28,1)
D-5	U-236 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(28,2)

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)	4.750E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.990E+01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	5.200E+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)	7.200E+00	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.500E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	4.200E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.380E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	3.000E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+03	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Am-241	9.080E-03	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): C-14	1.120E+00	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Co-60	2.190E-02	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Cs-137	4.590E-02	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Eu-152	4.460E-02	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): Eu-154	7.110E-02	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g): Eu-155	5.420E-02	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): Ni-63	1.630E+00	0.000E+00	---	S1(11)
R012	Initial principal radionuclide (pCi/g): Pu-238	7.590E-02	0.000E+00	---	S1(15)
R012	Initial principal radionuclide (pCi/g): Pu-239	1.890E-02	0.000E+00	---	S1(16)
R012	Initial principal radionuclide (pCi/g): Pu-240	4.520E-03	0.000E+00	---	S1(17)
R012	Initial principal radionuclide (pCi/g): Sr-90	6.100E-04	0.000E+00	---	S1(20)
R012	Concentration in groundwater (pCi/L): Am-241	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): C-14	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Co-60	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Eu-152	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): Eu-154	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): Eu-155	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): Ni-63	not used	0.000E+00	---	W1(11)
R012	Concentration in groundwater (pCi/L): Pu-238	not used	0.000E+00	---	W1(15)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(16)
R012	Concentration in groundwater (pCi/L): Pu-240	not used	0.000E+00	---	W1(17)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(20)
R013	Cover depth (m)	4.600E+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)	1.000E-03	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)	1.000E-03	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)	not used	8.000E+00	---	HUMID

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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	0	1	---	NS
R016	Distribution coefficients for Am-241				
R016	Contaminated zone (cm**3/g)	2.000E+02	2.000E+01	---	DCNUCC(2)
R016	Saturated zone (cm**3/g)	2.000E+02	2.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for C-14				
R016	Contaminated zone (cm**3/g)	2.000E+02	0.000E+00	---	DCNUCC(3)
R016	Saturated zone (cm**3/g)	2.000E+02	0.000E+00	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(4)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.008E-05	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(5)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.008E-05	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(6)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(8)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for Eu-155				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(9)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for Ni-63				
R016	Contaminated zone (cm**3/g)	3.000E+01	1.000E+03	---	DCNUCC(11)
R016	Saturated zone (cm**3/g)	3.000E+01	1.000E+03	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.333E-05	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCC(15)
R016	Saturated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCS(15)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(15)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(15)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCC(16)
R016	Saturated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCS(16)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(16)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(16)
R016	Distribution coefficients for Pu-240				
R016	Contaminated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCC(17)
R016	Saturated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCS(17)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(17)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(17)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	2.500E+01	3.000E+01	---	DCNUCC(20)
R016	Saturated zone (cm**3/g)	2.500E+01	3.000E+01	---	DCNUCS(20)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.992E-05	ALEACH(20)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(20)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.247E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(10)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.043E-06	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCC(12)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCS(12)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.746E-06	ALEACH(12)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(12)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(13)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(13)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.008E-05	ALEACH(13)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(13)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	3.000E+01	1.000E+02	---	DCNUCC(14)
R016	Saturated zone (cm**3/g)	3.000E+01	1.000E+02	---	DCNUCS(14)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.333E-05	ALEACH(14)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(14)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	2.000E+02	7.000E+01	---	DCNUCC(18)
R016	Saturated zone (cm**3/g)	2.000E+02	7.000E+01	---	DCNUCS(18)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(18)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(18)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	2.000E+02	7.000E+01	---	DCNUCC(19)
R016	Saturated zone (cm**3/g)	2.000E+02	7.000E+01	---	DCNUCS(19)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(19)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(19)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCC(21)
R016	Saturated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCS(21)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(21)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(21)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCC(22)
R016	Saturated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCS(22)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(22)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(22)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCC(23)
R016	Saturated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCS(23)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(23)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(23)
R016	Distribution coefficients for daughter Th-232				
R016	Contaminated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCC(24)
R016	Saturated zone (cm**3/g)	2.000E+02	6.000E+04	---	DCNUCS(24)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.254E-05	ALEACH(24)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(24)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCC(25)
R016	Saturated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCS(25)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.183E-03	ALEACH(25)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(25)
R016	Distribution coefficients for daughter U-234				
R016	Contaminated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCC(26)
R016	Saturated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCS(26)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.183E-03	ALEACH(26)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(26)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCC(27)
R016	Saturated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCS(27)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.183E-03	ALEACH(27)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(27)
R016	Distribution coefficients for daughter U-236				
R016	Contaminated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCC(28)
R016	Saturated zone (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCS(28)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.183E-03	ALEACH(28)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(28)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	not used	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	not used	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	not used	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	not used	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	not used	1.000E+00	-1 shows non-circular AREA.	FS

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	5.000E+01	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	7.071E+01	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	0.000E+00	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	0.000E+00	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	0.000E+00	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	0.000E+00	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	0.000E+00	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	0.000E+00	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	0.000E+00	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	0.000E+00	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	0.000E+00	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	0.000E+00	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	1.000E+00	1.000E+00	---	FRACA(1)
R017	Ring 2	2.732E-01	2.732E-01	---	FRACA(2)
R017	Ring 3	0.000E+00	0.000E+00	---	FRACA(3)
R017	Ring 4	0.000E+00	0.000E+00	---	FRACA(4)
R017	Ring 5	0.000E+00	0.000E+00	---	FRACA(5)
R017	Ring 6	0.000E+00	0.000E+00	---	FRACA(6)
R017	Ring 7	0.000E+00	0.000E+00	---	FRACA(7)
R017	Ring 8	0.000E+00	0.000E+00	---	FRACA(8)
R017	Ring 9	0.000E+00	0.000E+00	---	FRACA(9)
R017	Ring 10	0.000E+00	0.000E+00	---	FRACA(10)
R017	Ring 11	0.000E+00	0.000E+00	---	FRACA(11)
R017	Ring 12	0.000E+00	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)	not used	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	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.237E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.237E+00	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

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)
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)	2.000E-05	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	3.000E-02	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	2.000E-02	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	9.800E-01	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	3.000E-01	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	7.000E-07	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	1.000E-10	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	8.000E-01	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	2.000E-01	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	8.894E+01	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

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)
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	suppressed
2 -- inhalation (w/o radon)	suppressed
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	suppressed
9 -- radon	suppressed
Find peak pathway doses	active

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Contaminated Zone Dimensions

Area:	4750.00 square meters
Thickness:	19.90 meters
Cover Depth:	4.60 meters

Initial Soil Concentrations, pCi/g

Am-241	9.080E-03
C-14	1.120E+00
Co-60	2.190E-02
Cs-137	4.590E-02
Eu-152	4.460E-02
Eu-154	7.110E-02
Eu-155	5.420E-02
Ni-63	1.630E+00
Pu-238	7.590E-02
Pu-239	1.890E-02
Pu-240	4.520E-03
Sr-90	6.100E-04

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
TDOSE(t):	1.163E-05	3.673E-05	8.488E-05	1.773E-04	3.267E-04	6.722E-04	9.352E-04	7.140E-04	1.512E-04
M(t):	7.750E-07	2.448E-06	5.658E-06	1.182E-05	2.178E-05	4.481E-05	6.234E-05	4.760E-05	1.008E-05

0Maximum TDOSE(t): 9.361E-04 mrem/yr at t = 130.5 ñ 0.3 years

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.305E+02 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.305E+02 years

0 Water Dependent Pathways

0 Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	1.085E-09	0.0000	6.810E-12	0.0000	0.000E+00	0.0000	1.198E-10	0.0000	2.234E-12	0.0000	1.139E-11	0.0000	1.225E-09	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	4.759E-12	0.0000	7.212E-13	0.0000	0.000E+00	0.0000	5.382E-13	0.0000	5.775E-13	0.0000	1.669E-13	0.0000	6.763E-12	0.0000
Cs-137	2.734E-05	0.0292	2.686E-05	0.0287	0.000E+00	0.0000	3.055E-06	0.0033	4.971E-06	0.0053	3.832E-06	0.0041	6.606E-05	0.0706
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	4.138E-04	0.4421	2.122E-05	0.0227	0.000E+00	0.0000	4.639E-05	0.0496	1.256E-05	0.0134	1.451E-04	0.1551	6.391E-04	0.6828
Pu-238	1.961E-04	0.2095	1.226E-06	0.0013	0.000E+00	0.0000	2.168E-05	0.0232	4.049E-07	0.0004	2.063E-06	0.0022	2.215E-04	0.2367
Pu-239	2.525E-08	0.0000	1.609E-10	0.0000	0.000E+00	0.0000	2.791E-09	0.0000	5.358E-11	0.0000	2.636E-10	0.0000	2.852E-08	0.0000
Pu-240	1.806E-07	0.0002	1.128E-09	0.0000	0.000E+00	0.0000	1.996E-08	0.0000	3.727E-10	0.0000	1.900E-09	0.0000	2.040E-07	0.0002
Sr-90	7.380E-06	0.0079	2.336E-07	0.0002	0.000E+00	0.0000	8.894E-07	0.0010	3.609E-07	0.0004	2.602E-07	0.0003	9.125E-06	0.0097
Total	6.449E-04	0.6889	4.954E-05	0.0529	0.000E+00	0.0000	7.204E-05	0.0770	1.830E-05	0.0195	1.513E-04	0.1616	9.361E-04	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : 117-DR Cleanup Verification - Deep Zone File: 117dr_d.rad

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

0

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	5.173E-16	0.0000	3.461E-18	0.0000	0.000E+00	0.0000	4.890E-17	0.0000	5.253E-19	0.0000	3.736E-18	0.0000	5.740E-16	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	5.002E-07	0.0430	6.933E-08	0.0060	0.000E+00	0.0000	4.653E-08	0.0040	1.891E-08	0.0016	1.044E-08	0.0009	6.454E-07	0.0555
Cs-137	2.094E-06	0.1801	1.885E-06	0.1622	0.000E+00	0.0000	1.931E-07	0.0166	1.204E-07	0.0104	1.760E-07	0.0151	4.469E-06	0.3844
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	4.029E-06	0.3466	1.966E-07	0.0169	0.000E+00	0.0000	4.057E-07	0.0349	6.512E-08	0.0056	1.040E-06	0.0895	5.736E-06	0.4934
Pu-238	2.558E-08	0.0022	1.520E-10	0.0000	0.000E+00	0.0000	2.538E-09	0.0002	3.019E-11	0.0000	2.037E-10	0.0000	2.851E-08	0.0025
Pu-239	2.093E-12	0.0000	1.245E-14	0.0000	0.000E+00	0.0000	2.076E-13	0.0000	2.475E-15	0.0000	1.665E-14	0.0000	2.332E-12	0.0000
Pu-240	1.515E-11	0.0000	9.000E-14	0.0000	0.000E+00	0.0000	1.503E-12	0.0000	1.787E-14	0.0000	1.206E-13	0.0000	1.688E-11	0.0000
Sr-90	6.254E-07	0.0538	1.893E-08	0.0016	0.000E+00	0.0000	6.833E-08	0.0059	1.714E-08	0.0015	1.674E-08	0.0014	7.465E-07	0.0642
Total	7.274E-06	0.6257	2.170E-06	0.1867	0.000E+00	0.0000	7.162E-07	0.0616	2.216E-07	0.0191	1.244E-06	0.1070	1.163E-05	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	6.007E-15	0.0000	3.794E-17	0.0000	0.000E+00	0.0000	6.240E-16	0.0000	8.963E-18	0.0000	5.307E-17	0.0000	6.731E-15	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	1.348E-06	0.0367	1.982E-07	0.0054	0.000E+00	0.0000	1.430E-07	0.0039	1.148E-07	0.0031	3.969E-08	0.0011	1.843E-06	0.0502
Cs-137	6.211E-06	0.1691	5.925E-06	0.1613	0.000E+00	0.0000	6.513E-07	0.0177	7.949E-07	0.0216	7.320E-07	0.0199	1.431E-05	0.3897
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	1.207E-05	0.3286	6.080E-07	0.0166	0.000E+00	0.0000	1.303E-06	0.0355	3.017E-07	0.0082	3.832E-06	0.1043	1.812E-05	0.4932
Pu-238	1.795E-07	0.0049	1.097E-09	0.0000	0.000E+00	0.0000	1.895E-08	0.0005	2.943E-10	0.0000	1.675E-09	0.0000	2.015E-07	0.0055
Pu-239	1.471E-11	0.0000	8.998E-14	0.0000	0.000E+00	0.0000	1.553E-12	0.0000	2.416E-14	0.0000	1.373E-13	0.0000	1.651E-11	0.0000
Pu-240	1.065E-10	0.0000	6.512E-13	0.0000	0.000E+00	0.0000	1.124E-11	0.0000	1.746E-13	0.0000	9.941E-13	0.0000	1.196E-10	0.0000
Sr-90	1.845E-06	0.0502	5.750E-08	0.0016	0.000E+00	0.0000	2.149E-07	0.0059	7.575E-08	0.0021	5.944E-08	0.0016	2.253E-06	0.0613
Total	2.165E-05	0.5896	6.790E-06	0.1849	0.000E+00	0.0000	2.332E-06	0.0635	1.287E-06	0.0351	4.665E-06	0.1270	3.673E-05	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	6.796E-14	0.0000	4.215E-16	0.0000	0.000E+00	0.0000	7.268E-15	0.0000	1.205E-16	0.0000	6.609E-16	0.0000	7.643E-14	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	2.434E-06	0.0287	3.644E-07	0.0043	0.000E+00	0.0000	2.681E-07	0.0032	2.585E-07	0.0030	7.965E-08	0.0009	3.405E-06	0.0401
Cs-137	1.389E-05	0.1636	1.348E-05	0.1588	0.000E+00	0.0000	1.511E-06	0.0178	2.211E-06	0.0260	1.816E-06	0.0214	3.290E-05	0.3876
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	2.781E-05	0.3277	1.415E-06	0.0167	0.000E+00	0.0000	3.070E-06	0.0362	7.815E-07	0.0092	9.365E-06	0.1103	4.244E-05	0.5001
Pu-238	9.450E-07	0.0111	5.848E-09	0.0001	0.000E+00	0.0000	1.024E-07	0.0012	1.769E-09	0.0000	9.438E-09	0.0001	1.064E-06	0.0125
Pu-239	7.784E-11	0.0000	4.819E-13	0.0000	0.000E+00	0.0000	8.434E-12	0.0000	1.460E-13	0.0000	7.772E-13	0.0000	8.768E-11	0.0000
Pu-240	5.636E-10	0.0000	3.488E-12	0.0000	0.000E+00	0.0000	6.106E-11	0.0000	1.054E-12	0.0000	5.628E-12	0.0000	6.349E-10	0.0000
Sr-90	4.115E-06	0.0485	1.294E-07	0.0015	0.000E+00	0.0000	4.889E-07	0.0058	1.876E-07	0.0022	1.398E-07	0.0016	5.061E-06	0.0596
Total	4.919E-05	0.5796	1.539E-05	0.1814	0.000E+00	0.0000	5.441E-06	0.0641	3.440E-06	0.0405	1.141E-05	0.1344	8.488E-05	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 7.200E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 7.200E+00 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	7.070E-13	0.0000	4.395E-15	0.0000	0.000E+00	0.0000	7.701E-14	0.0000	1.365E-15	0.0000	7.176E-15	0.0000	7.969E-13	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	3.092E-06	0.0174	4.660E-07	0.0026	0.000E+00	0.0000	3.456E-07	0.0019	3.546E-07	0.0020	1.052E-07	0.0006	4.363E-06	0.0246
Cs-137	2.776E-05	0.1566	2.714E-05	0.1530	0.000E+00	0.0000	3.067E-06	0.0173	4.772E-06	0.0269	3.777E-06	0.0213	6.652E-05	0.3751
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	5.940E-05	0.3350	3.035E-06	0.0171	0.000E+00	0.0000	6.614E-06	0.0373	1.744E-06	0.0098	2.047E-05	0.1154	9.126E-05	0.5146
Pu-238	4.497E-06	0.0254	2.798E-08	0.0002	0.000E+00	0.0000	4.927E-07	0.0028	8.888E-09	0.0001	4.622E-08	0.0003	5.073E-06	0.0286
Pu-239	3.745E-10	0.0000	2.330E-12	0.0000	0.000E+00	0.0000	4.102E-11	0.0000	7.418E-13	0.0000	3.847E-12	0.0000	4.224E-10	0.0000
Pu-240	2.711E-09	0.0000	1.686E-11	0.0000	0.000E+00	0.0000	2.970E-10	0.0000	5.355E-12	0.0000	2.786E-11	0.0000	3.058E-09	0.0000
Sr-90	8.198E-06	0.0462	2.588E-07	0.0015	0.000E+00	0.0000	9.819E-07	0.0055	3.890E-07	0.0022	2.845E-07	0.0016	1.011E-05	0.0570
Total	1.030E-04	0.5806	3.092E-05	0.1744	0.000E+00	0.0000	1.150E-05	0.0649	7.269E-06	0.0410	2.468E-05	0.1392	1.773E-04	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.500E+01 years
0 Water Independent Pathways (Inhalation excludes radon)

0 Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.500E+01 years
0 Water Dependent Pathways

0 Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	5.711E-12	0.0000	3.560E-14	0.0000	0.000E+00	0.0000	6.270E-13	0.0000	1.142E-14	0.0000	5.905E-14	0.0000	6.444E-12	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	2.234E-06	0.0068	3.377E-07	0.0010	0.000E+00	0.0000	2.513E-07	0.0008	2.642E-07	0.0008	7.727E-08	0.0002	3.164E-06	0.0097
Cs-137	4.670E-05	0.1429	4.577E-05	0.1401	0.000E+00	0.0000	5.190E-06	0.0159	8.275E-06	0.0253	6.456E-06	0.0198	1.124E-04	0.3440
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	1.130E-04	0.3459	5.786E-06	0.0177	0.000E+00	0.0000	1.263E-05	0.0387	3.379E-06	0.0103	3.932E-05	0.1204	1.742E-04	0.5330
Pu-238	1.780E-05	0.0545	1.110E-07	0.0003	0.000E+00	0.0000	1.959E-06	0.0060	3.598E-08	0.0001	1.851E-07	0.0006	2.009E-05	0.0615
Pu-239	1.512E-09	0.0000	9.430E-12	0.0000	0.000E+00	0.0000	1.664E-10	0.0000	3.067E-12	0.0000	1.572E-11	0.0000	1.706E-09	0.0000
Pu-240	1.094E-08	0.0000	6.822E-11	0.0000	0.000E+00	0.0000	1.204E-09	0.0000	2.211E-11	0.0000	1.138E-10	0.0000	1.235E-08	0.0000
Sr-90	1.371E-05	0.0420	4.334E-07	0.0013	0.000E+00	0.0000	1.647E-06	0.0050	6.611E-07	0.0020	4.798E-07	0.0015	1.693E-05	0.0518
Total	1.935E-04	0.5922	5.244E-05	0.1605	0.000E+00	0.0000	2.168E-05	0.0664	1.262E-05	0.0386	4.652E-05	0.1424	3.267E-04	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 4.200E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 4.200E+01 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	9.141E-11	0.0000	5.715E-13	0.0000	0.000E+00	0.0000	1.009E-11	0.0000	1.870E-13	0.0000	9.568E-13	0.0000	1.032E-10	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	1.759E-07	0.0003	2.664E-08	0.0000	0.000E+00	0.0000	1.987E-08	0.0000	2.120E-08	0.0000	6.147E-09	0.0000	2.498E-07	0.0004
Cs-137	6.862E-05	0.1021	6.739E-05	0.1002	0.000E+00	0.0000	7.656E-06	0.0114	1.239E-05	0.0184	9.582E-06	0.0143	1.656E-04	0.2464
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	2.549E-04	0.3792	1.306E-05	0.0194	0.000E+00	0.0000	2.855E-05	0.0425	7.705E-06	0.0115	8.921E-05	0.1327	3.934E-04	0.5853
Pu-238	7.830E-05	0.1165	4.890E-07	0.0007	0.000E+00	0.0000	8.649E-06	0.0129	1.610E-07	0.0002	8.221E-07	0.0012	8.842E-05	0.1315
Pu-239	7.299E-09	0.0000	4.571E-11	0.0000	0.000E+00	0.0000	8.061E-10	0.0000	1.515E-11	0.0000	7.651E-11	0.0000	8.242E-09	0.0000
Pu-240	5.272E-08	0.0001	3.292E-10	0.0000	0.000E+00	0.0000	5.822E-09	0.0000	1.084E-10	0.0000	5.533E-10	0.0000	5.953E-08	0.0001
Sr-90	1.975E-05	0.0294	6.251E-07	0.0009	0.000E+00	0.0000	2.379E-06	0.0035	9.622E-07	0.0014	6.951E-07	0.0010	2.441E-05	0.0363
Total	4.218E-04	0.6275	8.159E-05	0.1214	0.000E+00	0.0000	4.726E-05	0.0703	2.124E-05	0.0316	1.003E-04	0.1492	6.722E-04	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.380E+02 years
0
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.380E+02 years
0
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	1.213E-09	0.0000	7.617E-12	0.0000	0.000E+00	0.0000	1.340E-10	0.0000	2.498E-12	0.0000	1.274E-11	0.0000	1.369E-09	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	1.886E-12	0.0000	2.858E-13	0.0000	0.000E+00	0.0000	2.133E-13	0.0000	2.289E-13	0.0000	6.615E-14	0.0000	2.680E-12	0.0000
Cs-137	2.432E-05	0.0260	2.390E-05	0.0256	0.000E+00	0.0000	2.717E-06	0.0029	4.422E-06	0.0047	3.409E-06	0.0036	5.876E-05	0.0628
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	4.143E-04	0.4431	2.124E-05	0.0227	0.000E+00	0.0000	4.645E-05	0.0497	1.258E-05	0.0135	1.453E-04	0.1554	6.400E-04	0.6843
Pu-238	2.020E-04	0.2160	1.263E-06	0.0014	0.000E+00	0.0000	2.233E-05	0.0239	4.170E-07	0.0004	2.125E-06	0.0023	2.281E-04	0.2439
Pu-239	2.669E-08	0.0000	1.704E-10	0.0000	0.000E+00	0.0000	2.950E-09	0.0000	5.673E-11	0.0000	2.785E-10	0.0000	3.015E-08	0.0000
Pu-240	1.908E-07	0.0002	1.192E-09	0.0000	0.000E+00	0.0000	2.108E-08	0.0000	3.936E-10	0.0000	2.006E-09	0.0000	2.154E-07	0.0002
Sr-90	6.530E-06	0.0070	2.067E-07	0.0002	0.000E+00	0.0000	7.869E-07	0.0008	3.193E-07	0.0003	2.303E-07	0.0002	8.073E-06	0.0086
Total	6.474E-04	0.6923	4.661E-05	0.0498	0.000E+00	0.0000	7.231E-05	0.0773	1.774E-05	0.0190	1.511E-04	0.1616	9.352E-04	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : 117-DR Cleanup Verification - Deep Zone File: 117dr_d.rad

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	5.307E-09	0.0000	3.359E-11	0.0000	0.000E+00	0.0000	5.866E-10	0.0000	1.094E-11	0.0000	5.574E-11	0.0000	5.994E-09	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	2.288E-21	0.0000	3.467E-22	0.0000	0.000E+00	0.0000	2.588E-22	0.0000	2.781E-22	0.0000	8.031E-23	0.0000	3.252E-21	0.0000
Cs-137	1.248E-06	0.0017	1.226E-06	0.0017	0.000E+00	0.0000	1.395E-07	0.0002	2.273E-07	0.0003	1.751E-07	0.0002	3.016E-06	0.0042
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	2.779E-04	0.3893	1.425E-05	0.0200	0.000E+00	0.0000	3.117E-05	0.0437	8.447E-06	0.0118	9.755E-05	0.1366	4.294E-04	0.6014
Pu-238	2.486E-04	0.3482	1.559E-06	0.0022	0.000E+00	0.0000	2.748E-05	0.0385	5.136E-07	0.0007	2.616E-06	0.0037	2.808E-04	0.3932
Pu-239	5.550E-08	0.0001	3.680E-10	0.0000	0.000E+00	0.0000	6.135E-09	0.0000	1.220E-10	0.0000	5.716E-10	0.0000	6.270E-08	0.0001
Pu-240	3.886E-07	0.0005	2.428E-09	0.0000	0.000E+00	0.0000	4.296E-08	0.0001	8.024E-10	0.0000	4.089E-09	0.0000	4.389E-07	0.0006
Sr-90	2.744E-07	0.0004	8.687E-09	0.0000	0.000E+00	0.0000	3.308E-08	0.0000	1.344E-08	0.0000	9.684E-09	0.0000	3.393E-07	0.0005
Total	5.285E-04	0.7402	1.705E-05	0.0239	0.000E+00	0.0000	5.887E-05	0.0825	9.202E-06	0.0129	1.004E-04	0.1406	7.140E-04	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	3.422E-08	0.0002	2.238E-10	0.0000	0.000E+00	0.0000	3.784E-09	0.0000	7.042E-11	0.0000	3.582E-10	0.0000	3.866E-08	0.0003
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	3.905E-13	0.0000	3.838E-13	0.0000	0.000E+00	0.0000	4.366E-14	0.0000	7.121E-14	0.0000	5.482E-14	0.0000	9.440E-13	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	2.081E-06	0.0138	1.067E-07	0.0007	0.000E+00	0.0000	2.334E-07	0.0015	6.331E-08	0.0004	7.308E-07	0.0048	3.216E-06	0.0213
Pu-238	1.299E-04	0.8591	8.927E-07	0.0059	0.000E+00	0.0000	1.436E-05	0.0950	2.699E-07	0.0018	1.364E-06	0.0090	1.468E-04	0.9708
Pu-239	1.396E-07	0.0009	1.088E-09	0.0000	0.000E+00	0.0000	1.543E-08	0.0001	3.472E-10	0.0000	1.349E-09	0.0000	1.578E-07	0.0010
Pu-240	8.860E-07	0.0059	5.535E-09	0.0000	0.000E+00	0.0000	9.795E-08	0.0006	1.830E-09	0.0000	9.323E-09	0.0001	1.001E-06	0.0066
Sr-90	1.518E-14	0.0000	4.806E-16	0.0000	0.000E+00	0.0000	1.830E-15	0.0000	7.435E-16	0.0000	5.357E-16	0.0000	1.877E-14	0.0000
Total	1.330E-04	0.8799	1.006E-06	0.0067	0.000E+00	0.0000	1.471E-05	0.0973	3.355E-07	0.0022	2.106E-06	0.0139	1.512E-04	1.0000

*Sum of all water independent and dependent pathways.

