WASTE SITE RECLASSIFICATION FORM

Operable Unit: 300-FF-2 **Control No.:** 2013-033

Waste Site Code(s)/Subsite Code(s):

300-257, 309 Process Sewer to River

Reclassification Category: Interim ☒ Final ☐

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

Approvals Needed: DOE ☒ Ecology ☐ EPA ☒

Description of current waste site condition:

The 300-257, 309 Process Sewer to River waste site is part of the 300-FF-2 Operable Unit. The 300-257 waste site was identified for remove, treat, and dispose in the *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington* (300-FF-2 ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 2001). Characterization sampling was conducted per the *300-257, 309 Process Sewer to River Waste Site Characterization and Sampling Plan*, 0300X-WI-G0040, Washington Closure Hanford, Richland, Washington (WCH 2013a), to determine if the site may be closed out as "No Action" or if the waste site requires remediation. Five focused sediment samples, including a duplicate sample, were collected for waste site evaluation.

The 300-257 waste site consists of process sewer piping that was originally connected to the 309 Building Rupture Loop Holding Tank (307-D Tank) and extends to the Columbia River bank. The tank was removed in the late 1970s, and all connections to the Radioactive Liquid Waste Sewer (300 RLWS) were severed and plugged. Streams from the 309 Building after the late 1970s included cooling water from air-conditioning chillers and floor drains from the south basement service area. The piping fed into a 91-cm (36-in.) corrugated steel pipe that flowed to the river.

Structures associated with the 300-257 waste site are the 3906 Lift Station and the 300-257 Overflow Structure.

Basis for reclassification:

Characterization sampling of the 300-257 waste site was conducted on February 19 and March 7, 2013 to determine if the waste site meets the remedial action objectives (RAOs) and remedial action goals (RAGs) established by the 300-FF-2 ROD (EPA 2001) and the *Remedial Design Report/Remedial Action Work Plan for the 300 Area*, DOE/RL-2001-47, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2009). Evaluation of the characterization sampling results support a reclassification of the 300-257 waste site to Interim No Action. The current site conditions achieve the industrial land use RAOs and RAGs established by the 300-FF-2 ROD (EPA 2001) and the 300 Area RDR/RAWP (DOE-RL 2009). The results of characterization sampling allow for industrial land use and also demonstrate that the 300-257 waste site is protective of groundwater and the Columbia River. The 300-257 waste site does not meet the RAOs and RAGs for unrestricted land use; therefore, institutional controls to maintain industrial land use of the site are required. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 300-257, 309 Process Sewer to River* (attached).

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WASTE SITE RECLASSIFICATION FORM

Operable Unit: 300-FF-2 **Control No.:** 2013-033

Waste Site Code(s)/Subsite Code(s):

300-257, 309 Process Sewer to River

Project Manager comments:

Waste Site Controls:

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

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

The 300-257 waste site does not meet the RAGs and RAOs for unrestricted land use; therefore, institutional controls to maintain industrial land use of this site are required as established in the 300-FF-2 ROD (EPA 2001).

T. K. Teynor		26 JUNE 2013
DOE Federal Project Director (printed)	Signature	Date
N/A		
Ecology Project Manager (printed)	Signature	Date
L. E. Gadbois	Larry Gadbois	27 June '13
EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 300-257, 309 PROCESS SEWER TO RIVER

Attachment to Waste Site Reclassification Form 2013-033

July 2013

REMAINING SITES VERIFICATION PACKAGE FOR THE 300-257, 309 PROCESS SEWER TO RIVER

EXECUTIVE SUMMARY

The 300-257, 309 Process Sewer to River waste site is identified as a 300-FF-2 Operable Unit source site in the *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington* (300-FF-2 ROD) (EPA 2001). The 300-257 waste site consists of process sewer piping that was originally connected to the 309 Building Rupture Loop Holding Tank and extends to the Columbia River bank. The tank was removed in the late 1970s, and all connections to the Radioactive Liquid Waste Sewer (300 RLWS) were severed and plugged. Streams from the 309 Building after the late 1970s included cooling water from air-conditioning chillers and floor drains from the south basement service area. The piping fed into a 91-cm (36-in.) corrugated steel pipe that flowed to the river.

Structures associated with the 300-257 waste site are the 3906 Lift Station and the 300-257 Overflow Structure.

Characterization sampling has been conducted per the *300-257, 309 Process Sewer to River Waste Site Characterization and Sampling Plan* (WCH 2013a) to determine if the site may be interim reclassified as "No Action" or if the waste site required remediation. Five focused sediment samples, including a duplicate sample, were collected for site evaluation.

The results of characterization sampling indicated that the 300-257 waste site achieved compliance with the remedial action objectives (RAOs) and remedial action goals (RAGs) for industrial land use established by the 300-FF-2 ROD (EPA 2001) and the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (300 Area RDR/RAWP) (DOE-RL 2009). A summary of the cleanup evaluation for the soil results against the applicable criteria is presented in Table ES-1. The results of the characterization sampling are used to make reclassification decisions for the 300-257 waste site in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2011).

In accordance with this evaluation, the verification sampling results support a reclassification of this site to Interim No Action. The current site conditions achieve the RAOs and the corresponding RAGs established in the 300 Area RDR/RAWP (DOE-RL 2009) and the 300-FF-2 ROD (EPA 2001). These results show that residual soil concentrations support future land uses that can be represented (or bounded) by an industrial land-use scenario and are protective of groundwater and the Columbia River. The 300-257 waste site does not meet the RAGs and RAOs for unrestricted land use; therefore, institutional controls to maintain industrial land use of the site are required.

Table ES-1. Summary of Remedial Action Goals for the 300-257 Waste Site. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain less than or equal to 15-mrem/yr dose rate above background over 1,000 years.	Maximum dose rate for the 300-257 waste site predicted using industrial site-specific RESRAD modeling is 6.57 mrem/yr above background.	Yes
Direct Exposure – Nonradionuclides	Attain individual COPC RAGs.	All individual COPC concentrations are below the direct exposure criteria.	Yes
Risk Requirements – Nonradionuclides	Attain a hazard quotient of <1 for all individual noncarcinogens.	The hazard quotients for individual nonradionuclide COPCs are <1.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogens.	The cumulative hazard quotient for all sampling areas (1.1×10^{-2}) is <1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	Excess cancer risk values for individual nonradionuclide COPCs are $<1 \times 10^{-6}$.	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	The total excess carcinogenic risk for all sampling areas (8.6×10^{-8}) is $<1 \times 10^{-5}$.	
Groundwater/River Protection – Radionuclides	Attain single COPC groundwater and river RAGs.	No radionuclide COPCs were quantified above groundwater/river protection lookup values.	Yes
	Attain National Primary Drinking Water Regulations: 4 mrem/yr (beta/gamma) dose standard to target receptor/organ [a].	No radionuclide COPCs were quantified above groundwater/river protection lookup values.	
	Meet drinking water standards for alpha emitters: the more stringent of 15 pCi/L MCL or 1/25th of the derived concentration guide for DOE Order 5400.5 [b].	No alpha-emitting radionuclide COPCs were quantified above groundwater/river protection lookup values.	
	Meet total uranium standard of 21.2 pCi/L [c].	Uranium was quantified below levels that are protective of 300 Area groundwater.	

Table ES-1. Summary of Remedial Action Goals for the 300-257 Waste Site. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and Columbia River cleanup requirements.	Residual concentrations of cadmium, chromium (total), copper, molybdenum, nickel, silver, zinc, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl) phthalate, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd) pyrene, and aroclor-1254 below the 3906 Lift Station exceeded soil RAGs for the protection of groundwater and/or the Columbia River. Additionally, residual concentrations of chromium (total), copper, nickel, and zinc at the 300-257 Overflow Structure exceeded soil RAGs for the protection of groundwater and/or the Columbia River. However, RESRAD modeling predicts that these constituents will not migrate to groundwater (and thus the Columbia River) at concentrations exceeding groundwater or river criteria within 1,000 years. Therefore, residual concentrations of these constituents achieve the remedial action objectives for groundwater and river protection [d, e].	Yes

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

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

[c] Based on the isotopic distribution of uranium in the Hanford Site Background, the 30 µg/L MCL (40 *Code of Federal Regulations* 141.66) corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* (BHI 2001).

[d] Based on generic RESRAD modeling using input parameters and soil-partitioning coefficients from the 300 Area RDR/RAWP (DOE-RL 2009) for the 3906 Lift Station, residual concentrations of cadmium, chromium (total), copper, molybdenum, nickel, silver, zinc, listed SVOCs, and aroclor-1254 are not expected to migrate more than 2 m (6.6 ft) vertically in 1,000 years (based on the contaminant with the lowest distribution coefficient [molybdenum] of 20 mL/g). The vadose zone underlying the soil below the 3906 Lift Station where these maximum concentrations are located is approximately 5 m (16 ft) thick based on an elevation at the base of the 3906 Lift Structure of 111 m (364 ft) and a groundwater elevation of approximately 106 m (348 ft) (*Hanford Site Groundwater Monitoring for 2011* [DOE-RL 2012). Therefore, residual concentrations of the listed contaminants are predicted to be protective of groundwater and the Columbia River.

[e] Based on site-specific RESRAD modeling in Appendix A using input parameters and soil-partitioning coefficients from the 300 Area RDR/RAWP (DOE-RL 2009) for the 300-257 Overflow Structure, residual concentrations of chromium (total), copper, nickel, and zinc are not predicted to migrate vertically to groundwater within 1,000 years. Therefore, residual concentrations of the listed contaminants are predicted to be protective of groundwater and the Columbia River.