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Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	Np-237	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	U-233	1.000E+00	6.211E-14	7.379E-13	8.408E-12	8.775E-11	7.097E-10	1.136E-08	1.507E-07	6.591E-07	4.234E-06
Am-241	Th-229	1.000E+00	1.104E-15	3.427E-15	8.817E-15	2.197E-14	8.221E-14	2.195E-12	1.014E-10	1.038E-09	2.391E-08
Am-241	ãDSR(j)		6.321E-14	7.413E-13	8.417E-12	8.777E-11	7.097E-10	1.137E-08	1.508E-07	6.601E-07	4.258E-06
0C-14	C-14	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Co-60	Co-60	1.000E+00	2.947E-05	8.417E-05	1.555E-04	1.992E-04	1.445E-04	1.141E-05	1.224E-10	1.485E-19	0.000E+00
0Cs-137	Cs-137	1.000E+00	9.736E-05	3.118E-04	7.168E-04	1.449E-03	2.449E-03	3.609E-03	1.280E-03	6.570E-05	2.057E-11
0Eu-152	Eu-152	7.208E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Eu-152	Eu-152	2.792E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-152	Gd-152	2.792E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-152	ãDSR(j)		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Eu-154	Eu-154	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Eu-155	Eu-155	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Ni-63	Ni-63	1.000E+00	3.519E-06	1.111E-05	2.604E-05	5.599E-05	1.068E-04	2.414E-04	3.926E-04	2.634E-04	1.973E-06
0Pu-238	Pu-238	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	U-234	1.000E+00	3.756E-07	2.654E-06	1.402E-05	6.684E-05	2.647E-04	1.165E-03	3.005E-03	3.698E-03	1.924E-03
Pu-238	Th-230	1.000E+00	5.798E-14	5.710E-13	4.858E-12	4.195E-11	3.056E-10	4.333E-09	4.663E-08	1.592E-07	5.295E-07
Pu-238	Ra-226	1.000E+00	1.180E-15	4.942E-15	1.581E-14	1.065E-13	1.185E-12	5.182E-11	2.252E-09	1.832E-08	2.465E-07
Pu-238	Pb-210	1.000E+00	5.206E-14	2.087E-13	5.972E-13	2.397E-12	1.020E-11	4.950E-10	5.061E-08	5.625E-07	9.214E-06
Pu-238	ãDSR(j)		3.756E-07	2.654E-06	1.402E-05	6.684E-05	2.647E-04	1.165E-03	3.005E-03	3.699E-03	1.934E-03
0Pu-239	Pu-239	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	U-235	1.000E+00	1.233E-10	8.736E-10	4.639E-09	2.235E-08	9.026E-08	4.355E-07	1.582E-06	3.244E-06	7.641E-06
Pu-239	Pa-231	1.000E+00	1.236E-14	4.991E-14	3.118E-13	2.525E-12	1.909E-11	2.977E-10	4.037E-09	1.930E-08	1.628E-07
Pu-239	Ac-227	1.000E+00	4.207E-14	1.124E-13	2.793E-13	9.999E-13	8.710E-12	3.134E-10	9.074E-09	5.374E-08	5.465E-07
Pu-239	ãDSR(j)		1.234E-10	8.737E-10	4.639E-09	2.235E-08	9.029E-08	4.361E-07	1.595E-06	3.317E-06	8.351E-06
0Pu-240	Pu-240	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-240	U-236	1.000E+00	3.735E-09	2.645E-08	1.405E-07	6.765E-07	2.732E-06	1.317E-05	4.766E-05	9.710E-05	2.214E-04
Pu-240	Th-232	1.000E+00	0.000E+00	4.611E-18	1.258E-17	4.001E-17	1.551E-16	1.352E-15	1.693E-14	8.049E-14	6.725E-13
Pu-240	Ra-228	1.000E+00	0.000E+00	2.360E-18	6.014E-18	1.559E-17	4.728E-17	4.404E-16	7.737E-15	3.929E-14	3.524E-13
Pu-240	Th-228	1.000E+00	0.000E+00	1.333E-18	3.387E-18	8.477E-18	2.326E-17	2.078E-16	4.163E-15	2.157E-14	1.987E-13
Pu-240	ãDSR(j)		3.735E-09	2.645E-08	1.405E-07	6.765E-07	2.732E-06	1.317E-05	4.766E-05	9.710E-05	2.214E-04
0Sr-90	Sr-90	1.000E+00	1.224E-03	3.694E-03	8.296E-03	1.658E-02	2.775E-02	4.002E-02	1.323E-02	5.562E-04	3.076E-11

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ó 0.5 yr) daughters.

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Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

0Nuclide

(i)	t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
Am-241	*3.430E+12	*3.430E+12	1.782E+12	1.709E+11	2.113E+10	1.320E+09	9.946E+07	2.272E+07	3.523E+06
C-14	*4.454E+12	*4.454E+12	*4.454E+12	*4.454E+12	*4.454E+12	*4.454E+12	*4.454E+12	*4.454E+12	*4.454E+12
Co-60	5.090E+05	1.782E+05	9.647E+04	7.529E+04	1.038E+05	1.315E+06	1.226E+11	*1.131E+15	*1.131E+15
Cs-137	1.541E+05	4.810E+04	2.093E+04	1.035E+04	6.126E+03	4.157E+03	1.172E+04	2.283E+05	7.293E+11
Eu-152	*1.765E+14	*1.765E+14	*1.765E+14	*1.765E+14	*1.765E+14	*1.765E+14	*1.765E+14	*1.765E+14	*1.765E+14
Eu-154	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14
Eu-155	*4.651E+14	*4.651E+14	*4.651E+14	*4.651E+14	*4.651E+14	*4.651E+14	*4.651E+14	*4.651E+14	*4.651E+14
Ni-63	4.262E+06	1.350E+06	5.761E+05	2.679E+05	1.404E+05	6.214E+04	3.820E+04	5.695E+04	7.604E+06
Pu-238	3.994E+07	5.651E+06	1.070E+06	2.244E+05	5.668E+04	1.288E+04	4.991E+03	4.055E+03	7.756E+03
Pu-239	*6.212E+10	1.717E+10	3.233E+09	6.712E+08	1.661E+08	3.440E+07	9.404E+06	4.522E+06	1.796E+06
Pu-240	4.016E+09	5.670E+08	1.068E+08	2.217E+07	5.490E+06	1.139E+06	3.147E+05	1.545E+05	6.776E+04
Sr-90	1.226E+04	4.061E+03	1.808E+03	9.048E+02	5.405E+02	3.748E+02	1.133E+03	2.697E+04	4.876E+11

*At specific activity limit

0

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 130.5 ñ 0.3 years

0Nuclide

(i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Am-241	9.080E-03	1.000E+03	4.258E-06	3.523E+06	1.349E-07	1.112E+08
C-14	1.120E+00	0.000E+00	0.000E+00	*4.454E+12	0.000E+00	*4.454E+12
Co-60	2.190E-02	7.18 ñ 0.01	1.992E-04	7.529E+04	3.088E-10	4.857E+10
Cs-137	4.590E-02	42.83 ñ 0.09	3.609E-03	4.156E+03	1.439E-03	1.042E+04
Eu-152	4.460E-02	0.000E+00	0.000E+00	*1.765E+14	0.000E+00	*1.765E+14
Eu-154	7.110E-02	0.000E+00	0.000E+00	*2.639E+14	0.000E+00	*2.639E+14
Eu-155	5.420E-02	0.000E+00	0.000E+00	*4.651E+14	0.000E+00	*4.651E+14
Ni-63	1.630E+00	137.6 ñ 0.3	3.926E-04	3.820E+04	3.921E-04	3.826E+04
Pu-238	7.590E-02	296.4 ñ 0.6	3.699E-03	4.055E+03	2.919E-03	5.139E+03
Pu-239	1.890E-02	1.000E+03	8.351E-06	1.796E+06	1.509E-06	9.941E+06
Pu-240	4.520E-03	1.000E+03	2.214E-04	6.776E+04	4.513E-05	3.324E+05
Sr-90	6.100E-04	41.46 ñ 0.08	4.003E-02	3.748E+02	1.496E-02	1.003E+03

*At specific activity limit

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Summary : 117-DR Cleanup Verification - Deep Zone File: 117dr_d.rad

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Np-237	Am-241	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0U-233	Am-241	1.000E+00	5.639E-16	6.700E-15	7.635E-14	7.967E-13	6.444E-12	1.032E-10	1.369E-09	5.985E-09	3.844E-08
0Th-229	Am-241	1.000E+00	1.003E-17	3.112E-17	8.006E-17	1.995E-16	7.465E-16	1.994E-14	9.210E-13	9.426E-12	2.171E-10
0C-14	C-14	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Co-60	Co-60	1.000E+00	6.454E-07	1.843E-06	3.405E-06	4.363E-06	3.164E-06	2.498E-07	2.680E-12	3.252E-21	0.000E+00
0Cs-137	Cs-137	1.000E+00	4.469E-06	1.431E-05	3.290E-05	6.652E-05	1.124E-04	1.656E-04	5.876E-05	3.016E-06	9.440E-13
0Eu-152	Eu-152	7.208E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-152	Eu-152	2.792E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-152	ãDOSE(j)		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Gd-152	Eu-152	2.792E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Eu-154	Eu-154	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Eu-155	Eu-155	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Ni-63	Ni-63	1.000E+00	5.736E-06	1.812E-05	4.244E-05	9.126E-05	1.742E-04	3.934E-04	6.400E-04	4.294E-04	3.216E-06
0Pu-238	Pu-238	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0U-234	Pu-238	1.000E+00	2.851E-08	2.015E-07	1.064E-06	5.073E-06	2.009E-05	8.842E-05	2.281E-04	2.807E-04	1.460E-04
0Th-230	Pu-238	1.000E+00	4.401E-15	4.334E-14	3.687E-13	3.184E-12	2.320E-11	3.289E-10	3.539E-09	1.208E-08	4.019E-08
0Ra-226	Pu-238	1.000E+00	8.953E-17	3.751E-16	1.200E-15	8.081E-15	8.993E-14	3.933E-12	1.710E-10	1.391E-09	1.871E-08
0Pb-210	Pu-238	1.000E+00	3.951E-15	1.584E-14	4.533E-14	1.819E-13	7.741E-13	3.757E-11	3.841E-09	4.269E-08	6.993E-07
0Pu-239	Pu-239	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0U-235	Pu-239	1.000E+00	2.331E-12	1.651E-11	8.767E-11	4.223E-10	1.706E-09	8.231E-09	2.990E-08	6.132E-08	1.444E-07
0Pa-231	Pu-239	1.000E+00	2.337E-16	9.433E-16	5.893E-15	4.773E-14	3.609E-13	5.627E-12	7.630E-11	3.648E-10	3.078E-09
0Ac-227	Pu-239	1.000E+00	7.951E-16	2.125E-15	5.279E-15	1.890E-14	1.646E-13	5.924E-12	1.715E-10	1.016E-09	1.033E-08
0Pu-240	Pu-240	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0U-236	Pu-240	1.000E+00	1.688E-11	1.196E-10	6.349E-10	3.058E-09	1.235E-08	5.953E-08	2.154E-07	4.389E-07	1.001E-06
0Th-232	Pu-240	1.000E+00	0.000E+00	2.084E-20	5.687E-20	1.809E-19	7.009E-19	6.109E-18	7.652E-17	3.638E-16	3.040E-15

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
Ra-228	Pu-240	1.000E+00	0.000E+00	1.067E-20	2.718E-20	7.047E-20	2.137E-19	1.991E-18	3.497E-17	1.776E-16	1.593E-15
0Th-228	Pu-240	1.000E+00	0.000E+00	6.027E-21	1.531E-20	3.832E-20	1.051E-19	9.395E-19	1.882E-17	9.751E-17	8.981E-16
0Sr-90	Sr-90	1.000E+00	7.465E-07	2.253E-06	5.061E-06	1.011E-05	1.693E-05	2.441E-05	8.073E-06	3.393E-07	1.877E-14

BRF(i) is the branch fraction of the parent nuclide.

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Summary : 117-DR Cleanup Verification - Deep Zone File: 117dr_d.rad

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
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Am-241	Am-241	1.000E+00	9.080E-03	9.065E-03	9.036E-03	8.975E-03	8.863E-03	8.484E-03	7.265E-03	5.591E-03	1.804E-03
0Np-237	Am-241	1.000E+00	0.000E+00	2.939E-09	8.802E-09	2.105E-08	4.358E-08	1.194E-07	3.635E-07	6.980E-07	1.449E-06
0U-233	Am-241	1.000E+00	0.000E+00	6.425E-15	5.771E-14	3.311E-13	1.427E-12	1.091E-11	1.077E-10	4.391E-10	2.672E-09
0Th-229	Am-241	1.000E+00	0.000E+00	2.023E-19	5.454E-18	7.516E-17	6.758E-16	1.455E-14	4.814E-13	4.409E-12	1.022E-10
0C-14	C-14	1.000E+00	1.120E+00	1.120E+00	1.120E+00	1.119E+00	1.118E+00	1.114E+00	1.100E+00	1.076E+00	9.800E-01
0Co-60	Co-60	1.000E+00	2.190E-02	1.920E-02	1.476E-02	8.494E-03	3.044E-03	8.727E-05	2.859E-10	1.588E-19	0.000E+00
0Cs-137	Cs-137	1.000E+00	4.590E-02	4.485E-02	4.282E-02	3.885E-02	3.243E-02	1.736E-02	1.880E-03	4.416E-05	4.034E-12
0Eu-152	Eu-152	7.208E-01	3.215E-02	3.052E-02	2.750E-02	2.211E-02	1.473E-02	3.618E-03	2.454E-05	5.378E-09	8.295E-25
Eu-152	Eu-152	2.792E-01	1.245E-02	1.182E-02	1.065E-02	8.563E-03	5.707E-03	1.401E-03	9.507E-06	2.083E-09	3.213E-25
Eu-152	äS(j):		4.460E-02	4.234E-02	3.816E-02	3.067E-02	2.044E-02	5.019E-03	3.405E-05	7.462E-09	1.151E-24
0Gd-152	Eu-152	2.792E-01	0.000E+00	7.788E-17	2.220E-16	4.800E-16	8.323E-16	1.364E-15	1.535E-15	1.535E-15	1.532E-15
0Eu-154	Eu-154	1.000E+00	7.110E-02	6.571E-02	5.613E-02	4.032E-02	2.181E-02	2.600E-03	1.350E-06	3.871E-12	4.350E-36
0Eu-155	Eu-155	1.000E+00	5.420E-02	4.713E-02	3.564E-02	1.981E-02	6.661E-03	1.530E-04	2.279E-10	3.349E-20	0.000E+00
0Ni-63	Ni-63	1.000E+00	1.630E+00	1.618E+00	1.595E+00	1.546E+00	1.461E+00	1.199E+00	5.949E-01	1.822E-01	1.097E-03
0Pu-238	Pu-238	1.000E+00	7.590E-02	7.530E-02	7.412E-02	7.170E-02	6.741E-02	5.444E-02	2.547E-02	7.069E-03	2.779E-05
0U-234	Pu-238	1.000E+00	0.000E+00	2.142E-07	6.368E-07	1.499E-06	3.016E-06	7.490E-06	1.642E-05	1.943E-05	9.757E-06
0Th-230	Pu-238	1.000E+00	0.000E+00	9.655E-13	8.637E-12	4.912E-11	2.083E-10	1.508E-09	1.246E-08	3.958E-08	1.308E-07
0Ra-226	Pu-238	1.000E+00	0.000E+00	1.395E-16	3.749E-15	5.131E-14	4.555E-13	9.388E-12	2.692E-10	2.001E-09	2.572E-08
0Pb-210	Pu-238	1.000E+00	0.000E+00	1.078E-18	8.591E-17	2.756E-15	4.882E-14	2.449E-12	1.538E-10	1.546E-09	2.423E-08
0Pu-239	Pu-239	1.000E+00	1.890E-02	1.890E-02	1.890E-02	1.889E-02	1.889E-02	1.887E-02	1.879E-02	1.867E-02	1.813E-02
0U-235	Pu-239	1.000E+00	0.000E+00	1.860E-11	5.574E-11	1.334E-10	2.767E-10	7.620E-10	2.363E-09	4.670E-09	1.065E-08
0Pa-231	Pu-239	1.000E+00	0.000E+00	1.968E-16	1.770E-15	1.018E-14	4.402E-14	3.411E-13	3.535E-12	1.562E-11	1.322E-10
0Ac-227	Pu-239	1.000E+00	0.000E+00	2.072E-18	5.504E-17	7.353E-16	6.251E-15	1.126E-13	2.301E-12	1.278E-11	1.250E-10
0Pu-240	Pu-240	1.000E+00	4.520E-03	4.519E-03	4.518E-03	4.516E-03	4.512E-03	4.498E-03	4.447E-03	4.362E-03	4.015E-03
0U-236	Pu-240	1.000E+00	0.000E+00	1.337E-10	4.006E-10	9.589E-10	1.988E-09	5.469E-09	1.689E-08	3.316E-08	7.313E-08
0Th-232	Pu-240	1.000E+00	0.000E+00	3.299E-21	2.967E-20	1.706E-19	7.378E-19	5.716E-18	5.921E-17	2.613E-16	2.201E-15

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Summary : 117-DR Cleanup Verification - Deep Zone File: 117dr_d.rad

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.380E+02	3.000E+02	1.000E+03
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ
Ra-228	Pu-240	1.000E+00	0.000E+00	1.287E-22	3.276E-21	4.029E-20	2.994E-19	3.910E-18	5.268E-17	2.480E-16	2.172E-15
0Th-228	Pu-240	1.000E+00	0.000E+00	1.092E-23	7.381E-22	1.735E-20	1.912E-19	3.357E-18	5.055E-17	2.436E-16	2.162E-15
0Sr-90	Sr-90	1.000E+00	6.100E-04	5.956E-04	5.678E-04	5.136E-04	4.262E-04	2.235E-04	2.253E-05	4.689E-07	2.537E-14
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BRF(i) is the branch fraction of the parent nuclide.
0RESCALC.EXE execution time = 16.97 seconds

CALCULATION BRIEF EXCERPTS

DISCLAIMER FOR CALCULATIONS

The calculations that are provided in the following appendix are included for reference only. Use of these calculations by persons who do not have access to all of their pertinent factors could lead to incorrect conclusions or assumptions.

Before applying these calculations to work activities or projects outside the context of this report, these calculations must be thoroughly reviewed with appropriate and authorized Hanford Site ERC personnel. Without this review, the ER Project cannot assume any responsibility for the use of these calculations.

CALCULATION BRIEFS

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

Figure C-1. RCRA Sample Design.