COPC = contaminant of potential concern
MCL = maximum contaminant level
RAG = remedial action goal
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity (dose assessment model)
SVOC = semivolatile organic compound

Soil cleanup levels were established in the 300-FF-2 ROD (EPA 2001) based, in part, on a limited ecological risk assessment. Although not required by the 300-FF-2 ROD, a comparison against ecological risk screening levels has been made for the site contaminants of potential concern and other constituents. Those constituents exceeding the ecological screening levels in the *Washington Administrative Code* 173-340 were arsenic, boron, copper, lead, mercury, molybdenum, nickel, silver, vanadium, and zinc. U.S. Environmental Protection Agency ecological soil screening levels were exceeded for cadmium, chromium (total), cobalt copper, lead, manganese, nickel, silver, vanadium, zinc, and total high molecular weight polycyclic aromatic hydrocarbons (PAH). Exceedance of screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because the maximum sample levels of cobalt, manganese, mercury, and vanadium are below Hanford Site background levels, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for ecological effects as a part of the final closeout decision for the Columbia River corridor portion of the Hanford Site.

REMAINING SITES VERIFICATION PACKAGE FOR THE 300-257, 309 PROCESS SEWER TO RIVER

STATEMENT OF PROTECTIVENESS

The 300-257, 309 Process Sewer to River waste site is identified as a 300-FF-2 Operable Unit source site in the *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington* (300-FF-2 ROD) (EPA 2001). The 300-257 waste site characterization data, site evaluations, and supporting documentation demonstrate that this site meets the industrial land-use objectives for reclassification to Interim No Action as established in the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (300 Area RDR/RAWP) (DOE-RL 2009) and the 300-FF-2 ROD (EPA 2001). The waste site is evaluated using the human health direct exposure cleanup levels for industrial land use and applicable standards for groundwater and river protection in the shallow zone (i.e., surface to 4.6 m [15 ft] deep). Institutional controls to maintain industrial land use are required as established in the 300-FF-2 ROD (EPA 2001).

Soil cleanup levels were established in the 300-FF-2 ROD (EPA 2001) based, in part, on a limited ecological risk assessment. Although not required by the 300-FF-2 ROD, a comparison against ecological risk screening levels has been made for the site contaminants of potential concern (COPCs) and other constituents. Those constituents exceeding the ecological screening levels in *Washington Administrative Code* (WAC) 173-340 were arsenic, boron, copper, lead, mercury, molybdenum, nickel, silver, vanadium, and zinc. U.S. Environmental Protection Agency (EPA) ecological soil screening levels were exceeded for cadmium, chromium (total), cobalt copper, lead, manganese, nickel, silver, vanadium, zinc, and total high molecular weight polycyclic aromatic hydrocarbons (PAH). Exceedance of screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because the maximum sample levels of cobalt, manganese, mercury, and vanadium are below Hanford Site background levels, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for ecological effects as a part of the final closeout decision for the Columbia River corridor portion of the Hanford Site.

GENERAL SITE INFORMATION AND BACKGROUND

The 300-257, 309 Process Sewer to River waste site, located in the 300-FF-2 Operable Unit of the Hanford Site, consists of process sewer piping that was originally connected to the 309 Building Rupture Loop Holding Tank (307-D Tank) and extends to the Columbia River bank (Figures 1, 2, and 3). The tank was removed in the late 1970s, and all connections to the Radioactive Liquid Waste Sewer (300 RLWS) were severed and plugged. Streams from the 309 Building included cooling water from air-conditioning chillers and floor drains from the south basement service area. The piping fed into a 91-cm (36-in.) corrugated steel pipe that flowed to the river.

Figure 1. The 300-257 Waste Site Location Map.

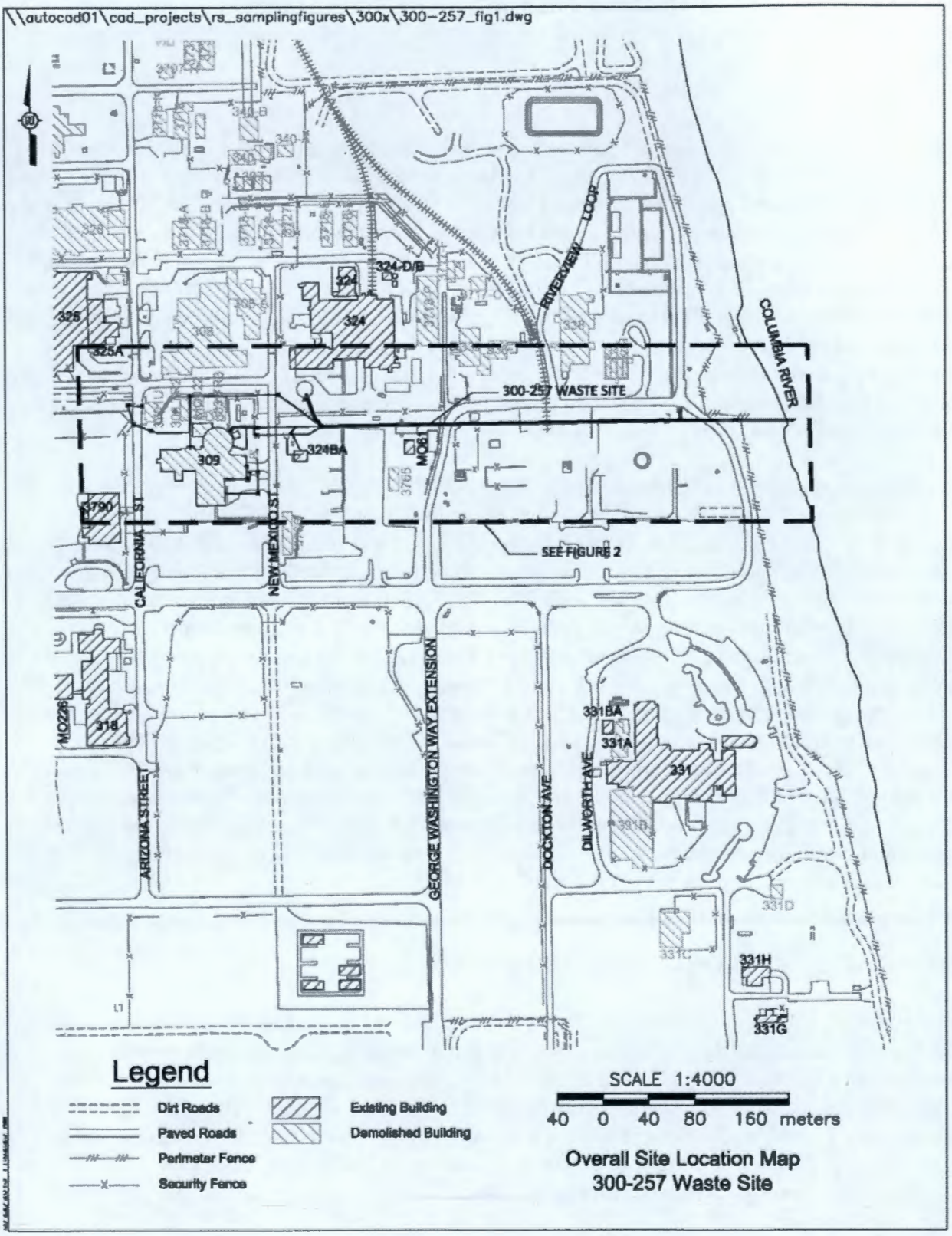


Figure 2. The 300-257 Waste Site Location Map, Enlarged View.