117-DR Variance Calculation for Shallow Zone Soils, 0100D-CA-V0250, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

117-DR Exhaust Tunnel Shallow & Deep Zone Sampling Plan, 0100D-CA-V0251, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

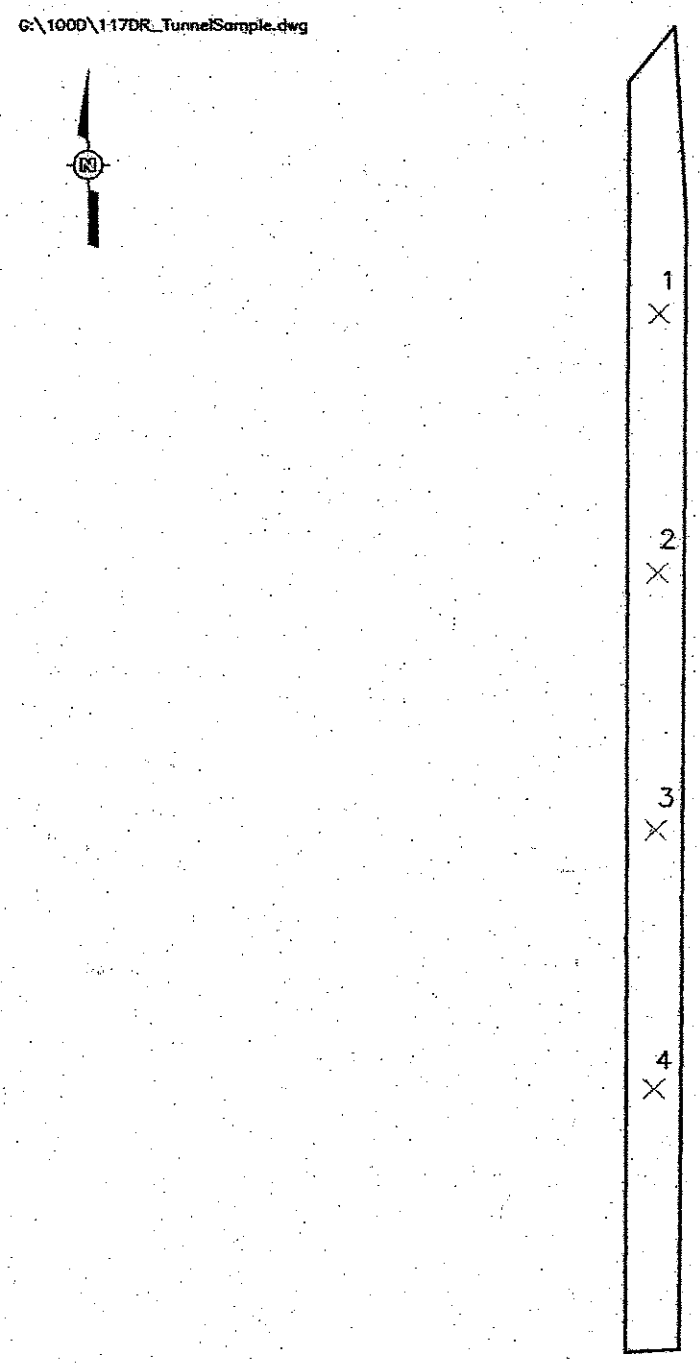
117-DR 95% UCL Calculation, 105DR-CA-V0001, Rev. 1, Bechtel Hanford, Inc., Richland, Washington.

117-DR RESRAD Calculation, 105DR-CA-V0002, Rev. 1, Bechtel Hanford, Inc., Richland, Washington.

117-DR Filter Building Comparison to Drinking Water Standards Calculation Brief, 105DR-CA-V0003, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

NOTE: The calculation briefs referenced in this appendix are kept in the active Environmental Restoration Contractor 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.

Figure C-1. RCRA Sample Design.



117-DR BUILDING EXHAUST TUNNEL	Sample Location	Northing	Easting
	1	151237.83	573749.16
	2	151228.49	573749.04
	3	151219.15	573748.92
	4	151209.81	573748.79

117-DR BUILDING EXHAUST TUNNEL

(SAMPLING PLAN)

SCALE 1:250

2.5 0 2.5 5 10 meters

E0311066

CALCULATION COVER SHEET

Project Title: 117-DR Exhaust Filter Building **Job No.** 22192
Area 100-DR
Discipline Environmental ***Calc. No.:** 0100D-CA-V0250
Subject 117-DR Variance Calculation for Shallow Zone Soils
Computer Program Excel **Program No.** Excel 97

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

Committed Calculation X **Preliminary** **Superseded**

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover - 1 Calculations - 4 Total -5	8/26/03 R.A. Thoren	8/26/03 I.D. Jacques	9/3/03 R.R. Nielson	9/3/03 K.J. Koegler	

SUMMARY OF REVISIONS

0	

Calculation Summary

Bechtel Hanford Inc.

CALCULATION SHEET

Originator	R.A. Thoren	Date	8/25/2003	Calc. No.	0100D-CA-V0250	Rev. No.	0
Project	117-DR Exhaust Filter Building	Job No.	22192	Checked	I.D. Jacques	Date	8/26/03
Subject	117-DR Variance Calculation for Shallow Zone Soils					Sheet No.	1 of 4

Problem:
Calculate the number of close out samples required for the 117-DR Exhaust Filter Building Shallow Zone Soils as required by the"100 Area Remedial Action Sampling and Analysis Plan" (DOE/RL-96-22, Rev. 3) and the "Instruction Guide for the Remediation of 100 Areas Waste Sites" (0100X-IG-G0001, Rev. 4).

Given:
1) Summary of Gamma Energy Analysis (GEA) results are from sample data group (SDG) H2306.
2) Lookup values from DOE/RL-96-22, Rev. 3.
3) Sample Design requirements from DOE/RL-96-22, Rev. 3 and 0100X-IG-G0001, Rev. 4.

Solution:
Calculation methodology is described in Appendix A of DOE/RL-96-22, Rev. 3. Data from attached worksheets are used to calculate the required number of closeout samples. The Variance calculation is based on the same three isotopes used to develop the statistical approach in DOE/RL-96-22, Rev. 3. The statistical design is based on the premise that these isotopes are the predominant components of the contamination and are representative of the contamination distribution.

Sheet No.	Contents	Topic
1	Calculation Summary	Summary of Calc Brief
2	Variance calculation	Required Number of Samples Calculation
3	Variance Calculation formulas	Formulas
4	Variance Sample Data	GEA data summary from SDG H2306

The calculation and data sheets are interlinked within the spreadsheet such that a change in the data will affect the calculation.

Conclusion:
The required number of samples calculated **(1 sample)** for the shallow zone soils is less than the default number **(4 samples)** specified in the "100 Area Remedial Action Sampling and Analysis Plan" (DOE/RL-96-22, Rev. 3). Therefore, the default number of samples will be collected from the shallow zone soils.

Variance

CALCULATION SHEET

Bechtel Hanford Inc.

Originator	R.A. Thoren	Date	8/25/2003	Calc. No.	0100D-CA-V0250	Rev. No.	0
Project	117-DR Exhaust Filter Building	Job No.	22192	Checked	J.D. Jacques	Date	8/26/03
Subject	117-DR Variance Calculation for Shallow Zone Soils					Sheet No.	2 of 4

1 **Statistical Evaluation of Analytical Data**
2 Decision Unit: Shallow Zone Sample Areas: A
3 The required number of samples resulting from the calculation is highlighted at the bottom of the page.
4 Each value is reflective of the specific analyte evaluated.
5 The highest value of the three evaluations is used to determine the required number of samples as compared against the default of four samples
6 Summary of Gamma Energy Analysis (GEA) results are from sample data group (SDG) H2306.
7 Mean, Standard Deviation, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.
8
9
10
11 **Samples values from GEA analysis**

12				Constituent					
13 Sample #	Sample Date	Location	Cobalt-60 pCi/g	Q	Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q
14								
15 Look-up Value (HI) ==>			1.4		6.2		3.3	
16 J00WD3	8/5/2003	A1-2	0.12	U	0.11	U	0.23	U
17 J00WD4	8/5/2003	A1-3	0.080	U	0.081	U	0.21	U
18 J00WD5	8/5/2003	A1-4	0.078	U	0.072	U	0.15	U
19 J00WD6	8/5/2003	A1-10	0.083	U	0.206		0.20	U
20 J00WD7	8/5/2003	A1-13	0.078	U	0.068	U	0.18	U
21 J00WD8	8/5/2003	A1-16	0.049	U	0.049	U	0.11	U
22 J00WD9	8/5/2003	A2-3	0.070	U	0.057	U	0.14	U
23 J00WF0	8/5/2003	A2-6	0.058	U	0.072	U	0.14	U
24 J00WF1	8/5/2003	A2-7	0.053	U	0.055		0.11	U
25 J00WF2	8/5/2003	A2-10	0.062	U	0.057	U	0.12	U
26 J00WF3	8/5/2003	A2-14	0.051	U	0.059	U	0.12	U
J00WF4	8/5/2003	A2-15	0.041	U	0.039	U	0.091	U
28 J00WF5	8/5/2003	A3-1	0.087	U	0.08	U	0.18	U
29 J00WF6	8/5/2003	A3-2	0.063	U	0.067	U	0.15	U
30 J00WF7	8/5/2003	A3-4	0.050	U	0.060		0.11	U
31 J00WF8	8/5/2003	A3-5	0.068	U	0.456		0.15	U
32 J00WF9	8/5/2003	A3-9	0.050	U	0.057	U	0.13	U
33 J00WH0	8/5/2003	A3-11	0.050	U	0.046	U	0.096	U
34 J00WH1	8/5/2003	A4-3	0.063	U	0.067	U	0.14	U
35 J00WH2	8/5/2003	A4-4	0.052	U	0.094		0.12	U
36 J00WH3	8/5/2003	A4-7	0.033	U	0.042		0.080	U
37 J00WH4	8/5/2003	A4-9	0.060	U	0.058	U	0.14	U
38 J00WH6	8/5/2003	A4-12	0.039	U	0.287		0.099	U
39 J00WH5	8/5/2003	A4-13	0.058	U	0.139		0.12	U
40 Mean (LV) ==>			0.06		0.10		0.14	
41 Standard Deviation (S) ==>			0.02		0.09		0.04	
42 α (5%) ==>			1.645		1.645		1.645	
43 β (20%) ==>			0.842		0.842		0.842	
44 Number of Samples ==>			1		1		1	

For

	A	B	C	D	E		G	H	I	J
1										
2										
3		Fluor Hanford Inc.				CALCULATION SHEET				
4		HANFORD								
5		Originator	R.A. Thoren	Date 8/25/03		Calc. No. 0100D-CA-V0250		Rev. No. 0		
6		Project	117-DR Exhaust Filter Building	Job No. 22192		Checked I.D. Jacques		Date 8/26/03		
7		Subject	117-DR Variance Calculation for Shallow Zone Soils					Sheet No. 3 of 4		
8										
9	1	Statistical Evaluation of Analytical Data								
10	2	Decision Unit:	Shallow Zone							
11	3	The required number of samples resulting from the calculation is highlighted at the bottom of the page.				Sample Areas: A				
12	4	Each value is reflective of the specific analyte evaluated.								
13	5	The highest value of the three evaluations is used to determine the required number of samples as compared against the default of four samples								
14	6	Summary of Gamma Energy Analysis (GEA) results are from sample data group (SDG) H2306.								
15	7	Mean, Standard Deviation, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.								
16	8									
17	9									
18	10									
19	11	Samples values from GEA analysis								
20	12									
21	13	Sample #	Sample Date	Location	Constituent					
22	14				Cobalt-60	Q	Cesium-137	Q	Europium-152	Q
23	15	Look-up Values==>			pCi/g		pCi/g		pCi/g	
24	16	=Data Summary!B23	=Data Summary!C23	=Data Summary!D23	1.4		5.3		5.3	
25	17	=Data Summary!B24	=Data Summary!C24	=Data Summary!D24	=Data Summary!E23	=Data Summary!F23	=Data Summary!G23	=Data Summary!H23	=Data Summary!I23	=Data Summary!J23
26	18	=Data Summary!B25	=Data Summary!C25	=Data Summary!D25	=Data Summary!E24	=Data Summary!F24	=Data Summary!G24	=Data Summary!H24	=Data Summary!I24	=Data Summary!J24
27	19	=Data Summary!B26	=Data Summary!C26	=Data Summary!D26	=Data Summary!E25	=Data Summary!F25	=Data Summary!G25	=Data Summary!H25	=Data Summary!I25	=Data Summary!J25
28	20	=Data Summary!B27	=Data Summary!C27	=Data Summary!D27	=Data Summary!E26	=Data Summary!F26	=Data Summary!G26	=Data Summary!H26	=Data Summary!I26	=Data Summary!J26
29	21	=Data Summary!B28	=Data Summary!C28	=Data Summary!D28	=Data Summary!E27	=Data Summary!F27	=Data Summary!G27	=Data Summary!H27	=Data Summary!I27	=Data Summary!J27
30	22	=Data Summary!B29	=Data Summary!C29	=Data Summary!D29	=Data Summary!E28	=Data Summary!F28	=Data Summary!G28	=Data Summary!H28	=Data Summary!I28	=Data Summary!J28
31	23	=Data Summary!B30	=Data Summary!C30	=Data Summary!D30	=Data Summary!E29	=Data Summary!F29	=Data Summary!G29	=Data Summary!H29	=Data Summary!I29	=Data Summary!J29
32	24	=Data Summary!B31	=Data Summary!C31	=Data Summary!D31	=Data Summary!E30	=Data Summary!F30	=Data Summary!G30	=Data Summary!H30	=Data Summary!I30	=Data Summary!J30
33	25	=Data Summary!B32	=Data Summary!C32	=Data Summary!D32	=Data Summary!E31	=Data Summary!F31	=Data Summary!G31	=Data Summary!H31	=Data Summary!I31	=Data Summary!J31
34	26	=Data Summary!B33	=Data Summary!C33	=Data Summary!D33	=Data Summary!E32	=Data Summary!F32	=Data Summary!G32	=Data Summary!H32	=Data Summary!I32	=Data Summary!J32
35	27	=Data Summary!B34	=Data Summary!C34	=Data Summary!D34	=Data Summary!E33	=Data Summary!F33	=Data Summary!G33	=Data Summary!H33	=Data Summary!I33	=Data Summary!J33
36	28	=Data Summary!B35	=Data Summary!C35	=Data Summary!D35	=Data Summary!E34	=Data Summary!F34	=Data Summary!G34	=Data Summary!H34	=Data Summary!I34	=Data Summary!J34
37	29	=Data Summary!B36	=Data Summary!C36	=Data Summary!D36	=Data Summary!E35	=Data Summary!F35	=Data Summary!G35	=Data Summary!H35	=Data Summary!I35	=Data Summary!J35
38	30	=Data Summary!B37	=Data Summary!C37	=Data Summary!D37	=Data Summary!E36	=Data Summary!F36	=Data Summary!G36	=Data Summary!H36	=Data Summary!I36	=Data Summary!J36
39	31	=Data Summary!B38	=Data Summary!C38	=Data Summary!D38	=Data Summary!E37	=Data Summary!F37	=Data Summary!G37	=Data Summary!H37	=Data Summary!I37	=Data Summary!J37
40	32	=Data Summary!B39	=Data Summary!C39	=Data Summary!D39	=Data Summary!E38	=Data Summary!F38	=Data Summary!G38	=Data Summary!H38	=Data Summary!I38	=Data Summary!J38
41	33	=Data Summary!B40	=Data Summary!C40	=Data Summary!D40	=Data Summary!E39	=Data Summary!F39	=Data Summary!G39	=Data Summary!H39	=Data Summary!I39	=Data Summary!J39
42	34	=Data Summary!B41	=Data Summary!C41	=Data Summary!D41	=Data Summary!E40	=Data Summary!F40	=Data Summary!G40	=Data Summary!H40	=Data Summary!I40	=Data Summary!J40
43	35	=Data Summary!B42	=Data Summary!C42	=Data Summary!D42	=Data Summary!E41	=Data Summary!F41	=Data Summary!G41	=Data Summary!H41	=Data Summary!I41	=Data Summary!J41
44	36	=Data Summary!B43	=Data Summary!C43	=Data Summary!D43	=Data Summary!E42	=Data Summary!F42	=Data Summary!G42	=Data Summary!H42	=Data Summary!I42	=Data Summary!J42
45	37	=Data Summary!B44	=Data Summary!C44	=Data Summary!D44	=Data Summary!E43	=Data Summary!F43	=Data Summary!G43	=Data Summary!H43	=Data Summary!I43	=Data Summary!J43
46	38	=Data Summary!B45	=Data Summary!C45	=Data Summary!D45	=Data Summary!E44	=Data Summary!F44	=Data Summary!G44	=Data Summary!H44	=Data Summary!I44	=Data Summary!J44
47	39	=Data Summary!B46	=Data Summary!C46	=Data Summary!D46	=Data Summary!E45	=Data Summary!F45	=Data Summary!G45	=Data Summary!H45	=Data Summary!I45	=Data Summary!J45
48	40	Mean (LV) ==========>			=Data Summary!E46	=Data Summary!F46	=Data Summary!G46	=Data Summary!H46	=Data Summary!I46	=Data Summary!J46
49	41	Standard Deviation (S) ==========>			=AVERAGE(E24:E47)		=AVERAGE(G24:G47)		=AVERAGE(I24:I47)	
50	42	α (5%) ==========>			=STDEV(E24:E47)		=STDEV(G24:G47)		=STDEV(I24:I47)	
51	43	β (20%) ==========>			1.645		1.645		1.645	
52	44	Number of Samples ==========>			0.842		0.842		0.842	
					=ROUNDUP((1.645+0.842)^2/(((E23-E48)/E49)^2),0)		=ROUNDUP((1.645+0.842)^2/(((G23-G48)/G49)^2),0)		=ROUNDUP((1.645+0.842)^2/(((I23-I48)/I49)^2),0)	

Data Summary

CALCULATION SHEET
Bechtel Hanford Inc.

Originator	R.A. Thoren	Date 8/25/2003	Calc. No.	0100D-CA-V0250	Rev. No. 0
Project	117-DR Exhaust Filter Building	Job No. 22192	Checked	I.D. Jacques	Date 8/26/03
Subject	117-DR Variance Calculation for Shallow Zone Soils				Sheet No. 4 of 4

1 **Statistical Evaluation of Analytical Data**
2 Decision Unit: Shallow Zone — Sample Areas: A
4 Each value is reflective of the specific analyte evaluated.
5 The highest value of the three evaluations is used to determine the required number of samples as compared against the default of four samples
6 Summary of Gamma Energy Analysis (GEA) results are from sample data group (SDG) H2306.
7 Mean, Standard Deviation, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

12 **Samples values from GEA analysis (SDG H2306)**

15	samp_num	samp_date_time	Sample Node	Co60	Q	Cs137	Q	Eu152	Q
16	J00WD3	8/5/2003	A1-2	0.12	U	0.11	U	0.23	U
17	J00WD4	8/5/2003	A1-3	0.080	U	0.081	U	0.21	U
18	J00WD5	8/5/2003	A1-4	0.078	U	0.072	U	0.15	U
19	J00WD6	8/5/2003	A1-10	0.083	U	0.206		0.20	U
20	J00WD7	8/5/2003	A1-13	0.078	U	0.068	U	0.18	U
21	J00WD8	8/5/2003	A1-16	0.049	U	0.049	U	0.11	U
22	J00WD9	8/5/2003	A2-3	0.070	U	0.057	U	0.14	U
23	J00WF0	8/5/2003	A2-6	0.058	U	0.072	U	0.14	U
24	J00WF1	8/5/2003	A2-7	0.053	U	0.055		0.11	U
25	J00WF2	8/5/2003	A2-10	0.062	U	0.057	U	0.12	U
26	J00WF3	8/5/2003	A2-14	0.051	U	0.059	U	0.12	U
27	J00WF4	8/5/2003	A2-15	0.041	U	0.039	U	0.091	U
28	J00WF5	8/5/2003	A3-1	0.087	U	0.08	U	0.18	U
29	J00WF6	8/5/2003	A3-2	0.063	U	0.067	U	0.15	U
30	J00WF7	8/5/2003	A3-4	0.050	U	0.060		0.11	U
31	J00WF8	8/5/2003	A3-5	0.068	U	0.456		0.15	U
32	J00WF9	8/5/2003	A3-9	0.050	U	0.057	U	0.13	U
33	J00WH0	8/5/2003	A3-11	0.050	U	0.046	U	0.096	U
34	J00WH1	8/5/2003	A4-3	0.063	U	0.067	U	0.14	U
35	J00WH2	8/5/2003	A4-4	0.052	U	0.094		0.12	U
36	J00WH3	8/5/2003	A4-7	0.033	U	0.042		0.080	U
37	J00WH4	8/5/2003	A4-9	0.060	U	0.058	U	0.14	U
38	J00WH6	8/5/2003	A4-12	0.039	U	0.287		0.099	U
39	J00WH5	8/5/2003	A4-13	0.058	U	0.139		0.12	U

CALCULATION COVER SHEET

Project Title:	117-DR Exhaust Tunnel Sample Design	**Job No.**	22192
Area	100-D/DR		
Discipline	Environmental Engineering	**Calc. No.**	0100D-CA-V0251
Subject	117-DR Exhaust Tunnel Shallow & Deep Zone Sampling Plan		
Computer Program	Excel	**Program No.**	Excel 97

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

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 = 2 Shts Total = 7 Shts	G. Cruz 9/12/03	J.M. Wimett 9/22/03	R.A. Thoren 9/29/03	K.J. Koegler 9/29/03	

SUMMARY OF REVISIONS

*Obtain Calc. No. from DIS

January 2003

DE01-437.03

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator G. Cruz **Date** 9/12/2003 **Calc. No.** 0100D-CA-V0251 **Rev. No.** 0

Project 117-DR Exhaust Tunnel Sample Design **Job No.** 22192 **Checked** **Date** 9/22/03

Subject 117-DR Exhaust Tunnel Shallow & Deep Zone Sampling Plan **Sheet No.** 1 of 2

Problem: Calculate and display required sampling nodes in concurrence with 100 Area SAP DOE/RL-96-22 Rev. 3 for verification and closure.

Given:
-SAP (DOE/RL-96-22 Rev. 3) and IG (0100X-IG-G0001 Rev. 4) requirements
-Shallow Sampling Area (Surface area of each zone determined from CAD program, Attachment 3, Sht 1of2, CAD file 1D:091203A, 117-DR Exhaust Tunnel Shallow Zone Sampling Plan)
-Deep Zone Sampling Area (Surface area of each zone determined from CAD program, Attachment 3, Sht 2of2, CAD file 1D:091203B, 117-DR Exhaust Tunnel Deep Zone Sampling Plan)

SAP and IG Requirements:

Shallow Zone
-Develop a 16 node sampling grid for the sampling area
-Use appendix A of the IG to determine which six of the sixteen will be sampled to collect HPGe and clean up verification samples

Overburden:
-Develop a 16 node sampling grid for the sampling area
-Use appendix A of the IG to determine which six of the sixteen will be sampled to collect HPGe and clean up verification samples

Deep Zone:
-Develop a 16 node sampling grid for the sampling area
-Use appendix A of the IG to determine which four of the sixteen will be sampled to collect HPGe and clean up verification samples

Determination of Shallow Zone Sampling Grid:

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

Total Area:	1010.07	m^2
Area of Decision Subunits (total area 1 subunit)	1010.07	m^2
Decision Subunit divided into 4 Sampling Areas:	252.51	m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):	15.78	m^2

Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)
See Attachment 3, Sht 1of2, 117-DR Exhaust Tunnel Shallow Zone Sampling Plan, for Sample Location Table

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator G. Cruz **Date** 9/12/2003 **Calc. No.** 0100D-CA-V0251 **Rev. No.** 0
Project 117-DR Exhaust Tunnel Sample Design **Job No.** 22192 **Checked** [illegible] **Date** 9/22/03
Subject 117-DR Exhaust Tunnel Shallow & Deep Zone Sampling Plan **Sheet No.** 2 of 2

Determination of Deep Zone Sampling Grid:

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

Total Area: 479.02 m^2
Area of Decision Subunits (total area 1 subunit) 479.02 m^2

Decision Subunits divided into 3 Sampling Areas: 159.67 m^2

Sampling Areas divided into a 16 node grid (node numbers 1-16): 9.97 m^2

Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)
See Attachment 3, Sht 2of2, 117-DR Exhaust Tunnel Deep Zone Sampling Plan,
for Sample Location Table

Bechtel Hanford, Inc.

Originator G. Cruz Date 9/12/2003 Calc. No. 0100D-CA-V0251 Rev. No. 0
Project 117-DR Exhaust Tunnel Sample Design Job No. 22192 Checked Date 9/22/03
Subject 117-DR Exhaust Tunnel Shallow & Deep Zone Sampling Plan Sheet No 1 of 1

ATTACHMENT 1

Sample Grid Point Lookup Table.

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

** Note: Grid nodes for each sampling area in each waste site should be numbered consistently, e.g., begin numbering the nodes in the northwesternmost node. Then number consecutively left to right as shown in Fig. 5-1 of this IG

Bechtel Hanford, Inc.

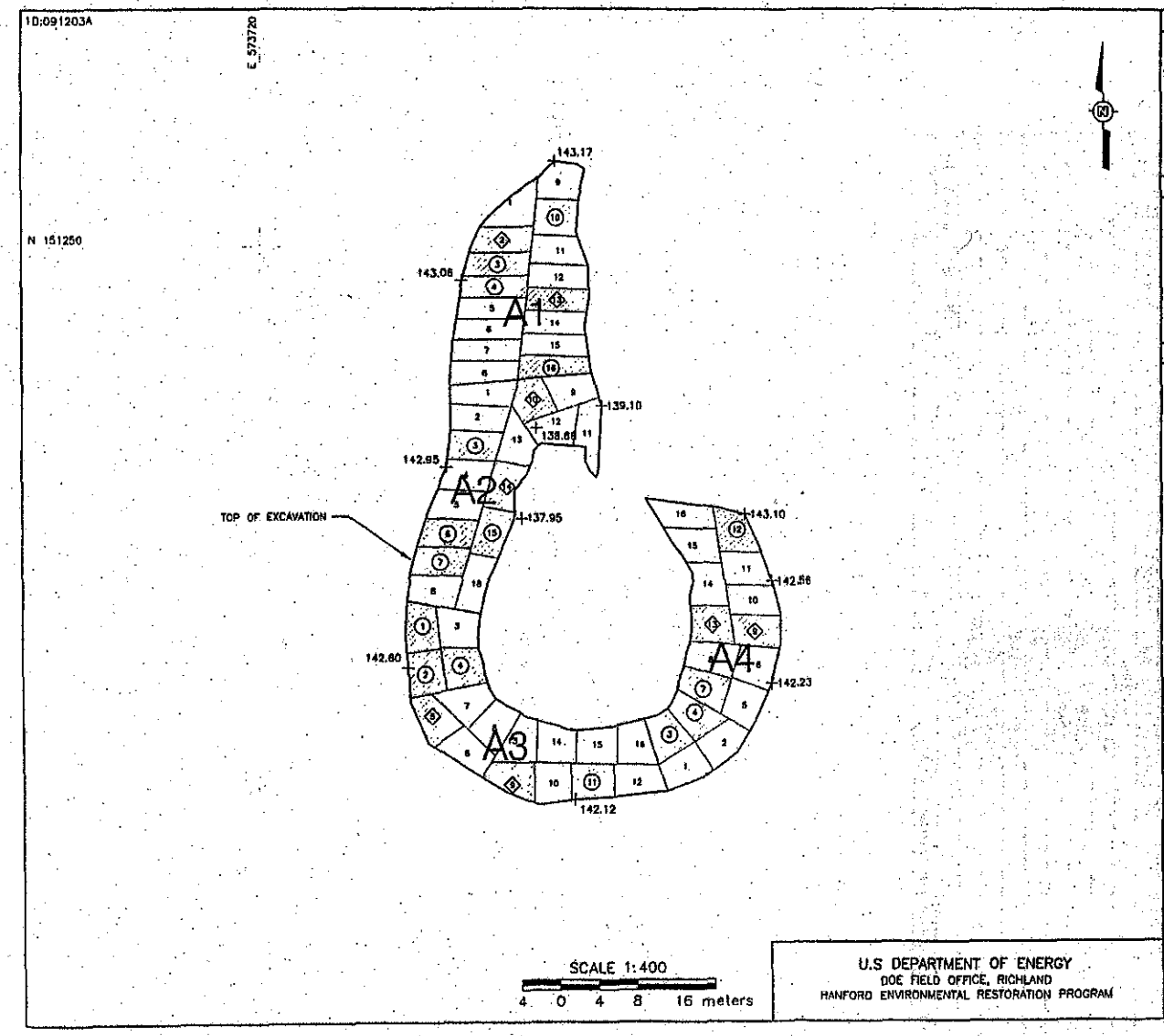
Originator G. Cruz Date 9/12/2003 Calc. No. 0100D-CA-V0251 Rev. No. 0
Project 117-DR Exhaust Tunnel Sample Design Job No. 22192 Checked Date 9/22/03
Subject 117-DR Exhaust Tunnel Shallow & Deep Zone Sampling Plan Sheet No. 1 of 1

ATTACHMENT 2

Number of Decision Subunits Based on Area.

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

a ROUND is an integer rounding function.



NOTES

1. SHALLOW ZONE NODE AREAS ARE APPROXIMATELY 15.78 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.
4. ALL ELEVATIONS SHOWN ARE REFERENCED DATUM NAVD88

LEGEND

GAMMA ENERGY ANALYSIS & CLOSEOUT VERIFICATION SAMPLING NODE

GAMMA ENERGY ANALYSIS SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	S-A1-3	151250.84	573744.74
		S-A1-4	151245.13	573744.28
		S-A1-7	151245.79	573743.87
		S-A1-10	151252.85	573750.35
		S-A1-13	151244.35	573750.47
		S-A1-16	151237.06	573749.92
	A2	S-A2-3	151228.01	573741.86
		S-A2-6	151219.84	573735.10
		S-A2-7	151218.97	573736.45
		S-A2-10	151233.84	573747.84
		S-A2-14	151224.44	573746.17
		S-A2-16	151219.68	573743.68
	A3	S-A3-1	151210.38	573735.57
		S-A3-2	151203.50	573736.68
		S-A3-4	151208.33	573740.42
		S-A3-5	151201.28	573737.53
		S-A3-8	151194.09	573745.54
		S-A3-11	151196.30	573753.30
	A4	S-A4-3	151199.17	573761.86
		S-A4-5	151201.43	573764.53
		S-A4-7	151203.83	573768.40
		S-A4-9	151209.68	573770.82
		S-A4-12	151210.10	573769.02
		S-A4-13	151210.28	573768.45

Attachment 3 Sheet No. 1 of 2
Originator G. CRUZ Date 9/12/03
Checked By J.M. WINETT Date 9/22/03
Calc. No. 01000-CA-V0251 Rev. No. 0

ATTACHMENT 3

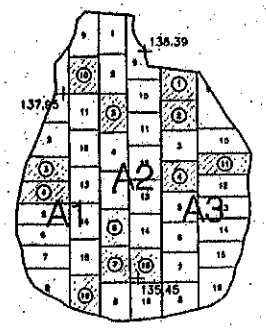
U.S DEPARTMENT OF ENERGY
DOE FIELD OFFICE, RICHLAND
HANFORD ENVIRONMENTAL RESTORATION PROGRAM

100 D AREA
100 AREA REMEDIAL DESIGN
117-DR EXHAUST TUNNEL
SHALLOW ZONE SAMPLING PLAN

10:0912038

E 573720

N 151250



SCALE 1:400

4 0 4 8 16 meters

NOTES

1. DEEP ZONE NODE AREAS ARE APPROXIMATELY 9.97 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE DEEP ZONE CONSISTS OF SAMPLING AREAS A1, A2, & A3 WITHIN DECISION SUBUNIT 1.
4. ALL ELEVATIONS SHOWN ARE REFERENCED DATUM NAVD88

LEGEND

GAMMA ENERGY ANALYSIS & CLOSEOUT VERIFICATION SAMPLING NODE

GAMMA ENERGY ANALYSIS SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	D-A1-3	151214.23	573745.02
		D-A1-4	151212.00	573744.82
		D-A1-10	151223.13	573748.69
		D-A1-16	151202.12	573748.78
	A2	D-A2-3	151219.81	573751.49
		D-A2-6	151208.60	573751.85
		D-A2-7	151205.07	573751.82
		D-A2-15	151204.86	573754.52
	A3	D-A3-1	151222.28	573757.69
		D-A3-2	151219.24	573757.70
		D-A3-4	151213.44	573757.72
		D-A3-11	151214.62	573761.83

Attachment 3 — Sheet No. 2 of 2
Originator G. CRUZ — Date 9/12/03
Chk'd By L.J. WINGETT — Date 9/22/03
Calc. No. 01900-CA-V0251 — Rev. No. 0

ATTACHMENT 3

U.S DEPARTMENT OF ENERGY
DOE FIELD OFFICE, RICHLAND
HANFORD ENVIRONMENTAL RESTORATION PROGRAM

100 D AREA
100 AREA REMEDIAL DESIGN
117-DR EXHAUST TUNNEL
DEEP ZONE SAMPLING PLAN

CALCULATION COVER SHEET

Project Title:	117-DR Cleanup Verification	**Job No.**	22192
Area	100-D		
Discipline	Environmental	***Calc. No.**	105DR-CA-V0001
Subject	117-DR 95% UCL Calculation		
Computer Program	Excel	**Program No.**	Excel 97

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 9 Total = 10	*Approved* *10/24/2003* I.D Jacques	*Approved* *10/24/2003* J.E. Thomson *Approved* *10/24/2003* T.B. Miley	*Approved* *11/6/2003* J.W. Golden	*Approved* *11/11/2003* K.J. Koegler	
1	No Changes	I.D. Jacques 12/16/03 I.D Jacques	J.E. Thomson 12/16/03 J.E. Thomson	J.W. Golden 12/22/03 J.W. Golden	R.B. Egge for K.J. Koegler	12-22-03

SUMMARY OF REVISIONS

1	Errors were discovered in the formulas for calculating the Shallow Zone 95%UCL on the mean for the following non-radioactive constituents: arsenic, barium, cadmium, lead, lithium, and selenium. The computational errors were corrected which resulted in different statistical values above background for each of the constituents. However, the revised values did not affect the overall conclusions of the calculation brief. Cleanup limits for lithium and sodium were changed from background values to NA since there are no cleanup limits for these constituents. An erroneous heading on the Shallow Zone Data and Deep Zone Data tables was also corrected.

* Obtain calc no. from DIS

Dec-02

DE01-437.03

Bechtel Hanford, Inc. CALCULATION SHEET

Originator	I.D Jacques	Date	12/16/03	Calc. No.	105DR-CA-V0001	Rev. No.	1
Project	117-DR Cleanup Verification	Job No.	22192	Checked	J.E. Thomson	Date	12/16/03
Subject	117-DR 95% UCL Calculation					Sheet No.	1 of 10

Purpose:
Calculate the 95% UCL to evaluate compliance with cleanup standards for the 117-DR waste site. Also, calculate the carcinogenic risk for applicable nonradionuclide analytes (shallow zone only), WAC 173-340 [Model Toxics Control Act (MTCA)] 3-part test, if required (all nonradionuclide analytes), and the relative percent difference (RPD) for duplicate and split samples for each contaminant of concern (COC).

Table of Contents:
Page 1: Calculation Sheet Summary
Page 2: Calculation Sheet Summary
Pages 3, 4, and 5: Shallow Zone Data
Pages 6, 7 and 8: Deep Zone Data
Pages 9 and 10: Split -Dup Analysis

Given/References:
1) Sample Results
2) Lookup values and RAGs are taken from the SAP (DOE-RL, 2000) and RDR (DOE-RL, 2001).
3) DOE-RL, 2000, Sampling and Analysis Plan for the 105-F and 105-DR Phase III Below-Grade Structures and Underlying Soils DOE/RL-99-35, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) DOE-RL, 2001, 100 Area Remedial Action Sampling and Analysis Plan (SAP), DOE/RL-96-22, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) DOE-RL, 2002, Remedial Design Report/Remedial Action Work Plan for the 100 Area, DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
5) BHI, 2001, Instruction Guide for the Remediation of the 100 Area Waste Sites, 0100X-IG-G0001, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.
6) Washington Administrative Code-173-340, and Statistical Guidance for Ecology Site Managers, Ecology Pub. #92-54, Washington Department of Ecology, Olympia, Washington.
7) Ecology, 1993, Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-Detection Limit or Below-PQL Values (Censored Data Sets).
6) EPA, 1994, WSEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA 540/R-94/013.
9) Ecology, 2001 Model Toxic Control Act Cleanup Levels and Risk Calculations (CLARC II) Update, Publication #940145, Washington State Department of Ecology, Olympia, Washington.
10) Hexavalent chromium carcinogenic risk cleanup levels for soil through the inhalation pathway are included in Calculation of Hexavalent Chromium Carcinogenic Risk, 0100X-CA-V0031.

Solution:
Calculation methodology is described in Ecology Pub. #92-54 and below. Use data from attached worksheets to calculate the 95% upper confidence limit (UCL) for each analyte, calculate carcinogenic risk, perform the WAC 173-340 3-part test for nonradionuclides, and calculate an RPD for each COC as indicated.

Calculation Description:
The subject calculations were performed on data from soil verification samples from the 117-DR waste site. The data were entered into an EXCEL 97 spreadsheet and calculations performed by utilizing the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP 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:

The statistical value calculated to evaluate the effectiveness of cleanup was the 95% UCL. For radionuclide data, calculation of the statistics was done on the reported value. In cases where the laboratory does not report a value below the minimal detectable activity (MDA), half of the MDA is used in the calculation. For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described. For the statistical evaluation of duplicate sample pairs, the data (both radionuclide and nonradionuclides) are averaged before being included in the data set (after adjustments for censored data as described).

For nonradioactive analytes with >50% of the data below detection limits, the maximum value for the sample data was used instead of the 95% UCL. All nonradionuclide data reported as being below detection limit were set to ½ the detection limit value for calculation of the statistics (Ecology, 1993).

For nonradionuclide data, 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. For small data sets (n < 10), the calculations are performed assuming nonparametric distribution, so no test for distribution is performed. For large data sets (n >= 10 results above detection), a distribution test is conducted on the data set using Ecology MTCAStat software.

The estimated hazard quotient (for applicable nonradionuclide COCs) is determined by dividing the statistical value (derived in this calculation) by the WAC 173-340 Method B non-carcinogenic cleanup limit (other than the applicable RAG). The nonradionuclide carcinogenic risk, above background, is determined by dividing the statistical value by the WAC 173-340 Method B carcinogenic cleanup limit and then multiplying by 10^{-6}. For data sets where all values are below detection or are below background, neither of these calculations are required. For noncarcinogenic nonradionuclide COCs, only the estimated fraction of risk computation must be performed. Where the cleanup level is less than the PQL and the associated analyte is detected at a concentration below the PQL, the cleanup level is considered to have been attained (WAC 173-303-707).

The WAC 173-340 3-part test determines if:
1) the statistical 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 of the raw data set exceeds two times the most stringent cleanup limit for each non-radionuclide COC.

The 3-part test is performed for nonradionuclide analytes found in shallow zone and deep zone soil.

The RPD is performed when both the main 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. These detection limit requirements are located in Table II-2 of the SAP, DOE/RL-96-22, where they are referred to as the RDL. 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

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	I.D Jacques	Date	12/16/03	Calc. No. 105DR-CA-V0001	Rev. No. 1
Project	117-DR Cleanup Verification	Job No.	22192	Checked J.E. Thomson	Date 12/16/03
Subject	117-DR 95% UCL Calculation				Sheet No. 2 of 10

For QA/QC split and duplicate RPD calculations, a value less than +/- 30% indicates the data compare favorably. If the RPD is greater than +/- 30%, further investigation regarding the usability of the data is performed. Additional discussion as necessary is provided in the data quality assessment section (Appendix B) of the applicable CVP.

Results:

The results presented in the summary tables that follow are for use in RESRAD dose/risk analysis and the Cleanup Verification Package (CVP) for this site.

Result Summary - Shallow Zone

Am-241	3.31E-02	U	pCi/g
C-14	9.27E-01	U	pCi/g
Cs-137	5.18E-02		pCi/g
Co-60	1.46E-02	U	pCi/g
Eu-152	3.26E-02	U	pCi/g
Eu-154	4.72E-02	U	pCi/g
Eu-155	4.27E-02	U	pCi/g
Ni-63	1.06E+00	U	pCi/g
Pu-238	2.40E-02	U	pCi/g
Pu-239/240	2.45E-02	U	pCi/g
Sr-90	-3.00E-03	U	pCi/g
U-233/234	0 (< BG)		pCi/g
U-235	0 (< BG)	U	pCi/g
U-238	0 (< BG)		pCi/g
Arsenic	2.9E+00		mg/kg
Barium	6.5E+01		mg/kg
Cadmium	1.9E-01		mg/kg
Chromium (total)	1.1E+01		mg/kg
Hexavalent Chromium	4.2E-01	U	mg/kg
Lead	6.5E+00		mg/kg
Lithium	1.2E+01		mg/kg
Mercury	2.0E-02	U	mg/kg
Selenium	3.0E-01	U	mg/kg
Silver	8.0E-02	U	mg/kg
Sodium	4.0E+02		mg/kg

Result Summary - Deep Zone

Am-241	9.08E-03	U	pCi/g
C-14	1.12E+00	U	pCi/g
Cs-137	4.59E-02		pCi/g
Co-60	2.19E-02	U	pCi/g
Eu-152	4.46E-02	U	pCi/g
Eu-154	7.11E-02	U	pCi/g
Eu-155	5.42E-02	U	pCi/g
Ni-63	1.63E+00	U	pCi/g
Pu-238	7.59E-02	U	pCi/g
Pu-239/240	2.34E-02	U	pCi/g
Sr-90	6.10E-04	U	pCi/g
U-238	0 (< BG)		pCi/g
U-235	0 (< BG)	U	pCi/g
U-238	0 (< BG)		pCi/g
Arsenic	2.4E+00		mg/kg
Barium	5.8E+01		mg/kg
Cadmium	2.1E-01		mg/kg
Chromium (total)	1.0E+01		mg/kg
Hexavent Chromium	4.2E-01	U	mg/kg
Lead	4.1E+00		mg/kg
Lithium	9.9E+00		mg/kg
Mercury	2.0E-02	U	mg/kg
Selenium	3.3E-01	U	mg/kg
Silver	8.0E-02	U	mg/kg
Sodium	3.9E+02		mg/kg

WAC 173-340 Evaluation (Shallow Zone)

WAC 173-340 3-Part Test:

95% UCL > Cleanup Limit?	NA
> 10% above Cleanup Limit?	NA
Any sample > 2X Cleanup Limit?	NA

Risk Estimate:

Nonrad noncarcinogenic sum of quotients:	NA
Nonrad carcinogenic risk:	NA

Because nonradioactive COCs were either not detected or were not detected above background, the 3-part test and excess risk were not calculated.

WAC 173-340 Evaluation (Deep Zone)

WAC 173-340 3-Part Test:

95% UCL > Cleanup Limit?	NA
> 10% above Cleanup Limit?	NA
Any sample > 2X Cleanup Limit?	NA

Because nonradioactive COCs were either not detected or were not detected above background, the 3-part test was not performed.

Split/Duplicate Results:

Relative Percent Difference (RPD) Results*
QA/QC Analysis
Shallow Zone

Analyte	Duplicate Analysis	Split Analysis
Am-241		
C-14		
Cs-137		
Co-60		
Eu-152		
Eu-154		
Eu-155		
Ni-63		
Pu-238		
Pu-239/240		
Sr-90		
U-233/234		
U-235		
U-238		
Arsenic		
Barium	0.60%	2.2%
Cadmium		
Chromium (total)	1.7%	7.1%
Hexavalent Chromium		
Lead		
Lithium		
Mercury		
Selenium		
Silver		
Sodium	14%	19%

Split/Duplicate Results:

Relative Percent Difference (RPD) Results*
QA/QC Analysis
Deep Zone

Analyte	Duplicate Analysis	Split Analysis
Am-241		
C-14		
Cs-137		
Co-60		
Eu-152		
Eu-154		
Eu-155		
Ni-63		
Pu-238		
Pu-239/240		
Sr-90		
U-233/234		
U-235		
U-238		
Arsenic		
Barium	9.1%	20%
Cadmium		
Chromium (total)	29%	17%
Hexavalent Chromium		
Lead		
Lithium		
Mercury		
Selenium		
Silver		
Sodium	6.6%	5.9%

* A blank box indicates the RPD did not need to be calculated. RPD calculation is required when both samples are greater than the MDA and both samples are greater than 5 times the TDL.

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator: I.D Jacques
Project: 117-DR Cleanup Verification
Subject: 117-DR 95% UCL Calculation

Date: 12/16/03
Job No.: 22192

Calc. No.: 105DR-CA-V0001
Checked by: J.E. Thomson

Rev. No.: 1 JDJ 12/22/03
Date: 12/16/03

Sheet No.: 3 of 10

117-DR Shallow Zone Data

Sampling Area	HEIS Number	Sample Date	Am-241 pCi/g	Q	MDA	C-14 pCi/g	Q	MDA	Cs-137 pCi/g	Q	MDA	Co-60 pCi/g	Q	MDA	Eu-152 pCi/g	Q	MDA	Eu-154 pCi/g	Q	MDA	Eu-155 pCi/g	Q	MDA	Ni-63 pCi/g	Q	MDA	Pu-238 pCi/g	Q	MDA	Pu-239/240 pCi/g	Q	MDA
A1	J00WJ0	08-Aug-2003	0.00E+00	U	1.70E-01	1.67E-01	U	3.10E+00	1.90E-02		1.90E-02	2.00E-02	U	2.00E-02	4.80E-02	U	4.80E-02	6.90E-02	U	6.90E-02	7.10E-02	U	7.10E-02	7.04E-01	U	2.50E+00	3.70E-02	U	2.80E-01	0.00E+00	U	2.80E-01
Duplicate of J00WJ0	J00WJ7	08-Aug-2003	0.00E+00	U	2.10E-01	1.22E+00	U	2.80E+00	4.00E-02		3.00E-02	2.60E-02	U	2.60E-02	6.00E-02	U	6.00E-02	8.90E-02	U	8.90E-02	5.40E-02	U	5.40E-02	1.12E+00	U	2.80E+00	-4.90E-02	U	3.70E-01	0.00E+00	U	3.70E-01
A2	J00WJ1	08-Aug-2003	5.00E-02	U	1.90E-01	9.54E-01	U	2.60E+00	6.30E-02		1.70E-02	1.50E-02	U	1.50E-02	3.50E-02	U	3.50E-02	5.20E-02	U	5.20E-02	3.70E-02	U	3.70E-02	1.21E+00	U	2.40E+00	0.00E+00	U	2.20E-01	0.00E+00	U	2.20E-01
A3	J00WJ2	08-Aug-2003	0.00E+00	U	2.00E-01	-2.92E-01	U	2.70E+00	5.10E-02	U	5.10E-02	3.10E-02	U	3.10E-02	6.80E-02	U	6.80E-02	9.80E-02	U	9.80E-02	1.00E-01	U	1.00E-01	7.36E-01	U	2.00E+00	0.00E+00	U	2.70E-01	0.00E+00	U	2.70E-01
A4	J00WJ3	08-Aug-2003	0.00E+00	U	2.10E-01	5.75E-01	U	2.70E+00	3.30E-02		2.70E-02	2.60E-02	U	2.60E-02	5.80E-02	U	5.80E-02	8.50E-02	U	8.50E-02	5.50E-02	U	5.50E-02	6.00E-01	U	2.40E+00	3.70E-02	U	2.80E-01	3.70E-02	U	2.80E-01

Statistical Computation Input Data

Composite Point	HEIS Number	Sample Date	Am-241 pCi/g	C-14 pCi/g	Cs-137 pCi/g	Co-60 pCi/g	Eu-152 pCi/g	Eu-154 pCi/g	Eu-155 pCi/g	Ni-63 pCi/g	Pu-238 pCi/g	Pu-239/240 pCi/g
A1	J00WJ0 and J00WJ7	08-Aug-2003	0.00E+00	6.94E-01	2.95E-02	1.15E-02	2.70E-02	3.95E-02	3.13E-02	9.12E-01	-6.00E-03	0.00E+00
A2	J00WJ1	08-Aug-2003	5.00E-02	9.54E-01	6.30E-02	7.50E-03	1.75E-02	2.60E-02	1.85E-02	1.21E+00	0.00E+00	0.00E+00
A3	J00WJ2	08-Aug-2003	0.00E+00	-2.92E-01	2.55E-02	1.55E-02	3.40E-02	4.90E-02	5.00E-02	7.36E-01	0.00E+00	0.00E+00
A4	J00WJ3	08-Aug-2003	0.00E+00	5.75E-01	3.30E-02	1.30E-02	2.90E-02	4.25E-02	2.75E-02	6.00E-01	3.70E-02	3.70E-02

Statistical Computations

	Am-241	C-14	Cs-137	Co-60	Eu-152	Eu-154	Eu-155	Ni-63	Pu-238	Pu-239/240
Statistical value based on	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat
N	4	4	4	4	4	4	4	4	4	4
% < Detection limit	100%	100%	25%	100%	100%	100%	100%	100%	100%	100%
mean	1.25E-02	4.83E-01	3.78E-02	1.19E-02	2.69E-02	3.93E-02	3.18E-02	8.65E-01	7.75E-03	9.25E-03
st. dev.	2.50E-02	5.40E-01	1.71E-02	3.35E-03	6.91E-03	9.68E-03	1.33E-02	2.63E-01	1.97E-02	1.85E-02
Z-statistic	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645
95%UCL on mean	3.31E-02	9.27E-01	5.18E-02	1.46E-02	3.26E-02	4.72E-02	4.27E-02	1.08E+00	2.40E-02	2.45E-02
max value	5.00E-02	1.22E+00	6.30E-02	3.10E-02	6.80E-02	9.80E-02	1.00E-01	1.21E+00	3.70E-02	3.70E-02
Statistical value	3.31E-02	9.27E-01	5.18E-02	1.46E-02	3.26E-02	4.72E-02	4.27E-02	1.08E+00	2.40E-02	2.45E-02
Background	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Statistical value above background	3.31E-02	9.27E-01	5.18E-02	1.46E-02	3.26E-02	4.72E-02	4.27E-02	1.08E+00	2.40E-02	2.45E-02
Lookup Value - 15 mrem/yr for rad	31.1	5.16	6.2	1.4	3.3	3.0	125.0	4026.0	37.4	33.9

Most Stringent Cleanup Limit for nonradionuclide and RAG Type

WAC 173-340 3-PART TEST

95% UCL > Cleanup Limit?
> 10% above Cleanup Limit?
Any sample > 2X Cleanup Limit?