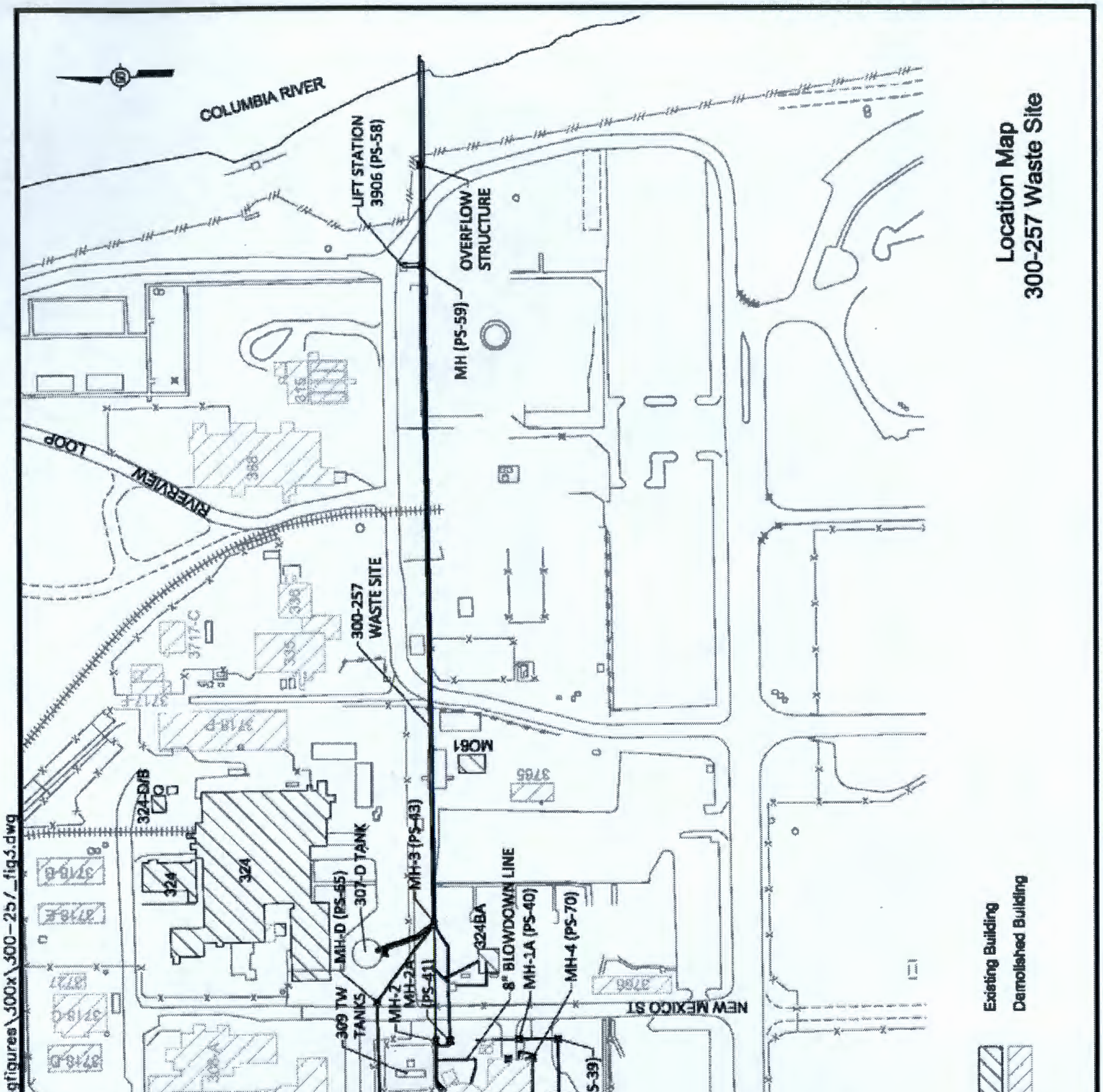
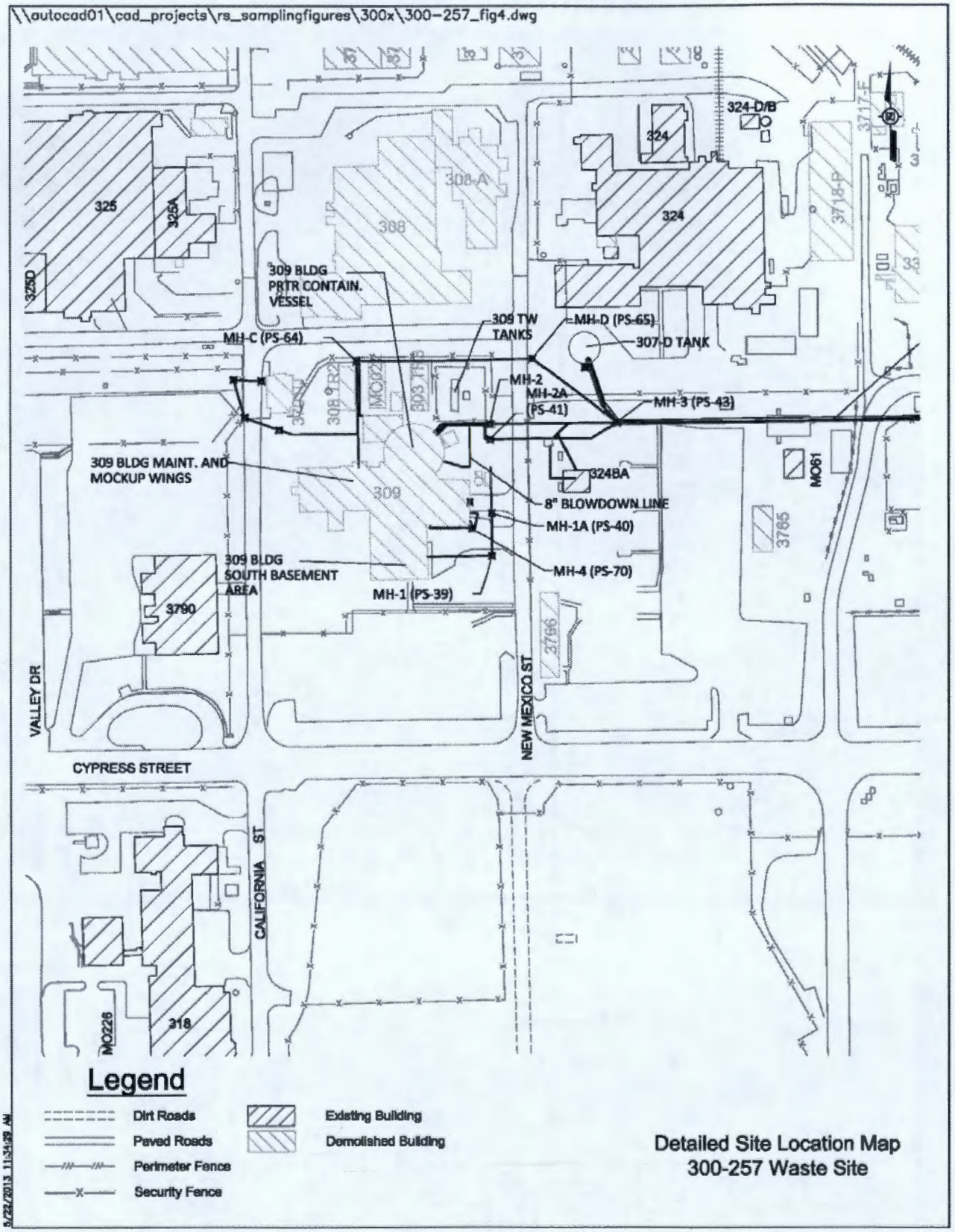


Figure 3. The 300-257 Waste Site Detailed Site Location Map, 309 Building Area.



No pipeline is visible on the river bank or at the edge of the river (Figure 4). The point of discharge was underwater. The area where the 309 Building Rupture Loop Holding Tank (307-D) was located is now covered with asphalt and is being used as a parking lot (Figure 5). The Waste Information Data System lists the 307-D Tank as the 300-55, 309 Rupture Loop Holding Tank waste site.

Figure 4. The 300-257 Riverbank Area Between the Overflow Structure and the Columbia River, May 6, 1999.