EXCESS RISK EVALUATION

WAC 173-340 B Non-Carcinogenic Cleanup:
Hazard quotient for each nonradionuclide:
WAC 173-340 B Carcinogenic Cleanup:
Excess risk for each carcinogenic nonradionuclide:

NON-RAD SUMMARY

WAC 173-340 3-Part-Test Compliance: NA
Nonrad noncarcinogenic sum of quotients: NA
Nonrad carcinogenic risk: NA

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	I.D Jacques	Date	12/16/03	Calc. No.	105DR-CA-V0001
Project	117-DR Cleanup Verification	Job No.	22192	Checked by:	J.E. Thomson
Subject	117-DR 95% UCL Calculation				

Rev. No.: 1
Date 12/16/03
Sheet No.: 4 of 10

117-DR Shallow Zone Data

Sampling Area	HEIS Number	Sample Date	Sr-90 pCi/g	Q	Sr-90 MDA	U-233/234 pCi/g	Q	U-233/234 MDA	U-235 pCi/g	Q	U-235 MDA	U-238 pCi/g	Q	U-238 MDA
A1	J00WJ0	08-Aug-2003	-1.90E-02	U	2.90E-01	4.94E-01		1.50E-01	2.40E-02	U	1.80E-01	6.52E-01		1.50E-01
Duplicate of J00WJ0	J00WJ7	08-Aug-2003	4.60E-02	U	2.80E-01	4.59E-01		1.80E-01	0.00E+00	U	2.20E-01	5.08E-01		1.80E-01
A2	J00WJ1	08-Aug-2003	-3.10E-02	U	2.60E-01	3.67E-01		1.80E-01	0.00E+00	U	2.10E-01	2.98E-01		1.80E-01
A3	J00WJ2	08-Aug-2003	-6.80E-02	U	2.70E-01	5.25E-01		1.60E-01	2.50E-02	U	1.90E-01	3.15E-01		1.60E-01
A4	J00WJ3	08-Aug-2003	-3.70E-02	U	2.90E-01	6.62E-01		1.60E-01	7.50E-02	U	1.90E-01	5.79E-01		1.60E-01

Sampling Area	Arsenic mg/kg	Q	Arsenic PQL	Barium mg/kg	Q	Barium PQL	Cadmium mg/kg	Q	Cadmium PQL	Chromium (total) mg/kg	Q	Chromium (total) PQL	Hexavalent Chromium mg/kg	Q	Hexavalent Chromium PQL	Lead mg/kg	Q	Lead PQL
A1	2.7E+00		3.8E-01	6.7E+01		2.0E-02	7.0E-02		4.0E-02	1.2E+01		9.0E-02	4.2E-01	U	4.2E-01	5.0E+00		1.7E-01
Duplicate of J00WJ0	3.1E+00		4.4E-01	6.7E+01		2.0E-02	1.9E-01		4.0E-02	1.2E+01		1.0E-01	4.2E-01	U	4.2E-01	5.0E+00		2.0E-01
A2	2.7E+00		4.1E-01	6.2E+01		2.0E-02	4.0E-02	U	4.0E-02	1.1E+01		1.0E-01	4.1E-01	U	4.1E-01	4.5E+00		1.8E-01
A3	2.4E+00		3.9E-01	5.9E+01		2.0E-02	4.0E-02	U	4.0E-02	8.4E+00		9.0E-02	4.1E-01	U	4.1E-01	7.4E+00		1.8E-01
A4	2.9E+00		4.2E-01	6.0E+01		2.0E-02	4.0E-02	U	4.0E-02	9.3E+00		1.0E-01	4.2E-01	U	4.2E-01	4.3E+00		1.9E-01

Statistical Computation Input Data

Composite Point	HEIS Number	Sample Date	Sr-90 pCi/g	U-233/234 pCi/g	U-235 pCi/g	U-238 pCi/g	Arsenic mg/kg	Barium mg/kg	Cadmium mg/kg	Chromium (total) mg/kg	Hexavalent Chromium mg/kg	Lead mg/kg
A1	J00WJ0 and J00WJ7	08-Aug-2003	1.35E-02	4.77E-01	1.20E-02	5.80E-01	2.9E+00	6.7E+01	1.3E-01	1.2E+01	2.1E-01	5.0E+00
A2	J00WJ1	08-Aug-2003	-3.10E-02	3.67E-01	0.00E+00	2.98E-01	2.7E+00	6.2E+01	2.0E-02	1.1E+01	2.1E-01	4.5E+00
A3	J00WJ2	08-Aug-2003	-6.80E-02	5.25E-01	2.50E-02	3.15E-01	2.4E+00	5.9E+01	2.0E-02	8.4E+00	2.1E-01	7.4E+00
A4	J00WJ3	08-Aug-2003	-3.70E-02	6.62E-01	7.50E-02	5.79E-01	2.9E+00	6.0E+01	2.0E-02	9.3E+00	2.1E-01	4.3E+00

Statistical Computations

	Sr-90	U-233/234	U-235	U-238	Arsenic	Barium	Cadmium	Chromium (total)	Hexavalent Chromium	Lead
Statistical value based on	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Small data set - Use nonparametric z-stat.	Small data set - Use nonparametric z-stat.	>50% Below Detection. Default to Maximum Value	Small data set - Use nonparametric z-stat.	>50% Below Detection. Default to Maximum Value	Small data set - Use nonparametric z-stat.
N	4	4	4	4	4	4	4	4	4	4
% < Detection limit	100%	0%	100%	0%	0%	0%	75%	0%	100%	0%
mean	-3.06E-02	5.08E-01	2.80E-02	4.43E-01	2.7E+00	6.2E+01	4.8E-02	1.0E+01	2.1E-01	5.3E+00
st. dev.	3.36E-02	1.22E-01	3.30E-02	1.58E-01	2.4E-01	3.4E+00	5.5E-02	1.5E+00	2.9E-03	1.4E+00
Z-statistic	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645
95%UCL on mean	-3.00E-03	6.08E-01	5.51E-02	5.73E-01	2.9E+00	6.5E+01	9.3E-02	1.1E+01	2.1E-01	6.5E+00
max value	4.60E-02	6.62E-01	7.50E-02	6.52E-01	3.1E+00	6.7E+01	1.9E-01	1.2E+01	4.2E-01	7.4E+00
Statistical value	-3.00E-03	6.08E-01	5.51E-02	5.73E-01	2.9E+00	6.5E+01	1.9E-01	1.1E+01	4.2E-01	6.5E+00
Background	NA	1.1	0.11	1.1	NA	NA	NA	NA	NA	NA
Statistical value above background	-3.00E-03	0 (< BG)	0 (< BG)	0 (< BG)	2.9E+00	6.5E+01	1.9E-01	1.1E+01	4.2E-01	6.5E+00
Lookup Value - 15 mrem/yr for rad	4.5	1.1	1.0	1.1						
Most Stringent Cleanup Limit for nonradionuclide and RAG Type					20.0 Background - GW/River Protection	132.0 Background - GW Protection	0.81 Background - GW/River Protection	18.5 Background - GW/River Protection	2.0 River Protection	10.2 Background - GW/River Protection
WAC 173-340 3-PART TEST										
95% UCL > Cleanup Limit?					NA	NA	NA	NA	NA	NA
> 10% above Cleanup Limit?					NA	NA	NA	NA	NA	NA
Any sample > 2X Cleanup Limit?					NA	NA	NA	NA	NA	NA
EXCESS RISK EVALUATION										
WAC 173-340 B Non-Carcinogenic Cleanup:					24	5,600	80	80,000	400	353
Hazard quotient for each nonradionuclide:					NA	NA	NA	NA	NA	NA
WAC 173-340 B Carcinogenic Cleanup:					0.67	NA	13.9	NA	2.1	NA
Excess risk for each carcinogenic nonradionuclide:					NA	NA	NA	NA	NA	NA
NON-RAD SUMMARY					Since arsenic was not detected above background, the 3-part test and excess risk are not calculated.	Since barium was not detected above background, the 3-part test and excess risk are not calculated.	Since cadmium was not detected above background, the 3-part test and excess risk are not calculated.	Since chromium was not detected above background, the 3-part test and excess risk are not calculated.	Since hexavalent chromium was not detected in any of the verification samples, the 3-part test and excess risk are not calculated.	Since lead was not detected above background, the 3-part test and excess risk are not calculated.
WAC 173-340 3-Part-Test Compliance:										
Nonrad noncarcinogenic sum of quotients:										
Nonrad carcinogenic risk:										

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	I.D Jacques	Date	12/16/03	Calc. No.	105DR-CA-V0001
Project	117-DR Cleanup Verification	Job No.	22192	Checked by:	J.E. Thomson
Subject	117-DR 95% UCL Calculation				

Rev. No.: 1
Date 12/16/03
Sheet No.: 5 of 10

117-DR Shallow Zone Data

Sampling Area	HEIS Number	Sample Date	Lithium mg/kg	Q	PQL	Mercury mg/kg	Q	PQL	Selenium mg/kg	Q	PQL	Silver mg/kg	Q	PQL	Sodium mg/kg	Q	PQL
A1	J00WJ0	08-Aug-2003	1.0E+01		2.0E-02	1.0E-02	U	1.0E-02	2.6E-01	U	2.6E-01	7.0E-02	U	7.0E-02	3.3E+02		6.4E-01
Duplicate of J00WJ0	J00WJ7	08-Aug-2003	9.9E+00		2.0E-02	2.0E-02	U	2.0E-02	3.0E-01	U	3.0E-01	8.0E-02	U	8.0E-02	2.9E+02		7.4E-01
A2	J00WJ1	08-Aug-2003	1.1E+01		2.0E-02	2.0E-02	U	2.0E-02	2.8E-01	U	2.8E-01	8.0E-02	U	8.0E-02	4.5E+02		6.9E-01
A3	J00WJ2	08-Aug-2003	1.3E+01		2.0E-02	2.0E-02	U	2.0E-02	2.7E-01	U	2.7E-01	7.0E-02	U	7.0E-02	3.4E+02		6.6E-01
A4	J00WJ3	08-Aug-2003	7.8E+00		2.0E-02	2.0E-02	U	2.0E-02	2.9E-01	U	2.9E-01	8.0E-02	U	8.0E-02	2.9E+02		7.1E-01

Statistical Computation Input Data

Composite Point	HEIS Number	Sample Date	Lithium mg/kg	Mercury mg/kg	Selenium mg/kg	Silver mg/kg	Sodium mg/kg
A1	J00WJ0 and J00WJ7	08-Aug-2003	1.0E+01	7.5E-03	1.4E-01	3.8E-02	3.1E+02
A2	J00WJ1	08-Aug-2003	1.1E+01	1.0E-02	1.4E-01	4.0E-02	4.5E+02
A3	J00WJ2	08-Aug-2003	1.3E+01	1.0E-02	1.4E-01	3.5E-02	3.4E+02
A4	J00WJ3	08-Aug-2003	7.8E+00	1.0E-02	1.5E-01	4.0E-02	2.9E+02

Statistical Computations

	Lithium	Mercury	Selenium	Silver	Sodium
Statistical value based on	Small data set - Use nonparametric z-stat.	>50% Below Detection. Default to Maximum Value	>50% Below Detection. Default to Maximum Value	>50% Below Detection. Default to Maximum Value	Small data set - Use nonparametric z-stat.
N	4	4	4	4	4
% < Detection limit	0%	100%	100%	100%	0%
mean	1.0E+01	9.4E-03	1.4E-01	3.8E-02	3.4E+02
st. dev.	2.0E+00	1.2E-03	4.1E-03	2.4E-03	7.1E+01
Z-statistic	1.645	1.645	1.645	1.645	1.645
95%UCL on mean	1.2E+01	1.0E-02	1.4E-01	4.0E-02	4.0E+02
max value	1.3E+01	2.0E-02	3.0E-01	8.0E-02	4.5E+02
Statistical value	1.2E+01	2.0E-02	3.0E-01	8.0E-02	4.0E+02
Background	NA	NA	NA	NA	NA
Statistical value above background	1.2E+01	2.0E-02	3.0E-01	8.0E-02	4.0E+02
Lookup Value - 15 mrem/yr for rad					
Most Stringent Cleanup Limit for nonradionuclide and RAG Type	NA Background	0.33 Background - GW/River Protection	1.0 River Protection	0.73 Background - River Protection	NA Background
WAC 173-340 3-PART TEST					
95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA
> 10% above Cleanup Limit?	NA	NA	NA	NA	NA
Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA
EXCESS RISK EVALUATION					
WAC 173-340 B Non-Carcinogenic Cleanup:	NA	24	400	400	NA
Hazard quotient for each nonradionuclide:	NA	NA	NA	NA	NA
WAC 173-340 B Carcinogenic Cleanup:	NA	NA	NA	NA	NA
Excess risk for each carcinogenic nonradionuclide:	NA	NA	NA	NA	NA
NON-RAD SUMMARY					
WAC 173-340 3-Part-Test Compliance:	There are no cleanup limits for lithium. Lithium was not detected above background, the 3-part test and excess risk are not calculated.	Since mercury was not detected above background, the 3-part test and excess risk are not calculated.	Since selenium was not detected in any of the verification samples, the 3-part test and excess risk are not calculated.	Since silver was not detected above background, the 3-part test and excess risk are not calculated.	There are no clean up limits for sodium. Sodium was not detected above background, the 3-part test and excess risk are not calculated.
Nonrad noncarcinogenic sum of quotients:					
Nonrad carcinogenic risk:					

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	I.D Jacques	Date	12/16/03	Calc. No.	105DR-CA-V0001
Project	117-DR Cleanup Verification	Job No.	22192	Checked by:	J.E. Thomson
Subject	117-DR 95% UCL Calculation				

Rev. No.: 1 IDJ 12/22/03
Date: 12/16/03
Sheet No.: 6 of 10

117-DR Deep Zone Data

Sampling Area	HEIS Number	Sample Date	Am-241 pCi/g	Q	MDA	C-14 pCi/g	Q	MDA	Cs-137 pCi/g	Q	MDA	Co-60 pCi/g	Q	MDA
A1	J00WJ4	08-Aug-2003	-7.00E-02	U	1.80E-01	7.84E-01	U	2.40E+00	4.50E-02	U	4.50E-02	4.30E-02	U	4.30E-02
Duplicate of J00WJ4	J00WJ8	08-Aug-2003	8.20E-02	U	2.10E-01	1.66E+00	U	2.90E+00	5.00E-02	U	5.00E-02	4.50E-02	U	4.50E-02
A2	J00WJ5	08-Aug-2003	-2.40E-02	U	1.80E-01	4.27E-01	U	2.40E+00	3.90E-02	U	3.90E-02	3.70E-02	U	3.70E-02
A3	J00WJ6	08-Aug-2003	0.00E+00	U	1.80E-01	4.06E-01	U	2.50E+00	4.90E-02		3.20E-02	2.90E-02	U	2.90E-02

Sampling Area	Eu-152 pCi/g	Q	MDA	Eu-154 pCi/g	Q	MDA	Eu-155 pCi/g	Q	MDA	Ni-63 pCi/g	Q	MDA	Pu-238 pCi/g	Q	MDA	Pu-239/240 pCi/g	Q	MDA
A1	8.80E-02	U	8.80E-02	1.50E-01	U	1.50E-01	9.70E-02	U	9.70E-02	4.46E-01	U	2.50E+00	1.06E-01	U	4.10E-01	5.30E-02	U	4.10E-01
Duplicate of J00WJ4	9.20E-02	U	9.20E-02	1.40E-01	U	1.40E-01	9.80E-02	U	9.80E-02	1.72E+00	U	3.60E+00	4.70E-02	U	3.60E-01	0.00E+00	U	3.60E-01
A2	7.80E-02	U	7.80E-02	1.20E-01	U	1.20E-01	9.40E-02	U	9.40E-02	1.59E+00	U	3.10E+00	0.00E+00	U	3.70E-01	0.00E+00	U	3.70E-01
A3	6.70E-02	U	6.70E-02	1.10E-01	U	1.10E-01	1.10E-01	U	1.10E-01	1.96E-01	U	3.00E+00	4.20E-02	U	3.20E-01	0.00E+00	U	3.20E-01

Statistical Computation Input Data

Composite Point	HEIS Number	Sample Date	Am-241 pCi/g	C-14 pCi/g	Cs-137 pCi/g	Co-60 pCi/g	Eu-152 pCi/g	Eu-154 pCi/g	Eu-155 pCi/g	Ni-63 pCi/g	Pu-238 pCi/g	Pu-239/240 pCi/g
A1	J00WJ4 and J00WJ8	08-Aug-2003	6.00E-03	1.21E+00	2.38E-02	2.20E-02	4.50E-02	7.25E-02	4.88E-02	1.08E+00	7.65E-02	2.65E-02
A2	J00WJ5	08-Aug-2003	-2.40E-02	4.27E-01	1.95E-02	1.85E-02	3.90E-02	6.00E-02	4.70E-02	1.59E+00	0.00E+00	0.00E+00
A3	J00WJ6	08-Aug-2003	0.00E+00	4.06E-01	4.90E-02	1.45E-02	3.35E-02	5.50E-02	5.50E-02	1.96E-01	4.20E-02	0.00E+00

Statistical Computations

Statistical value based on	Am-241	C-14	Cs-137	Co-60	Eu-152	Eu-154	Eu-155	Ni-63	Pu-238	Pu-239/240
	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat
N	3	3	3	3	3	3	3	3	3	3
% < Detection limit	100%	100%	67%	100%	100%	100%	100%	100%	100%	100%
mean	-6.00E-03	6.82E-01	3.08E-02	1.83E-02	3.92E-02	6.25E-02	5.03E-02	9.56E-01	3.95E-02	8.83E-03
st. dev.	1.59E-02	4.59E-01	1.59E-02	3.75E-03	5.75E-03	9.01E-03	4.21E-03	7.06E-01	3.83E-02	1.53E-02
Z-statistic	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645
95%UCL on mean	9.08E-03	1.12E+00	4.59E-02	2.19E-02	4.46E-02	7.11E-02	5.42E-02	1.63E+00	7.59E-02	2.34E-02
max value	8.20E-02	1.66E+00	5.00E-02	4.50E-02	9.20E-02	1.50E-01	1.10E-01	1.72E+00	1.06E-01	5.30E-02
Statistical value	9.08E-03	1.12E+00	4.59E-02	2.19E-02	4.46E-02	7.11E-02	5.42E-02	1.63E+00	7.59E-02	2.34E-02
Background	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Statistical value above background	9.08E-03	1.12E+00	4.59E-02	2.19E-02	4.46E-02	7.11E-02	5.42E-02	1.63E+00	7.59E-02	2.34E-02

Most Stringent Cleanup Limit for nonradionuclide and RAG Type

WAC 173-340 3-PART TEST

95% UCL > Cleanup Limit?
> 10% above Cleanup Limit?
Any sample > 2X Cleanup Limit?

NON-RAD SUMMARY

WAC 173-340 3-Part-Test Compliance: NA

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator: I.D Jacques — Date: 12/16/03 — Calc. No.: 105DR-CA-V0001 — Rev. No.: 1 IDJ 12/22/03
Project: 117-DR Cleanup Verification — Job No.: 22192 — Checked by: J.E. Thomson — Date: 12/16/03
Subject: 117-DR 95% UCL Calculation — Sheet No.: 7 of 10

117-DR Deep Zone Data

Sampling Area	HEIS Number	Sample Date	Sr-90 pCi/g	Q	MDA	U-233/234 pCi/g	Q	MDA	U-235 pCi/g	Q	MDA	U-238 pCi/g	Q	MDA
A1	J00WJ4	08-Aug-2003	-6.50E-02	U	2.90E-01	5.36E-01		1.70E-01	0.00E+00	U	2.10E-01	6.47E-01		1.70E-01
Duplicate of J00WJ4	J00WJ8	08-Aug-2003	-2.80E-02	U	3.00E-01	4.94E-01		1.60E-01	5.20E-02	U	2.00E-01	6.01E-01		1.60E-01
A2	J00WJ5	06-Aug-2003	6.00E-03	U	2.80E-01	4.23E-01		1.60E-01	5.10E-02	U	2.00E-01	5.29E-01		1.60E-01
A3	J00WJ6	08-Aug-2003	-7.60E-02	U	2.90E-01	6.19E-01		1.60E-01	0.00E+00	U	1.90E-01	5.16E-01		1.60E-01

Sampling Area	Arsenic mg/kg	Q	PQL	Barium mg/kg	Q	PQL	Cadmium mg/kg	Q	PQL	Chromium (total) mg/kg	Q	PQL	Hexavent Chromium mg/kg	Q	PQL	Lead mg/kg	Q	PQL
A1	2.3E+00		3.9E-01	5.3E+01		2.0E-02	4.0E-02	U	4.0E-02	8.7E+00		9.0E-02	4.2E-01	U	4.2E-01	3.9E+00		1.8E-01
Duplicate of J00WJ4	2.6E+00		4.3E-01	5.9E+01		2.0E-02	1.7E-01		4.0E-02	1.2E+01		1.0E-01	4.2E-01	U	4.2E-01	4.2E+00		2.0E-01
A2	2.0E+00		4.2E-01	5.6E+01		2.0E-02	1.7E-01		4.0E-02	8.2E+00		1.0E-01	4.2E-01	U	4.2E-01	3.7E+00		1.9E-01
A3	2.2E+00		4.2E-01	5.8E+01		2.0E-02	2.1E-01		4.0E-02	9.9E+00		1.0E-01	4.1E-01	U	4.1E-01	3.9E+00		1.9E-01

Statistical Computation Input Data

Composite Point	HEIS Number	Sample Date	Sr-90 pCi/g	U-233/234 pCi/g	U-235 pCi/g	U-238 pCi/g	Arsenic mg/kg	Barium mg/kg	Cadmium mg/kg	Chromium (total) mg/kg	Hexavent Chromium mg/kg	Lead mg/kg
A1	J00WJ4 and J00WJ8	08-Aug-2003	-4.65E-02	5.15E-01	2.60E-02	6.24E-01	2.5E+00	5.6E+01	9.5E-02	1.0E+01	2.1E-01	4.1E+00
A2	J00WJ5	08-Aug-2003	6.00E-03	4.23E-01	5.10E-02	5.29E-01	2.0E+00	5.6E+01	1.7E-01	8.2E+00	2.1E-01	3.7E+00
A3	J00WJ6	08-Aug-2003	-7.60E-02	6.19E-01	0.00E+00	5.16E-01	2.2E+00	5.8E+01	2.1E-01	9.9E+00	2.1E-01	3.9E+00

Statistical Computations

	Sr-90	U-233/234	U-235	U-238	Arsenic	Barium	Cadmium	Chromium (total)	Hexavent Chromium	Lead
Statistical value based on	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Small Data Set. Use nonparametric z-stat.	Small Data Set. Use nonparametric z-stat.	Small Data Set. Use nonparametric z-stat.	Small Data Set. Use nonparametric z-stat.	>50% Below Detection. Default to Maximum Value	Small Data Set. Use nonparametric z-stat.
N	3	3	3	3	3	3	3	3	3	3
% < Detection limit	100%	0%	100%	0%	0%	0%	0%	0%	100%	0%
mean	-3.88E-02	5.19E-01	2.57E-02	5.56E-01	2.2E+00	5.7E+01	1.6E-01	9.4E+00	2.1E-01	3.9E+00
st. dev.	4.15E-02	9.81E-02	2.55E-02	5.90E-02	2.3E-01	1.2E+00	5.8E-02	1.1E+00	2.9E-03	1.8E-01
Z-statistic	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645
95%UCL on mean	6.10E-04	6.12E-01	4.99E-02	6.12E-01	2.4E+00	5.8E+01	2.1E-01	1.0E+01	2.1E-01	4.1E+00
max value	6.00E-03	6.19E-01	5.20E-02	6.47E-01	2.6E+00	5.9E+01	2.1E-01	1.2E+01	4.2E-01	4.2E+00
Statistical value	6.10E-04	6.12E-01	4.99E-02	6.12E-01	2.4E+00	5.8E+01	2.1E-01	1.0E+01	4.2E-01	4.1E+00
Background	NA	1.1	0.11	1.1	NA	NA	NA	NA	NA	NA
Statistical value above background	6.10E-04	0 (< BG)	0 (< BG)	0 (< BG)	2.4E+00	5.8E+01	2.1E-01	1.0E+01	4.2E-01	4.1E+00

	Arsenic	Barium	Cadmium	Chromium (total)	Hexavent Chromium	Lead
Most Stringent Cleanup Limit for nonradionuclide and RAG Type	20.0 Background - GW/River Protection	132.0 Background - GW Protection	0.81 Background - GW/River Protection	18.5 Background - GW/River Protection	2.0 River Protection	10.2 Background - GW/River Protection
WAC 173-340 3-PART TEST						
95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA	NA
> 10% above Cleanup Limit?	NA	NA	NA	NA	NA	NA
Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA	NA
NON-RAD SUMMARY						
WAC 173-340 3-Part-Test Compliance:	Since arsenic was not detected above background, the 3-part test is not calculated.	Since barium was not detected above background, the 3-part test is not calculated.	Because cadmium was not detected above background, the 3-part test is not calculated.	Since chromium was not detected above background, the 3-part test is not calculated.	Since hexavalent chromium was not detected in any of the verification samples, the 3-part test is not calculated.	Since lead was not detected above background, the 3-part test is not calculated.

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	I.D Jacques *IDJ*	Date	12/16/03	Calc. No.	105DR-CA-V0001
Project	117-DR Cleanup Verification	Job No.	22192	Checked by:	J.E. Thomson *JET*
Subject	117-DR 95% UCL Calculation				

Rev. No.: 1
Date: 12/16/03
Sheet No.: 8 of 10

117-DR Deep Zone Data

Sampling Area	HEIS Number	Sample Date	Lithium mg/kg	Q	PQL	Mercury mg/kg	Q	PQL	Selenium mg/kg	Q	PQL	Silver mg/kg	Q	PQL	Sodium mg/kg	Q	PQL
A1	J00WJ4	08-Aug-2003	8.7E+00		2.0E-02	2.0E-02	U	2.0E-02	2.7E-01	U	2.7E-01	7.0E-02	U	7.0E-02	3.0E+02		6.6E-01
Duplicate of J00WJ4	J00WJ8	08-Aug-2003	8.9E+00		2.0E-02	1.0E-02	U	1.0E-02	3.0E-01	U	3.0E-01	8.0E-02	U	8.0E-02	2.8E+02		7.3E-01
A2	J00WJ5	08-Aug-2003	1.0E+01		2.0E-02	1.0E-02	U	1.0E-02	2.9E-01	U	2.9E-01	8.0E-02	U	8.0E-02	4.0E+02		7.0E-01
A3	J00WJ6	08-Aug-2003	8.2E+00		2.0E-02	1.0E-02	U	1.0E-02	3.3E-01	U	3.3E-01	8.0E-02	U	8.0E-02	3.0E+02		7.1E-01

Statistical Computation Input Data

Composite Point	HEIS Number	Sample Date	Lithium mg/kg		Mercury mg/kg		Selenium mg/kg		Silver mg/kg		Sodium mg/kg	
A1	J00WJ4 and J00WJ8	08-Aug-2003	8.8E+00		7.5E-03		1.4E-01		3.8E-02		2.9E+02	
A2	J00WJ5	08-Aug-2003	1.0E+01		5.0E-03		1.5E-01		4.0E-02		4.0E+02	
A3	J00WJ6	08-Aug-2003	8.2E+00		5.0E-03		1.7E-01		4.0E-02		3.0E+02	

Statistical Computations

	Lithium		Mercury		Selenium		Silver		Sodium	
Statistical value based on	Small Data Set. Use nonparametric z-stat.		>50% Below Detection. Default to Maximum Value		>50% Below Detection. Default to Maximum Value		>50% Below Detection. Default to Maximum Value		Small Data Set. Use nonparametric z-stat.	
N	3		3		3		3		3	
% < Detection limit	0%		100%		100%		100%		0%	
mean	9.0E+00		5.8E-03		1.5E-01		3.9E-02		3.3E+02	
st. dev.	9.2E-01		1.4E-03		1.2E-02		1.4E-03		6.0E+01	
Z-statistic	1.645		1.645		1.645		1.645		1.645	
95%UCL on mean	9.9E+00		7.2E-03		1.6E-01		4.1E-02		3.9E+02	
max value	1.0E+01		2.0E-02		3.3E-01		8.0E-02		4.0E+02	
Statistical value	9.9E+00		2.0E-02		3.3E-01		8.0E-02		3.9E+02	
Background	NA		NA		NA		NA		NA	
Statistical value above background	9.9E+00		2.0E-02		3.3E-01		8.0E-02		3.9E+02	
Most Stringent Cleanup Limit for nonradionuclide and RAG Type	NA	Background	0.33	Background - GW/River Protection	1.0	Background - GW/River Protection	0.73	Background - River Protection	NA	Background
WAC 173-340 3-PART TEST										
95% UCL > Cleanup Limit?	NA		NA		NA		NA		NA	
> 10% above Cleanup Limit?	NA		NA		NA		NA		NA	
Any sample > 2X Cleanup Limit?	NA		NA		NA		NA		NA	
NON-RAD SUMMARY	There are no cleanup limits for lithium. Since lithium was not detected above background, the 3-part test is not calculated.		Since mercury was not detected above background, the 3-part test is not calculated.		Since selenium was not detected above background, the 3-part test is not calculated.		Since silver was not detected above background, the 3-part test is not calculated.		There are no cleanup limits for sodium. Since sodium was not detected above background, the 3-part test is not calculated.	
WAC 173-340 3-Part-Test Compliance:										

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator: I.D Jacques
Project: 117-DR Cleanup Verification
Subject: 117-DR 95% UCL Calculation

Date: 12/16/03
Job No.: 22192

Calc. No.: 105DR-CA-V0001
Checked by: J.E. Thomson

Rev. No.: 1
Date: 12/16/03

Sheet No.: 9 of 10

Split/Duplicate Analysis:

Sample Area	HEIS Number	Am-241 pCi/g	Q	MDA	C-14 pCi/g	Q	MDA	Cs-137 pCi/g	Q	MDA	Co-60 pCi/g	Q	MDA	Eu-152 pCi/g	Q	MDA	Eu-154 pCi/g	Q	MDA	Eu-155 pCi/g	Q	MDA	Ni-63 pCi/g	Q	MDA
Shallow Zone Results:																									
A1	J00WJ0	0.00E+00	U	1.70E-01	1.67E-01	U	3.10E+00	1.90E-02		1.90E-02	2.00E-02	U	2.00E-02	4.80E-02	U	4.80E-02	6.90E-02	U	6.90E-02	7.10E-02	U	7.10E-02	7.04E-01	U	2.50E+00
Duplicate of J00WJ0	J00WJ7	0.00E+00	U	2.10E-01	1.22E+00	U	2.80E+00	4.00E-02		3.00E-02	2.60E-02	U	2.60E-02	6.00E-02	U	6.00E-02	8.90E-02	U	8.90E-02	5.40E-02	U	5.40E-02	1.12E+00	U	2.80E+00
Split of J00WJ0	J00WJ9	-2.91E-03	U	1.22E-01	-1.16E-01	U	7.83E-01	1.90E-02	U	2.71E-02	-4.12E-04	U	2.73E-02	1.92E-02	U	6.05E-02	-2.30E-02	U	8.22E-02	2.34E-02	U	5.89E-02	2.56E+00	U	5.79E+00
Deep Zone Results:																									
A1	J00WJ4	-7.00E-02	U	1.80E-01	7.64E-01	U	2.40E+00	4.50E-02	U	4.50E-02	4.30E-02	U	4.30E-02	8.80E-02	U	8.80E-02	1.50E-01	U	1.50E-01	9.70E-02	U	9.70E-02	4.46E-01	U	2.50E+00
Duplicate of J00WJ4	J00WJ8	8.20E-02	U	2.10E-01	1.66E+00	U	2.90E+00	5.00E-02	U	5.00E-02	4.50E-02	U	4.50E-02	9.20E-02	U	9.20E-02	1.40E-01	U	1.40E-01	9.80E-02	U	9.80E-02	1.72E+00	U	3.60E+00
Split of J00WJ4	J00WK0	5.12E-02	U	6.94E-02	4.16E-02	U	7.82E-01	3.69E-02		1.71E-02	3.56E-03	U	1.67E-02	-1.52E-02	U	3.62E-02	-3.00E-02	U	4.87E-02	4.62E-02	U	4.67E-02	4.34E+00	U	6.17E+00

Sample Area	HEIS Number	Pu-238 pCi/g	Q	MDA	Pu-239/240 pCi/g	Q	MDA	Sr-90 pCi/g	Q	MDA	U-233/234 pCi/g	Q	MDA	U-235 pCi/g	Q	MDA
Shallow Zone Results:																
A1	J00WJ0	3.70E-02	U	2.80E-01	0.00E+00	U	2.80E-01	-1.90E-02	U	2.90E-01	4.94E-01		1.60E-01	2.40E-02	U	1.80E-01
Duplicate of J00WJ0	J00WJ7	-4.90E-02	U	3.70E-01	0.00E+00	U	3.70E-01	4.60E-02	U	2.80E-01	4.59E-01		1.80E-01	0.00E+00	U	2.20E-01
Split of J00WJ0	J00WJ9	0.00E+00	U	8.17E-02	0.00E+00	U	8.17E-02	5.68E-02	U	1.44E-01	6.86E-01		8.22E-02	9.83E-02		5.33E-02
Deep Zone Results:																
A1	J00WJ4	1.06E-01	U	4.10E-01	5.30E-02	U	4.10E-01	-6.50E-02	U	2.90E-01	5.36E-01		1.70E-01	0.00E+00	U	2.10E-01
Duplicate of J00WJ4	J00WJ8	4.70E-02	U	3.60E-01	0.00E+00	U	3.60E-01	-2.80E-02	U	3.00E-01	4.94E-01		1.60E-01	5.20E-02	U	2.00E-01
Split of J00WJ4	J00WK0	0.00E+00	U	7.11E-02	-5.25E-03	U	1.26E-01	2.00E-02	U	1.37E-01	6.68E-01		7.18E-02	5.15E-02	U	4.66E-02

Shallow Zone Analysis:

	(TDL)	Am-241	C-14	Cs-137	Co-60	Eu-152	Eu-154	Eu-155	Ni-63	Pu-238	Pu-239/240	Sr-90	U-233/234	U-235
Duplicate Analysis		1	50	0.1	0.1	0.2	0.2	0.1	30	1	1	1	1	1
	Both > MDA?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)	No-Stop (acceptable)
	Both >5xTDL?												No-Stop (acceptable)	
	RPD													
Split Analysis	Both > MDA?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)	No-Stop (acceptable)
	Both >5xTDL?												No-Stop (acceptable)	
	RPD													

Deep Zone Analysis:

	(TDL)	Am-241	C-14	Cs-137	Co-60	Eu-152	Eu-154	Eu-155	Ni-63	Pu-238	Pu-239/240	Sr-90	U-233/234	U-235
Duplicate Analysis		1	50	0.1	0.1	0.2	0.2	0.1	30	1	1	1	1	1
	Both > MDA?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)	No-Stop (acceptable)
	Both >5xTDL?												No-Stop (acceptable)	
	RPD													
Split Analysis	Both > MDA?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)	No-Stop (acceptable)
	Both >5xTDL?												No-Stop (acceptable)	
	RPD													

* A blank box indicates the RPD did not need to be calculated. RPD calculation is required when both samples are greater than the MDA and both samples are greater than 5 times the TDL.

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator: I.D Jacques
Project: 117-DR Cleanup Verification
Subject: 117-DR 95% UCL Calculation

Date: 12/16/03
Job No.: 22192

Calc. No.: 105DR-CA-V0001
Checked by: J.E. Thomson

Rev. No.: 1
Date: 12/16/03

Sheet No.: 10 of 10

Split/Duplicate Analysis:

Sample Area	HEIS Number	U-238 pCi/g	Q	MDA	Arsenic mg/kg	Q	PQL	Barium mg/kg	Q	PQL	Cadmium mg/kg	Q	PQL	Chromium (total) mg/kg	Q	PQL	Hexavalent Chromium mg/kg	Q	PQL
Shallow Zone Results:																			
A1	J00WJ0	6.52E-01		1.50E-01	2.70E+00		3.80E-01	6.65E+01		2.00E-02	7.00E-02		4.00E-02	1.17E+01		9.00E-02	4.20E-01	U	4.20E-01
Duplicate of J00WJ0	J00WJ7	5.08E-01		1.80E-01	3.10E+00		4.40E-01	6.69E+01		2.00E-02	1.90E-01		4.00E-02	1.19E+01		1.00E-01	4.20E-01	U	4.20E-01
Split of J00WJ0	J00WJ9	9.16E-01		1.03E-01	2.50E+00		2.30E-01	6.80E+01		4.30E-01	3.80E-02	U	3.80E-02	1.09E+01		5.80E-02	3.50E-01	U	3.50E-01
Deep Zone Results:																			
A1	J00WJ4	6.47E-01		1.70E-01	2.3E+00		3.9E-01	5.3E+01		2.0E-02	4.0E-02	U	4.0E-02	8.7E+00		9.0E-02	4.2E-01	U	4.2E-01
Duplicate of J00WJ4	J00WJ6	6.01E-01		1.60E-01	2.6E+00		4.3E-01	5.9E+01		2.0E-02	1.7E-01		4.0E-02	1.2E+01		1.0E-01	4.2E-01	U	4.2E-01
Split of J00WJ4	J00WK0	8.57E-01		7.18E-02	2.4E+00		2.4E-01	6.5E+01		4.4E-01	3.9E-02	U	3.9E-02	1.0E+01		5.9E-02	3.5E-01	U	3.5E-01

Sample Area	HEIS Number	Lead mg/kg	Q	PQL	Lithium mg/kg	Q	PQL	Mercury mg/kg	Q	PQL	Selenium mg/kg	Q	PQL	Silver mg/kg	Q	PQL	Sodium mg/kg	Q	PQL
Shallow Zone Results:																			
A1	J00WJ0	5.00E+00		1.70E-01	1.01E+01		2.00E-02	1.00E-02	U	1.00E-02	2.60E-01	U	2.60E-01	7.00E-02	U	7.00E-02	3.29E+02		6.40E-01
Duplicate of J00WJ0	J00WJ7	5.00E+00		2.00E-01	9.90E+00		2.00E-02	2.00E-02	U	2.00E-02	3.00E-01	U	3.00E-01	8.00E-02	U	8.00E-02	2.87E+02		7.40E-01
Split of J00WJ0	J00WJ9	5.10E+00		1.40E-01	1.26E+01		7.20E-01	1.70E-02	U	1.70E-02	2.20E-01	U	2.20E-01	5.70E-02	B	5.70E-02	2.71E+02	B	1.45E+01
Deep Zone Results:																			
A1	J00WJ4	3.9E+00		1.8E-01	8.7E+00		2.0E-02	2.0E-02	U	2.0E-02	2.7E-01	U	2.7E-01	7.0E-02	U	7.0E-02	3.0E+02		6.6E-01
Duplicate of J00WJ4	J00WJ6	4.2E+00		2.0E-01	8.9E+00		2.0E-02	1.0E-02	U	1.0E-02	3.0E-01	U	3.0E-01	8.0E-02	U	8.0E-02	2.8E+02		7.3E-01
Split of J00WJ4	J00WK0	4.1E+00		1.4E-01	1.4E+01		7.3E-01	1.7E-02	U	1.7E-02	2.2E-01	U	2.2E-01	8.5E-02	B	8.5E-02	2.8E+02	B	1.5E+01

Shallow Zone Analysis:

	(TDL)	1	10	2	0.5	1	0.5	5	2.5	0.2	10	1	50
Duplicate Analysis	Both > MDA?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)		No-Stop (acceptable)	No-Stop (acceptable)				Yes (calc RPD)
	RPD			0.60%		1.7%							14%
Split Analysis	Both > MDA?	Yes (continue)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)		Yes (calc RPD)		No-Stop (acceptable)	No-Stop (acceptable)				Yes (calc RPD)
	RPD			2.2%		7.1%							19%

Deep Zone Analysis:

	(TDL)	1	10	2	0.5	1	0.5	5	2.5	0.2	10	1	50
Duplicate Analysis	Both > MDA?	Yes (continue)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)		Yes (calc RPD)		No-Stop (acceptable)	No-Stop (acceptable)				Yes (calc RPD)
	RPD			9.1%		29%							6.6%
Split Analysis	Both > MDA?	Yes (continue)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)		Yes (calc RPD)		No-Stop (acceptable)	No-Stop (acceptable)				Yes (calc RPD)
	RPD			20%		17%							5.9%

* A blank box indicates the RPD did not need to be calculated. RPD calculation is required when both samples are greater than the MDA and both samples are greater than 5 times the TDL.

CALCULATION COVER SHEET

Project Title 117-DR Cleanup Verification **Job No.** 22192
Area 100-D Area
Discipline Environmental ***Calc. No.** 105DR-CA-V0002
Subject 117-DR RESRAD Calculation
Computer Program RESRAD **Program No.** Version 6.21

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover – 1 pg Summary – 6 pg Attm. 1 - 1 pg Attm. 2 - 31 pg Attm. 3 - 50 pg Attm. 4 - 19 pg Attm. 5 - 31 pg Attm. 6 - 50 pg Attm. 7 - 19 pg Total – 208 pages	I.D. Jacques *Approved 10/31/03*	S. W. Clark *Approved 10/31/03*	J.W. Golden *Approved 11/6/03*	K. J. Koegler *Approved 11/11/03*	
1	No Changes	I. D. Jacques I. D. Jacques 12/8/03	S. W. Clark S W Clark 12/8/03	J.W. Golden J Golden 12/12/03	K. J. Koegler K J Koegler	12/16/03

SUMMARY OF REVISION

1	Errors were discovered in the formulas in the 117-DR 95% UCL Calculation (105DR-CA-V0001) for calculating the Shallow Zone 95%UCL on the mean for the following non-radioactive constituents: arsenic, barium, cadmium, lead, lithium, and selenium. The computational errors were corrected in the 117-DR 95% UCL Calculation which resulted in different statistical values above background for each of the constituents. These values were changed on table 3 of this calculation brief. The changes did not affect the RESRAD run because none of the non-radioactive constituent values were carried forward to the RESRAD calculations. The changes affected only page 3 of this calculation brief.

*Obtain Calc. No. from DIS
DE01-437.03

January 2003

Bechtel Hanford, Inc. **CALCULATION SUMMARY**

Originator:	I. D. Jacques	Date:	10-31-03	Calc. No.:	105DR-CA-V0002	Rev.:	0
Project:	117-DR Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	10/31/03
Subject:	117-DR RESRAD Calculation					Sheet No. 1 of 6	

PROBLEM STATEMENT:

Calculate the soil and groundwater concentrations, dose, and risk contributions from remaining radionuclide contaminants in the vadose zone soil at the 117-DR Exhaust Filter Building remediation site over a period of 1,000 years.

REFERENCES:

1) Cleanup verification data from *117-DR Cleanup Verification 95% UCL Calculation*, Calculation No. 105DR-CA-V0001, 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. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) *Sampling and Analysis Plan for the 105-F and 105-DR Phase III Below-Grade Structures and Underlying Soils*, DOE/RL-99-35, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) Radioactive and non-radioactive contaminants of concern from the *117-DR Exhaust Filter Building Proposed Additional Soil Sampling and 1720-HA Arsenal Removal/Disposal Summary*, CCN# 106839, April 2, 2003, Bechtel Hanford, Inc., Richland, Washington. For the purpose of these RESRAD calculations, the radioactive contaminants of concern (COCs) are americium-241, carbon-14, cesium-137, cobalt-60, cesium-137, europium-152, europium-154, europium-155, nickel-63, plutonium-238, plutonium-239/240, strontium-90, uranium-233/234, uranium-235, and uranium-238. The nonradioactive COCs include arsenic, barium, cadmium, chromium (total), hexavalent chromium, lead, lithium, mercury, selenium, silver, and sodium.
5) RESidual RADioactivity (RESRAD) computer code, version 6.21, 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.