Figure 5. Former Location of the 309 Building Rupture Loop Holding Tank, February 16, 1999 (View to North).

Structures associated with the 300-257 waste site are the 3906 Lift Station (Figure 6) and the 300-257 Overflow Structure (Figure 7). The open grate at the top of the Overflow Structure is higher than the surrounding terrain. The slope of the pipeline coming into the 300-257 Overflow Structure is 1% and the slope of the pipeline leaving the 300-257 Overflow Structure and going down the river bank to the river is 19%.

Figure 6. The 300-257 Waste Site 3906 Lift Station, February 8, 1999.

Figure 7. The 300-257 Waste Site Overflow Structure Grate, May 6, 1999.

SAMPLING ACTIVITIES

Characterization sampling for the 300-257 waste site was conducted February 19 and March 7, 2013, to determine if contaminant concentrations at this site meet the cleanup criteria specified in the 300 Area RDR/RAWP (DOE-RL 2009) and the 300-FF-2 ROD (EPA 2001). The sample results are provided in Appendix A and indicate that the site achieved compliance with the remedial action objectives (RAOs) and remedial action goals (RAGs) for human health direct exposure in an industrial land-use scenario and for the applicable standards for groundwater and river protection. The following subsections provide additional discussion of the information used to develop the sampling design. A more detailed discussion of the sampling design can be found in the *300-257, 309 Process Sewer to River Waste Site Characterization and Sampling Plan* (WCH 2013a).

Contaminants of Potential Concern

The COPCs for the 300-257 waste site are given in Table 1.

The required COPCs for verification sampling included the expanded list of inductively coupled plasma (ICP) metals, mercury, uranium (total), gamma-emitting radionuclides, gross alpha, and gross beta.

Characterization samples were analyzed using EPA-approved analytical methods.

Table 1. 300-257, 309 Process Sewer to River – Laboratory Analytical Methods and Contaminants of Potential Concern.

Analysis	Analytical Method	Contaminants of Potential Concern
ICP metals [a]	EPA Method 6010	Metals
Mercury	EPA Method 7471	Mercury
Uranium (total)	Kinetic phosphorescence analysis	Uranium (total)
GEA	Gamma spectroscopy	Gamma-emitting radionuclides
Gross alpha [b]	Proportional counting	Plutonium, americium, uranium
Gross beta [c]	Proportional counting	Strontium-90

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

[b] If gross alpha was detected above 15 pCi/g, the GEA data were to be evaluated to determine if further alpha-specific analysis is needed.

[c] If gross beta activity was detected above 23 pCi/g, the data were to be evaluated and strontium-90 analysis performed, if necessary.

EPA = U.S. Environmental Protection Agency
GEA = gamma energy analysis
ICP = inductively coupled plasma

Sample Design

A map of the characterization sample locations is provided in Figure 8. A summary of sediment characterization samples collected for the 300-257 waste site is provided in Table 2, and a summary of wipe characterization samples collected for the 300-257 waste site is provided in Table 3. The wipe characterization samples are listed for information only since the units for wipe samples are not in pCi/g or mg/kg and thus are not directly comparable to the RAGs.

Although not required by the sample design (WCH 2013a), several additional analyses were requested for sample J1RH84, collected at FS-2. The additional analyses included isotopic plutonium, plutonium-241, isotopic uranium, americium-241/curium-244, technetium-99, tritium, carbon-14, nickel-63, strontium-90, ion chromatography (IC) anions, nitrate/nitrite, sulfide, total cyanide, semivolatile organic compounds (SVOCs), PAH, polychlorinated biphenyls (PCBs), TPH, pH, and volatile organic compounds (VOCs). Analysis for strontium-90 was requested for the remaining sediment samples at the time of collection. The data from these additional analyses were included for site evaluation with the required sample analyses.

Figure 8. The 300-257 Waste Site Sample Locations.