SOLUTION:

1) Separate RESRAD runs were performed for the relevant vadose zone soil horizons (shallow zone and deep zone). Table 1 shows the elevations (NAVD'88) and dimensions of each soil horizon. The shallow zone was chosen as the sidewalls of the excavation to 4.6 m deep (from the backfill reference elevation of 143.1 m to an elevation of 138.5 m). The deep zone is the remaining portion of the vadose zone from 4.6 m below ground surface to groundwater (elevation 118.6 m). The total-plan view area of the excavation was used to conservatively estimate the site area input parameter for each soil horizon. Attachment 1 shows the dimensions of each soil horizon and the contaminant pathways considered for dose, risk, and groundwater protection.

Bechtel Hanford, Inc. **CALCULATION SUMMARY**

Originator:	I. D. Jacques	Date:	10-31-03	Calc. No.:	105DR-CA-V0002	Rev.:	0
Project:	117-DR Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	10/31/03
Subject:	117-DR RESRAD Calculation					Sheet No. 2 of 6	

Input factors for each run 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.

Table 1. Dimensions and Elevations of 117-DR Soil Horizons

RESRAD Run #	Vadose Zone Horizon	Upper Elevation (m)	Lower Elevation (m)	Thickness (m)
1-Radionuclides	Shallow Zone	143.1	138.5	4.6
2-Radionuclides	Deep Zone	138.5	118.6	19.9

2) The year where the peak dose (or concentration) occurs from each individual COC and layer is determined by a preliminary run. This year is then added for all horizons for the final RESRAD runs. For the direct exposure pathways (i.e., soil ingestion and inhalation and external radiation), the peak year occurred at year 0 (the present, year 2003). For the water dependent pathways (i.e., drinking water and food ingestion) the peak years were year 7.2 for cobalt-60, year 42 for cesium-137 and strontium-90, and year 138 for nickel-63. The 7.2, 42, and 138-year time periods were included in all of the RESRAD runs.

METHODOLOGY:

1) The relative individual Pu-239 and Pu-240 activities were calculated from the combined Pu-239/249 results reported. The calculations were performed in accordance with Calculation No. 0100B-CA-V0013. The relative activities for Pu-239 and Pu-240 were calculated by multiplying the cleanup verification value for Pu-239/240 by 0.807 and 0.193, respectively. Table 2 shows the results from this calculation.

Table 2. Conversion of Pu-239/240 Activity to Relative Pu-239 and Pu-240 Activities

RESRAD Run #	Vadose Zone Horizon	Pu-239/240 Activity (pCi/g)	Pu-239, (pCi/g) (0.807 multiplier)	Pu-240, (pCi/g) (0.193 multiplier)
1	Shallow Zone	0.0245	0.0198	0.00473
1	Deep Zone	0.0234	0.0189	0.00452

2) Runs of RESRAD Version 6.21 were completed for the vadose zone using the radionuclide concentrations shown in Table 3. RESRAD numerical output reports for dose, risk, and concentration for the shallow and deep zones are presented in the Attachments to this Calculation Summary. Shallow and deep zone concentrations of nonradionuclide COCs are included in Table 3 for evaluation of their potential to affect groundwater or the Columbia River. However, the concentrations of all nonradionuclide COCs are less than the remedial action goals (RAGs) from the RDR/RAWP or less than background levels so no evaluation is necessary.

Bechtel Hanford, Inc. **CALCULATION SUMMARY**

Originator:	I. D. Jacques	Date:	12-08-03	Calc. No.:	105DR-CA-V0002	Rev.:	1
Project:	117-DR Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	
Subject:	117-DR RESRAD Calculation					Sheet No. 3 of 6	

Table 3. Cleanup Verification Data Set

Radionuclide COCs	Shallow Zone[a]	Deep Zone[a]
	Radionuclide Activity, pCi/g	
Am-241	3.31E-02 (U)	9.08E-03 (U)
C-14	9.27E-01 (U)	1.12E+00 (U)
Cs-137	5.18E-02	4.59E-02
Co-60	1.46E-02 (U)	2.19E-02 (U)
Eu-152	3.26E-02 (U)	4.46E-02 (U)
Eu-154	4.72E-02 (U)	7.11E-02 (U)
Eu-155	4.27E-02 (U)	5.42E-02 (U)
Ni-63	1.08E+00 (U)	1.63E+00 (U)
Pu-238	2.40E-02 (U)	7.59E-02 (U)
Pu-239/240	2.45E-02 (U)	2.34E-02 (U)
Sr-90	-3.00E-03 (U)[b]	6.10E-04 (U)
U-233/240	0 (<BG)[c]	0 (<BG)[c]
U-235	0 (<BG) (U)[c]	0 (<BG) (U)[c]
U-238	0 (<BG)[c]	0 (<BG)[c]
Nonradionuclide COCs	Nonradionuclide Concentration, mg/kg	
Arsenic	2.9E+00[c]	2.4E+00[c]
Barium	6.5E+01[c]	5.8E+01[c]
Cadmium	1.9E-01[c]	2.1E-01[c]
Chromium (total)	1.1E+01[c]	1.0E+01[c]
Hexavalent Chromium	4.2E-01 (U)[c]	4.2E-01 (U)[c]
Lead	6.5E+00[c]	4.1E+00[c]
Lithium	1.2E+01[c]	9.9E+00[c]
Mercury	2.0E-02 (U)[c]	2.0E-02 (U)[c]
Selenium	3.0E-01 (U)[c]	3.3E-01 (U)[c]
Silver	8.0E-02 (U)[c]	8.0E-02 (U)[c]
Sodium	4.0E+02[c]	3.9E+02[c]

[a] The Shallow Zone and Deep Zone concentrations are from the *117-DR 95% UCL Calculation*, Calculation No. 105DR-CA-V0001, Rev. 0.
[b] Value was not input into RESRAD because the concentration is less than zero.
[c] Value was not input into RESRAD because the concentration is below RAGs, below Hanford Site background, below Washington State background, or because the analyte was not detected in cleanup verification samples at the indicated PQLs.
(U) = All analytical results for the data set were below laboratory detection limits.
(<BG) = Less than background.

RESULTS:

1) Radionuclide "All Pathways" Dose Rate:

1) The "all pathways" (maximum) dose rates are shown in Table 4. The maximum total all pathways dose rate of 1.20 mrem/yr occurs at year zero (2003) (principally from the shallow zone). The maximum deep zone dose rate of 9.35×10^{-4} mrem/yr occurs in year 138.

Bechtel Hanford, Inc. **CALCULATION SUMMARY**

Originator:	I. D. Jacques	Date:	10-31-03	Calc. No.:	105DR-CA-V0002	Rev.:	0
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Subject:	117-DR RESRAD Calculation					Sheet No. 4 of 6	

Table 4. All Pathways Dose Rate (mrem/yr)

RESRAD Run #	Vadose Zone Horizons	"All Pathways" Dose Contributions in mrem/yr at Each Time Slice (yr)								
		0	1	3	7.2	15	42	138	300	1000
1	Shallow Zone	1.20E+00	7.48E-01	5.47E-01	4.15E-01	2.71E-01	1.02E-01	3.14E-02	2.07E-02	1.24E-02
2	Deep Zone	1.16E-05	3.67E-05	8.49E-05	1.77E-04	3.27E-04	6.72E-04	9.35E-04	7.14E-04	1.51E-04
Total All Pathways Dose Rate (mrem/yr)		1.20E+00	7.48E-01	5.47E-01	4.15E-01	2.72E-01	1.03E-01	3.23E-02	2.14E-02	1.26E-02

2) Radionuclide Excess Cancer Risk

The radionuclide excess cancer risk results are shown on Table 5. The maximum risk (4.26×10^{-5}) occurs at year 0 and is primarily from shallow zone soils.

Table 5. Radionuclide Excess Cancer Risk

RESRAD Run #	Vadose Zone Horizons	Excess Cancer Risk at Each Time Slice (yr)								
		0	1	3	7.2	15	42	138	300	1000
1	Shallow Zone	4.26E-05	2.10E-05	1.24E-05	9.07E-06	5.68E-06	1.76E-06	2.18E-07	6.22E-08	2.61E-08
2	Deep Zone	9.04E-09	9.58E-09	1.06E-08	1.26E-08	1.59E-08	2.34E-08	2.83E-08	1.85E-08	1.25E-09
Total Excess Cancer Risk		4.26E-05	2.10E-05	1.24E-05	9.08E-06	5.70E-06	1.78E-06	2.46E-07	8.07E-08	2.73E-08

3) Radionuclide Groundwater Protection

The radionuclide concentrations in groundwater calculated by the RESRAD model are summarized in Table 6. Only concentrations are presented here. Cesium-137, cobalt-60, nickel-63, and strontium-90 were calculated to reach groundwater in the 1,000 years of the RESRAD model run for the vadose zone. These radionuclide contaminants reach groundwater at concentrations below the RAGs.

Bechtel Hanford, Inc. **CALCULATION SUMMARY**

Originator:	I. D. Jacques	Date:	10-31-03	Calc. No.:	105DR-CA-V0002	Rev.:	0
Project:	117-DR Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	10/31/03
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Table 6. RESRAD Estimated Groundwater (Well Water) Concentrations.

Radio-nuclide	Vadose Zone Horizon	Groundwater Concentration in pCi/L at Each Time Slice (yr)									RAG from RDR (pCi/L)
		0	1	3	7.2	15	42	138	300	1000	
Am-241	Total	0	0	0	0	0	0	0	0	0	1.2
C-14	Total	0	0	0	0	0	0	0	0	0	2,000
Cs-137	SZ	0	0	0	0	0	0	0	0	0	60
	DZ	0	1.16E-04	3.31E-04	7.20E-04	1.25E-03	1.88E-03	6.72E-04	3.45E-05	1.08E-11	
	Total	0	1.16E-04	3.31E-04	7.20E-04	1.25E-03	1.88E-03	6.72E-04	3.45E-05	1.08E-11	
Co-60	SZ	0	0	0	0	0	0	0	0	0	100
	DZ	0	4.94E-05	1.14E-04	1.58E-04	1.18E-04	9.45E-06	1.02E-10	1.24E-19	0	
	Total	0	4.94E-05	1.14E-04	1.58E-04	1.18E-04	9.45E-06	1.02E-10	1.24E-19	0	
Eu-152	Total	0	0	0	0	0	0	0	0	0	200
Eu-154	Total	0	0	0	0	0	0	0	0	0	60
Eu-155	Total	0	0	0	0	0	0	0	0	0	600
Ni-63	SZ	0	0	0	0	0	0	0	0	0	50
	DZ	0	1.92E-02	5.69E-02	1.32E-01	2.61E-01	6.00E-01	9.84E-01	6.61E-01	4.96E-03	
	Total	0	1.92E-02	5.69E-02	1.32E-01	2.61E-01	6.00E-01	9.84E-01	6.61E-01	4.96E-03	
Pu-238	Total	0	0	0	0	0	0	0	0	0	1.6
Pu-239/240	Total	0	0	0	0	0	0	0	0	0	1.2
Sr-90	SZ	0	0	0	0	0	0	0	0	0	8
	DZ	0	1.12E-05	3.20E-05	6.95E-05	1.20E-04	1.77E-04	5.90E-05	2.49E-06	1.38E-13	
	Total	0	1.12E-05	3.20E-05	6.95E-05	1.20E-04	1.77E-04	5.90E-05	2.49E-06	1.38E-13	

4) Nonradionuclide Groundwater Protection

The nonradionuclide COCs associated with this site are present at concentrations below the applicable RAGs for direct exposure and groundwater protection.

CONCLUSIONS:

- The maximum total dose rate for the 117-DR Building site is 1.20 mrem/yr and occurs at year zero (year 2003). Maximum total dose rate at year 2018 is 2.72×10^{-1} mrem/yr. Maximum total dose rate after 1,000 years is 1.26×10^{-2} mrem/yr.
- The dominant pathways for the dose rate at the year of maximum dose are direct external exposure and plant ingestion.
- The primary radionuclide contributing to the dose rate at the year of maximum dose is Carbon-14 from the plant ingestion pathway.
- None of the 117-DR Building site COCs are projected to exceed remedial action goals (RAGs) within the 1,000 years of the RESRAD evaluation.
- Maximum total excess lifetime cancer risk (4.26×10^{-5}) occurs at year zero and is primarily contributed from the shallow zone. Maximum total excess lifetime cancer risk at year 2018 is 5.70×10^{-6}. Maximum total excess lifetime cancer risk after 1,000 years is 2.73×10^{-8}.

Bechtel Hanford, Inc. **CALCULATION SUMMARY**

Originator:	I. D. Jacques	Date:	10-31-03	Calc. No.:	105DR-CA-V0002	Rev.:	0
Project:	117-DR Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	10/31/03
Subject:	117-DR RESRAD Calculation					Sheet No. 6 of 6	

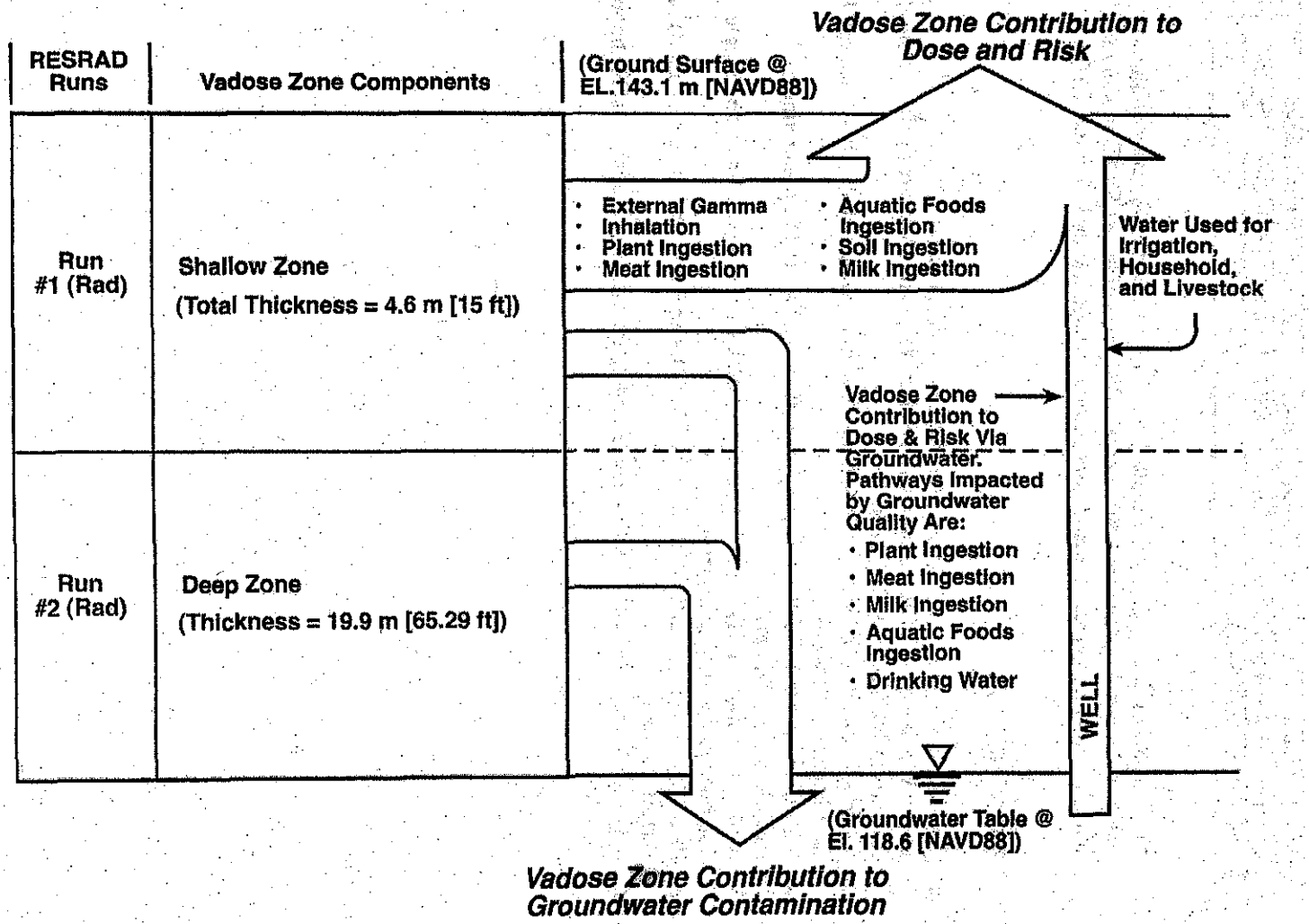
- Of the contaminants of concern, cobalt-60, cesium-137, nickel-63, and strontium-90 are calculated to reach groundwater within the 1,000 years of the RESRAD model run. These radionuclides reach groundwater at concentrations significantly below the RAGs.

ATTACHMENTS:

1. Graphic showing 117-DR Cleanup Verification Model (1 page)
2. RESRAD Output: 117-DR – Shallow Zone (Run #1), Part I: Mixture Sums and Single Radionuclide Guidelines (31 pages)
3. RESRAD Output: 117-DR – Shallow Zone (Run #1), Part III: Intake Quantities and Health Risk Factors (50 pages)
4. RESRAD Output: 117-DR – Shallow Zone (Run #1), Part IV: Concentration of Radionuclides (19 pages)
5. RESRAD Output: 117-DR – Deep Zone (Run #2), Part I: Mixture Sums and Single Radionuclide Guidelines (31 pages)
6. RESRAD Output: 117-DR – Deep Zone (Run #2), Part III: Intake Quantities and Health Risk Factors (50 pages)
7. RESRAD Output: 117-DR – Deep Zone (Run #2), Part IV: Concentration of Radionuclides (19 pages)

ATTACHMENT 1

117-DR Cleanup Verification Model



Attachment 1 Sheet No. 1 of 1
Originator I. D. Jacques Date 10/31/02
Chk'd By S. W. Clark Date 10/31/02
Calc. No. 105DR-CA-V0001 Rev. No. 0

CALCULATION COVER SHEET

Project Title:	117-DR Cleanup Verification	**Job No.**	22192
Area	100 D Area		
Discipline	Environmental	***Calc. No.**	105DR-CA-V0003
Subject	117-DR Filter Building Comparison to Drinking Water Standards Calculation Brief		
Computer Program	Excel	**Program No.**	Excel 97

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

Committed Calculation X **Preliminary** **Superseded**

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover - 1 Calculations - 4 Total - 5	I. D. Jacques Duane Jacques 11/6/03	S. W. Callison SW Callison 11-6-03	J. W. Golden J. W. Golden 11-10-03	K. J. Koegler K. J. Koegler 11/11/03	11/11/03

SUMMARY OF REVISIONS

*Obtain Calc. No. from DIS

December 2002

DE01-437.03

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	I. D. Jacques	Date 11/6/03	Calc. No. 105DR-CA-V0003	Rev. No.	0
Project	117-DR Cleanup Verification	Job No. 22192	Checked S. W. Callison	Date	11-6-03
Subject	117-DR Filter Building Comparison to Drinking Water Standards Calculation Brief			Sheet No.	1 of 4

Purpose:
Compare RESRAD derived groundwater radionuclide concentrations to remedial action goals and maximum contaminant levels (MCLs) for groundwater. Compare beta/gamma emitter dose contributions to the maximum allowable dose of 4 mrem/yr. Compare alpha emitter dose contributions to the maximum allowable gross particle activity of 15 pCi/L or 1/25th of the derived concentration guide (DCG).

Table of Contents:
1. Calculation Summary
2. Comparison to MCLs
3. Comparison for alpha emitters
4. Cumulative Dose Comparison

Given/References:
1) RESRAD derived groundwater radionuclide concentrations from Calculation 105DR-CA-V0002, *117-DR RESRAD Calculation*.

2) Remedial action goals for groundwater and MCLs summarized in Table 2-3 of the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations office, Richland, WA.

3) *Maximum allowable* dose of 4 *mrem/yr* for *beta/gamma emitters* and *maximum allowable gross particle activity* of 15 pCi/L for alpha *emitters* from: 40 CFR 141, "*National Primary Drinking* Water Regulation," *Code of Federal Regulations*, as amended (40 CFR Part 141, Subpart B, 141.51).

4) 1/25th of the derived concentration guide values from *Radiation Protection of the Public and Environment*, DOE Order 5400.5, U.S. Department of Energy, Washington D.C.

5) Individual organ-dose caclulation methodology for beta/gamma emitter dose contribution to the maximum allowable dose of 4 mrem/yr from: *Maximum Permissible Body Burdens and Maximum Permissible Concetrations of Radionuclides in Air or Water for Occupational Exposure*, National Bureau of Standards (NBS) Handbook 69, as amended, U.S. Department of Commerce, Washington D.C., and National Primary Drinking Water Regulations, EPA-570/9-76-003, U.S. Environmental Protection Agency, Office of Water Supply, Washington D.C.

Solution:
1. The site data for the calculation are the groundwater concentrations for the contaminants of concern (COCs) (daughter products are not considered) over time from the RESRAD groundwater concentration file.

2. If the site conceptual model breaks the contamination into multiple layers with differing concentrations, then the groundwater concentrations from the various model runs are added (for each time interval) to provide the concentration data for comparison to the individual remedial action goals and MCLs and the dose calculation for the beta and gamma emitters.

3. Compare the summed concentrations for each radionuclide to the groundwater remedial action goal and MCL given in the RDR/RAWP, Table 2-3.

4. The cumulative dose for each organ for all beta and gamma emitting COCs (C-14, Cs-137, Co-60, Eu-152, Eu-154, Eu-155, Ni-63, and Sr-90) at time t is calculated separately using the corresponding to 4 mrem/year dose (C4) and the sum of fractions equation shown below (from EPA-570/9-76-003). The organs for which doses need to be computed are total body, bone, liver and gastrointestinal tract [lower large intestine] (GI(LLI)). The individual organ doses are compared to 4 mrem/yr.

$$Dose_{organ\ x}(t) = [Conc_A(t)/C4A(x) + Conc_B(t)/C4B(x) + \ldots] \times (4\ mrem/yr)$$

where:
$Dose_{organ\ x}(t)$ is the total dose to organ x in mrem/yr
$Conc_A(t)$ is the concentration of isotope A at time t in pCi/L
C4A(x) is the 4 mrem/yr dose equivalent concentration for organ x of isotope A at time t in pCi/L
If the dose for organ x < 4 mrem/yr, then the standard is met.

Conclusions:
1. The summed concentrations for each radionuclide COC are less than the groundwater remedial action goal and MCL given in the RDR/RAWP, Table 2-3.

2. The cumulative dose for each total body, bone, liver and gastrointestinal tract for all beta and gamma emitting COCs is less than 4 mrem/yr

3. RESRAD modeling indicates that the alpha emitting COCs (Am-241, Pu-238, and Pu-239/240) will not impact groundwater. Therefore, concentrations for the alpha emitting COCs are less than the maximum allowable gross particle activity of 15 pCi/L and the 1/25th of the DCG.

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	I. D. Jacques	Date 11/6/03	Calc. No. 105DR-CA-V0003		Rev. No. 0
Project	117-DR Cleanup Verification	Job 22192	Checked S. W. Callison		Date 11/6/03
Subject	117-DR Filter Building Comparison to Drinking Water Standards Calculation Brief				Sheet No. 2 of 4

Comparison of the summed concentrations for each alpha emitting radionuclide to the 15 pCi/L limit in 40 CFR 141.15 and 1/25th of the DCG from DOE Order 5400.5. Data derived from RESRAD modelling.