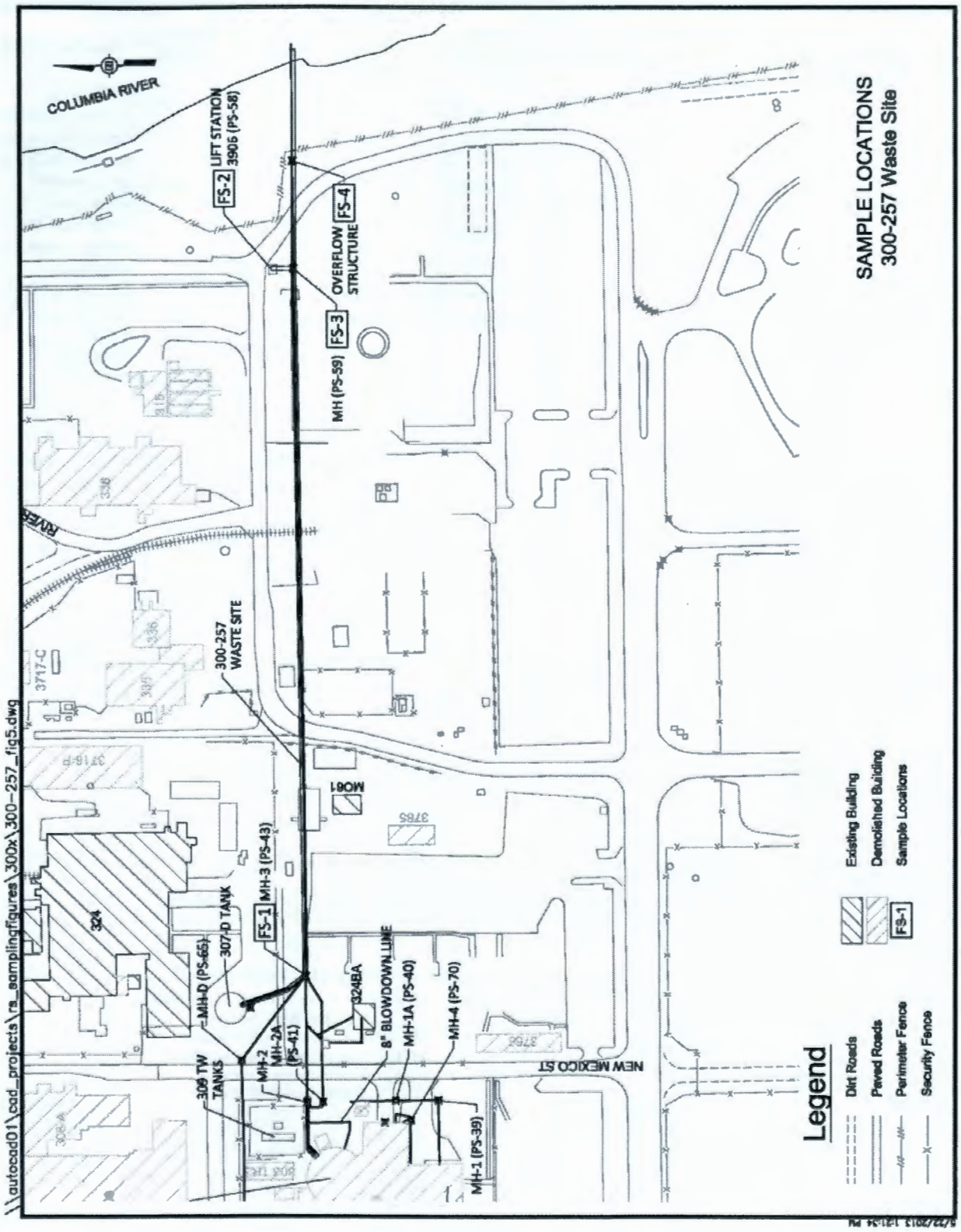


Table 2. 300-257 Characterization Sampling Summary Table of Sediment Samples.

Sample Identification	Sample Location	Sample Date	Sample Media	HEIS Number	WSP Coordinates		Depth bgs (m)	Sample Analysis
					Northing (m)	Easting (m)		
FS-2	Manhole PS-58 3906 Lift Station	3/7/13	Sediment	J1RH84	115710.0	584534.5	5.5	ICP metals [a], mercury, uranium (total) KPA, GEA, gross alpha, gross beta, isotopic plutonium [b], plutonium-241 [b], isotopic uranium, americium-241/curium-244 [b], technetium-99 [b], tritium [b], carbon-14 [b], nickel-63 [b], strontium-90 [b], PAH [b], PCB [b], SVOA [b], TPH [b], VOA [b], IC anions [b], nitrogen in nitrate and nitrite [b], total cyanide [b], sulfide [b], pH [b]
FS-4 floor	300-257 Overflow Structure	2/19/13		J1RF86	115703.1	594581.2	4	ICP metals [a], mercury, uranium (total) KPA, GEA, gross alpha, gross beta, strontium-90 [b]
FS-4 W pipe entry				J1RF87				
FS-4 E pipe exit				J1RF88				
Dup	Duplicate [c] of J1RF86			J1RF89				
Split	Split [c] of J1RF86			J1RF91				
EB	Equipment blank		Silica sand	J1RF90	NA	NA	NA	ICP metals [a], mercury

Source: Field logbook EL-1665 (WCH 2013b).

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

[b] Although not required in the sample design, additional analyses for isotopic plutonium, plutonium-241, isotopic uranium, americium-241/curium-244, technetium-99, tritium, carbon-14, nickel-63, strontium-90, IC anions, nitrate/nitrite, sulfide, total cyanide, semivolatile organic compounds, PAH, PCBs, TPH, pH, and volatile organic compounds were performed for sample J1RH84. Analysis for strontium-90 was performed for the remaining focused samples.

[c] The duplicate sample and split sample were collected at a location selected at the project analytical lead's discretion.

GEA = gamma energy analysis
HEIS = Hanford Environmental Information System
IC = ion chromatography
ICP = inductively coupled plasma
KPA = kinetic phosphorescence analysis
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyl
SVOA = semivolatile organic analysis
TPH = total petroleum hydrocarbons
VOA = volatile organic analysis
WSP = Washington State Plane

Table 3. 300-257 Characterization Sampling Summary Table of Wipe Samples.