Radionuclide	Time (years)									Exceeds 15 pCi/L?	1/25th of DCG (pCi/L)	Exceeds DCG?	Peak Conc.	Year of Peak Conc.
	0	1	3	7	15	43	140	300	1000					
Am-241	0	0	0	0	0	0	0	0	0	No	1.2	No	0.00E+00	NA
Pu-238	0	0	0	0	0	0	0	0	0	No	1.6	No	0.00E+00	NA
Pu-239/240	0	0	0	0	0	0	0	0	0	No	1.6	No	0.00E+00	NA

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	I. D. Jacques	**Date** 11/6/03	**Calc. No.** 105DR-CA-V0003	**Rev. No.**	0
Project	117-DR Cleanup Verification	**Job** 22192	**Checked** S. W. Callison	**Date**	11-6-03
Subject	117-DR Filter Building Comparison to Drinking Water Standards Calculation Brief			**Sheet No.**	3 of 4

Comparison of the summed concentrations for each radionuclide to the GW MCL
Data derived from RESRAD modelling, units are pCi/L.

Radionuclide	Time (years) 0	1	3	7.2	15	42	138	300	1000	MCL	Exceeds MCL?	Peak Conc.	Year of Peak
C-14	0	0	0	0	0	0	0	0	0	2,000	No	0.00E+00	0
Cs-137	0	1.16E-04	3.31E-04	7.20E-04	1.25E-03	1.88E-03	6.72E-04	3.45E-05	1.08E-11	60	No	1.88E-03	42
Co-60	0	4.94E-05	1.14E-04	1.58E-04	1.16E-04	9.45E-06	1.02E-10	1.24E-19	0	100	No	1.58E-04	7.2
Eu-152	0	0	0	0	0	0	0	0	0	200	No	0.00E+00	0
Eu-154	0	0	0	0	0	0	0	0	0	60	No	0.00E+00	0
Eu-155	0	0	0	0	0	0	0	0	0	600	No	0.00E+00	0
Ni-63	0	1.92E-02	5.69E-02	1.32E-01	2.61E-01	6.00E-01	9.84E-01	6.61E-01	4.96E-03	50	No	9.84E-01	138
Sr-90	0	1.12E-05	3.20E-05	6.95E-05	1.20E-04	1.77E-04	5.90E-05	2.49E-06	1.38E-13	8	No	1.77E-04	42

Bechtel Hanford, Inc.

CALCULATION SHEET

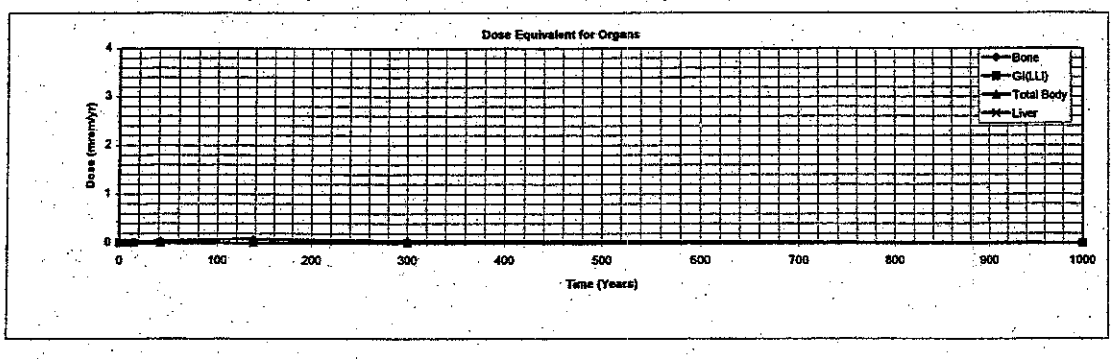
Originator	I. D. Jacques	Date 11/6/03	Calc. No. 105DR-CA-V0003		Rev. No. 0
Project	117-DR Cleanup Verification	Job 22192	Checked S. W. Callison		Date 11-6-03
Subject	117-DR Filter Building Comparison to Drinking Water Standards Calculation Brief				Sheet No. 4 of 4

Comparison of the summed concentrations for each radionuclide to the GW MCL
Data derived from RESRAD modelling, units are pCi/L.

Radionuclide	Time (years) 0	1	3	7.2	15	42	138	300	1000	Organ	C_4	Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak Conc.
C-14	0	0	0	0	0	0	0	0	0	Bone	2,000	No	0	NA
										Total Body	9,000	No		
Cs-137	0	1.16E-04	3.31E-04	7.20E-04	1.25E-03	1.88E-03	6.72E-04	3.45E-05	1.08E-11	Bone	80	No	1.88E-03	42
										GI(LLI)	2,000	No		
										Total Body	200	No		
										Liver	60	No		
Co-60	0	4.94E-05	1.14E-04	1.58E-04	1.18E-04	9.45E-06	1.02E-10	1.24E-19	0	GI(LLI)	100	No	1.58E-04	7.2
										Total Body	900	No		
										Liver	3,000	No		
Eu-152	0	0	0	0	0	0	0	0	0	Bone	30,000	No	0	NA
										GI(LLI)	200	No		
										Total Body	200,000	No		
										Liver	100,000	No		
Eu-154	0	0	0	0	0	0	0	0	0	Bone	5,000	No	0	NA
										GI(LLI)	60	No		
										Total Body	70,000	No		
										Liver	60,000	No		
Eu-155	0	0	0	0	0	0	0	0	0	Bone	100,000	No	0	NA
										GI(LLI)	600	No		
										Total Body	900,000	No		
										Liver	600,000	No		
Ni-63	0	1.92E-02	5.69E-02	1.32E-01	2.61E-01	6.00E-01	9.84E-01	6.61E-01	4.96E-03	Bone	50	No	9.84E-01	138
										GI(LLI)	3,000	No		
										Total Body	2,000	No		
										Liver	600	No		
Sr-90	0	1.12E-05	3.20E-05	6.95E-05	1.20E-04	1.77E-04	5.90E-05	2.49E-06	1.38E-13	Bone	8	No	1.77E-04	42
										GI(LLI)	100	No		
										Total Body	8	No		

Cumulative dose for each organ (with time)

Organ	Time (years) 0	1	3	7.2	15	42	138	300	1000	Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak Conc.
Bone	0.00E+00	1.55E-03	4.59E-03	1.06E-02	2.10E-02	4.82E-02	7.88E-02	5.29E-02	3.97E-04	No	7.88E-02	138
GI(LLI)	0.00E+00	2.83E-05	8.24E-05	1.87E-04	3.60E-04	8.11E-04	1.32E-03	8.82E-04	6.61E-06	No	1.32E-03	138
Total Body	0.00E+00	4.65E-05	1.37E-04	3.14E-04	6.08E-04	1.33E-03	2.01E-03	1.32E-03	9.92E-06	No	2.01E-03	138
Liver	0.00E+00	1.41E-04	4.16E-04	9.63E-04	1.88E-03	4.21E-03	6.63E-03	4.41E-03	3.31E-05	No	6.63E-03	138



APPENDIX D

PROPOSED CLOSURE PATH FOR THE REMAINING PORTION OF THE 105-DR/LSFF EXHAUST TUNNEL

0557012

Proposed Closure Path for the Remaining Portion of the 105-DR / LSFF Exhaust Tunnel

Background

The Large Sodium Fire Facility (LSFF) is a *Resource Conservation and Recovery Act of 1976* (RCRA)-permitted waste treatment, storage, and disposal unit (TSD), which was operated from 1972 to 1986 under RCRA TSD Permit No. T-1-1. The LSFF was used to study the fire and safety aspects associated with sodium and other alkali metal fires for application to liquid metal reactors. The LSFF occupied the former supply/exhaust fan room of the 105-DR Reactor Building and used the 105-DR Reactor Building exhaust system, which includes the 117-DR Filter Building, exhaust tunnels, exhaust stack, exhaust stack sampling building, and exhaust stack sampling building drywell.

To ease management of closure activities, the TSD was divided into seven "subunits." Four of the seven subunits are already closed. These subunits include the exhaust fan room, small fire room, large fire room, sodium handling room, and an office area (122-DR-1:1); the gravel scrubber (122-DR-1:3); the 116-DR-8 Crib and associated piping (122-DR-1:6); and the outdoor storage area (122-DR-1:7). Certification of closure for these LSFF TSD subunits is documented in the *105-DR Large Sodium Fire Facility Soil Sampling Data Evaluation Report* (WHC 1996) and in a Washington State Department of Ecology letter regarding closure certification for 122-DR-1 subunits 1, 3, 6, and 7 (Ecology 1996).

The LSFF Closure Plan deferred the remaining three LSFF TSD subunits (122-DR-1:2, 122-DR-1:4, and 122-DR-1:5) to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) Interim Safe Storage (ISS) process (EPA et al. 1998) for the 105 DR Reactor Building for final closure. These subunits include the 117-DR Exhaust Filter Building (122-DR-1:4), which also includes the downstream (post-filter) tunnel between the filter building and the exhaust stack; the underground exhaust tunnel between the 105-DR Building and the 117-DR Building (100-DR-1:2); and the 116-DR Exhaust Stack (122-DR-1:5).

Status of Remaining LSFF Subunits

As previously stated, the LSFF closure plan deferred the remaining three TSD subunits to the CERCLA process, and directed that the subunits be addressed with the 105-DR Reactor Building for final closure. As such, they were included with other below-grade 105-DR reactor components under CERCLA for ISS.

With the exception of the deep foundation of the exhaust stack (subunit 5), recent decontamination and decommissioning (D&D) activities removed subunits 4 and 5. With regards to subunit 2, the upper exhaust tunnel and approximately the top 3 feet of the lower exhaust tunnel were removed. Before removal of the top portion, the lower exhaust tunnel was sampled for the radionuclides and lead as specified in the 105-DR SAP, and met all applicable remedial action goals, as presented in the 105-DR Cleanup Verification Package (CVP) (DOE-RL 2004).

LSFF Subunit 2 (lower exhaust tunnel)

During a recent review of the CVP for the 2, 4, and 5 LSFF subunits, a question was raised with regards to the potential residual concentrations of the LSFF contaminants of concern (lithium and sodium) in the remaining lower exhaust tunnel. As stated above, the exhaust tunnel verification samples collected during recent D&D activities were analyzed for radionuclides and lead only.

From the *105-DR Large Sodium Fire Facility Closure Plan* (closure plan) (DOE-RL 1995), scale samples from the exhaust tunnel were collected and analyzed for lithium and sodium carbonate in 1987. The 1987 samples were analyzed by Pacific Northwest Laboratories. The 1987 laboratory report is included as an attachment. The sodium carbonate and lithium exhaust tunnel scale concentrations are summarized in Table 1.

Table 1 – 1987 Lower Exhaust Tunnel Scale Sodium and Lithium Analytical Data.

Sample Location	Soluble Alkalinity (as sodium carbonate)	Lithium
	Reported by lab as %	mg/kg
1	57% (570,000 mg/kg)	7,500
2	62% (620,000 mg/kg)	1,600
3	0.2% (2,000 mg/kg)	105
4	63% (630,000 mg/kg)	11,000
5	0.4% (4,000 mg/kg)	2,400
6	67% (670,000 mg/kg)	10,000
7	0.3% (3,000 mg/kg)	2,100

A sample location diagram from the closure plan is also attached. During the 1987 sampling, scale deposits were generally identified only on the floor of the exhaust tunnel in areas where the exhaust changed its flow path. Scale was identified on the floor of the baffle or plenum immediately beneath where the exhaust exited the LSFF burn rooms. Scale was also identified on the floor of the exhaust tunnel immediately below where the exhaust transitioned from the lower tunnel to the former upper tunnel. The floor of the remaining lower exhaust tunnel is approximately 16.5 ft (DOE-RL 2000) below the ground surface.

The Washington State dangerous waste designation criteria for sodium and lithium carbonate are 10,000 mg/kg and 100,000 mg/kg, respectively. The lithium scale concentrations are well below the dangerous waste criteria. When the mass of the concrete is included into the waste matrix, the concentration of lithium drops even further.

The analytical method followed in 1987, would not be the same followed today. The 1987 activity utilized a Soluble Alkalinity test to determine the amount of sodium carbonate present in the plenum. Since the Soluble Alkalinity test does not have the ability to differentiate sodium carbonate from other similar contaminants in the waste matrix, the analytical results are extremely conservative (high). Still, when using the 1987 results from the soluble alkalinity test as an input to the waste calculation, the plenum does not designate as dangerous.

Considering the mass of the remaining concrete and making a conservative assumption that the scale covers the interior portion of the remaining tunnel at a thickness of 0.64 cm (0.25 inch), the resulting concrete-scale waste would not be a dangerous waste. The calculated concrete-scale sodium carbonate concentration is 8,096 mg/kg, which is below the sodium carbonate dangerous waste designation level of 10,000 mg/kg. The scale and exhaust tunnel sodium carbonate calculation is attached. Assuming that the scale covers the interior portions of the remaining tunnel at a thickness of 0.64 cm (0.25 inch) is also very conservative. The 1987 investigation identified scale in localized areas on the floor of the tunnel. Scale was not identified as uniform throughout the interior surfaces of the tunnel.

In addition, the Washington State dangerous waste designation criteria also requires "a person whose waste contains one or more toxic constituents must determine the equivalent concentration for the waste (WAC 173-303-100(5)(b)(ii))." If the result is <.001%, the waste is not a toxic dangerous waste. Using the formula provided in the regulation, the equivalent concentration of the waste equals (=) lithium (1.1%/10,000) + sodium carbonate (.8%/1000) =.0009%. Again, this number is extremely conservative, because the numbers used are "worst case."

Proposed Closure Path for Subunit 2 (lower exhaust tunnel)

Considering the relatively small amount of scale identified in 1987 and the large volume of concrete associated with the tunnel structure, the remaining concrete-scale waste matrix is well below the lithium carbonate and sodium carbonate dangerous waste designation criteria. On this basis, the remaining below-grade exhaust tunnel is acceptable to leave in place and should not require additional sampling or removal to obtain RCRA clean closure.

If there is a desire to remove the plenum, due to the physical constraints, it should be addressed as part of the final ISS decision for the 105-DR Reactor Building. Still, since the exhaust plenum waste matrix is well below the lithium carbonate and sodium carbonate dangerous waste designation criteria, the project should proceed with the RCRA clean closed certification. The cover signature page documents concurrence with this proposed closure path.

Attachments

Attachment 1 – 1987 Analytical Data and Sample Location Diagram for Scale Samples Collected from the Lower Exhaust Tunnel.

Attachment 2 – Sodium Carbonate Scale and Exhaust Tunnel Concentration Calculation

References

DOE-RL 1995, *105-DR Large Sodium Fire Facility Closure Plan*, DOE/RL-90-25, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL 2000, *Sampling and Analysis Plan for the 105-F and 105-DR Phase III Below Grade Structures and Underlying Soils*, DOE/RL-99-35, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL 2004, *Cleanup Verification Package for the 118-DR-2:2, 105-DR Reactor Below-Grade Structures and Underlying Soils, and the 100-D-49:4 Reactor Cooling Water Effluent Underground Pipeline*, CVP-2003-00016, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology 1996, Letter from the Washington State Department of Ecology to the U.S. Department of Energy and Westinghouse Hanford Company, regarding the clean closure certification for Areas 1, 3, 6, and 7 of the 105-DR Large Sodium Fire Facility, CCN 9601918.

EPA, Ecology, and DOE, 1998, "Action Memorandum for the 105-F and 105-DR Reactor Buildings and Ancillary Facilities, Hanford Site, Benton County, Washington," U.S. Environmental Protection Agency Region 10, Washington State Department of Ecology, and U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WHC 1996, *105-DR Large Sodium Fire Facility Closure Activities Evaluation Report*, WHC-SD-EN-EV-034, Rev. 1, Westinghouse Hanford Company, Richland, Washington for the U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Attachment 1

Attachment 1: Sample Results

DOE/RL-90-25, Rev. 2
03/27/95

Battelle
Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington U.S.A. 99352
Telephone (509) 376-3564
Telex 15-2874

August 18, 1987

7 Scale pit sludge
6 Tunnel. Dust coil
5 Tunnel. Near Rolin Tank Room
4 Rolin Tank entry chamber floor
3 Water Rust in lead Tunnel
2 Small Fire Room entry chamber (Co-Pa int not)
1 Annex Room " "

John Biglin
W/221T
Westinghouse Hanford Company
P. O. Box 1970
Richland, WA 99352

Dear Mr. Biglin:

ANALYSIS OF CLEANUP RESIDUES

All materials had been exposed to air long enough prior to sampling that any hydroxide had reacted with carbon dioxide of the air to form carbonate.

pH of 0.1% Solution:

1 = 10.1, 2 = 10.2, 3 = 9.5, 4 = 10.1, 5 = 10.1, 6 = 10.0, 7 = 9.4

Soluble Alkalinity (as sodium carbonate)

1 = 57%, 2 = 62%, 3 = 0.2%, 4 = 63%, 5 = 0.4%, 6 = 67%, 7 = 0.3%
scrape sludge

Total Lead (ppm)

1 = 125, 2 = 60, 3 = <0.5, 4 = 40, 5 = 1300, 6 = 35, 7 = 780
scrape

Total Lithium (ppm)

1 = 7500, 2 = 1600, 3 = 105, 4 = 11000, 5 = 2400, 6 = 10000, 7 = 2100

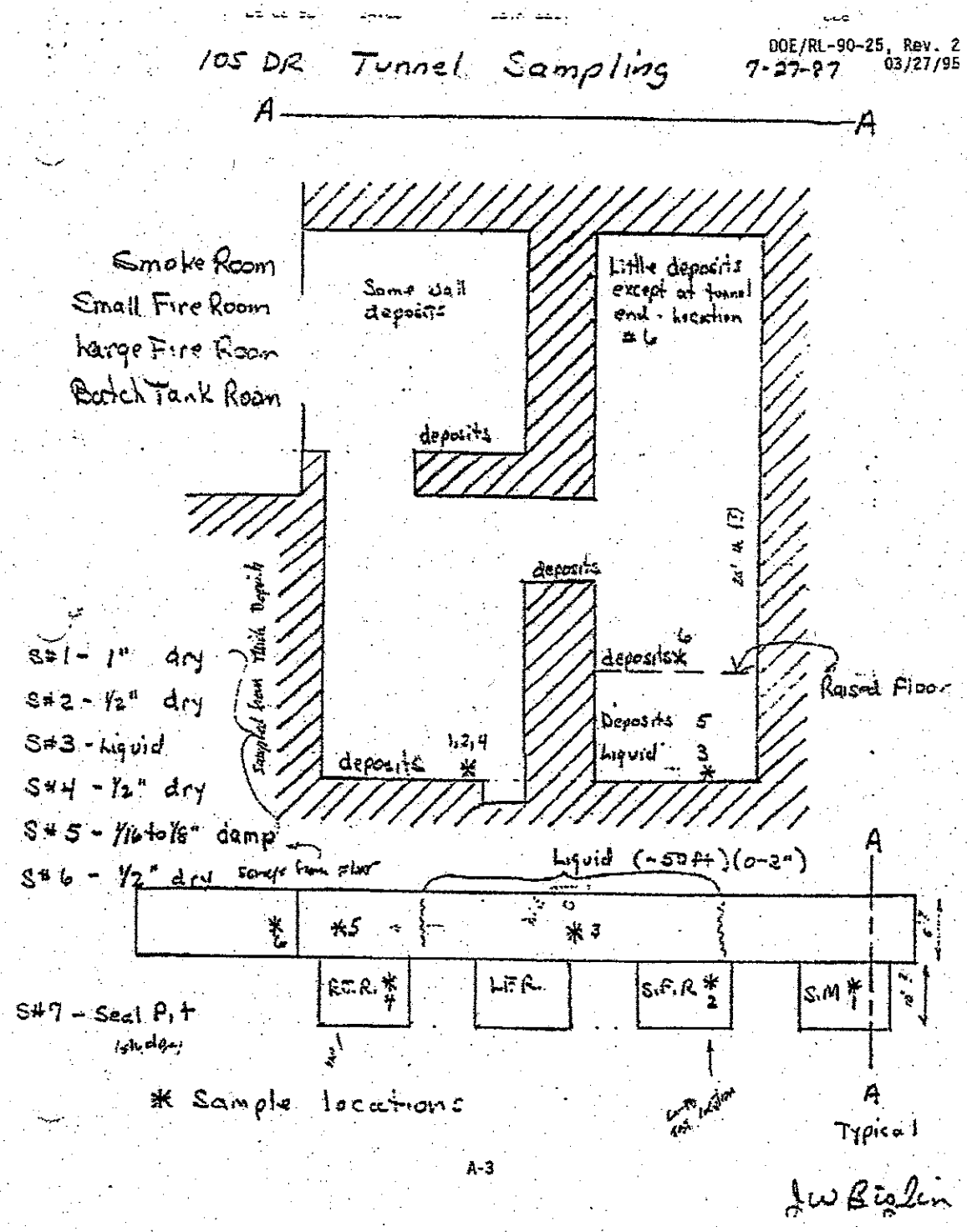
Very truly yours,

Bob Keough
R. F. Keough

RFK/tts

A-1

Attachment 1: Sample Location Diagram



A-3

JW Biglin

Attachment 2

Exhaust Tunnel Sodium Carbonate Concentration

Remaining Tunnel Components	Quantity	Surface Area Dimensions			Volume Dimensions			Surface Area		Volume		Concrete Mass	Contaminated Concrete Mass	Sodium Carbonate Mass
		Surfaces	Length (ft)	Width (ft)	Length (ft)	Width (ft)	Depth (ft)	(ft^2)	(m^2)	(ft^3)	(m^3)	(kg)	(kg)	(kg)
316 East/West Walls	3	3	84.75	13.5	86.25	15	1.5	3432.4	318.9	5821.9	164.9	396171.1	4865.3	3259.8
316 South Wall	1	1	5	13.5	5	15	1.5	67.5	6.3	112.5	3.2	7655.5	95.7	64.1
316 Slab	1	1	84.75	5	84.75	5	1.5	423.8	39.4	635.6	18.0	43253.5	600.7	402.4
315 East/West Walls	8	8	10	13.5	11.5	15	1.5	1080.0	100.3	2070.0	58.6	140860.8	1530.9	1025.7
315 Stem Walls	4	4	16.5	9.25	7.5	9.25	1.5	610.5	56.7	416.3	11.8	28325.3	865.4	579.8
315 Slab	1	0.5	84.75	11.5	84.75	11.5	1.5	487.3	45.3	1461.9	41.4	99483.0	690.8	462.8
Totals								**6101.4**	**566.8**	**10518.2**	**297.9**	**715749.1**	**8648.7**	**5794.6**

Assumptions -

- Concrete density = 2402.8 kg/m^3
- Thickness of surface contaminated concrete = 0.635 cm
- Sodium carbonate concentration = 670,000 mg/kg Concentrations ranged from 2,000 mg/kg to 670,000 mg/kg.
- Reference drawings: HW72035, HW72036, HW72037

Exhaust Tunnel Concrete Sodium Carbonate concentration = $\frac{\text{Sodium Carbonate Mass}}{\text{Concrete Mass}}$ = **8,096 mg/kg**

CONCURRENCE PAGE

Title: Proposed Closure Path for the Remaining Portion of the 105-DR / LSFF Exhaust Tunnel

Concurrence: U.S. Department of Energy, Richland Operations Office

Signature 1/26/04
Date

Washington State Department of Ecology

Signature 1-26-04
Date

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