Sample Identification	Sample Location	Sample Date	Sample Media	HEIS Number	WSP Coordinates		Depth bgs (m)	Sample Analysis
					Northing (m)	Easting (m)		
FS-1	Manhole PS-43	2/19/13	Wipe	J1RF82	115697.6	584221.9	7.6	ICP metals [a], mercury, uranium (total) KPA, GEA, gross alpha, gross beta
FS-3 floor	Manhole PS-59			J1RF83	115702.3	584534.6	2.9	
FS-3 pipe W entry				J1RF84				
FS- 3 pipe N exit				J1RF85				

Source: Field logbook EL-1665 (WCH 2013b).

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

GEA = gamma energy analysis
HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
KPA = kinetic phosphorescence analysis
WSP = Washington State Plane

Note that the focused sediment samples were all taken at either sample location FS-2 (3906 Lift Station) or sample location FS-4 (300-257 Overflow Structure), and the wipe samples were all taken at either sample location FS-1 or sample location FS-3. Thus, the maximum concentrations listed in Table 4 occurred at either the 3906 Lift Station or the 300-257 Overflow Structure. Table 5 lists at which of these locations the exceedance of RAGs occurred.

Table 4. Comparison of Maximum Contaminant Concentrations to Remedial Action Goals for the 300-257 Waste Site's Sediment Characterization Samples. (3 Pages)

COPC	Maximum Result (pCi/g)	Industrial Soil Lookup Values [a] (pCi/g)			Does the Maximum Result Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Direct Exposure	Protective of Groundwater	Protective of the River		
Radionuclides						
Cesium-137	25.0	25	NA	NA	No	Yes [b]
Cobalt-60	0.225	5.2	NA	NA	No	
Europium-152	0.437	12	NA	NA	No	
Strontium-90	0.317	2,500	NA	NA	No	
Uranium-234	0.350 (<BG)	167	127.4	127.4	No	--
Uranium-238	0.284 (<BG)	167	127.4	127.4	No	--
COPC	**Maximum Result (mg/kg)**	**Soil Cleanup Levels [a] (mg/kg)**			**Does the Maximum Result Exceed RAGs?**	**Do the Results Pass RESRAD Modeling?**
		Industrial Direct Exposure	**Protective of Groundwater**	**Protective of the River**		
Metals						
Arsenic	10.3	58	20 [c]	20 [c]	No	--
Barium	69.9 (<BG)	4,900 [d]	200	400	No	--
Beryllium	0.36 (<BG)	104 [d]	1.51 [e]	1.51 [e]	No	--
Boron [f]	4.0	700,000	320	NA	No	--
Cadmium	1.8	139 [d]	0.81 [e]	0.81 [e]	Yes	Yes [g]
Chromium (total)	36.7	5.25E+06	18.5 [e]	18.5 [e]	Yes	Yes [g, h]
Cobalt	14.9 (<BG)	1,050	15.7 [e]	NA	No	--
Copper	253	130,000	59.2	22.0 [e]	Yes	Yes [g, h]

Table 4. Comparison of Maximum Contaminant Concentrations to Remedial Action Goals for the 300-257 Waste Site's Sediment Characterization Samples. (3 Pages)

COPC	Maximum Result (mg/kg)	Soil Cleanup Levels [a] (mg/kg)			Does the Maximum Result Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Industrial Direct Exposure	Protective of Groundwater	Protective of the River		
Lead	423	1,000	NA [i]	NA [i]	No	--
Lithium	6.3 (<BG)	7,000	33.5 [e]	NA	No	--
Manganese	476 (<BG)	165,000	512 [e]	512 [e]	No	--
Mercury	0.14 (<BG)	1,050	0.33 [e]	0.33 [e]	No	--
Molybdenum [f]	48.2	17,500	8	NA	Yes	Yes [g]
Nickel	47.9	70,000	19.1 [e]	27.4	Yes	Yes [g, h]
Silver	6.9	17,500	8	0.73 [d]	Yes	Yes [g]
Uranium (total)	2.2 (<BG)	505	53	106	No	--
Vanadium	40.9 (<BG)	24,500	85.1 [e]	NA	No	--
Zinc	3,350	1.05E+06	480	67.8 [e]	Yes	Yes [g, h]
Inorganics and TPH						
Chloride	116	NA	25,000	NA	No	--
Cyanide	0.19	70,000	20	1.04	No	--
Nitrogen in Nitrate	0.59 (<BG)	5.60E+06	1,000	2,000	No	--
Sulfate	40.4 (<BG)	NA	25,000	NA	No	--
TPH – diesel range ext	130	200	200	200	No	--
Semivolatile Organic Analytes						
Acenaphthene	0.42	210,000	96	129	No	--
Anthracene	0.40	1.05E+06	240	1,920	No	--
Benzo(a)anthracene	1.4	180	0.015 [j]	0.015 [j]	Yes	Yes [g]
Benzo(a)pyrene	0.90	18	0.015 [j]	0.015 [j]	Yes	Yes [g]
Benzo(b)fluoranthene	1.3	180	0.015 [j]	0.015 [j]	Yes	Yes [g]
Benzo(g,h,i)perylene [k]	0.69	105,000	48	192	No	--
Benzo(k)fluoranthene	0.50	180	0.015 [j]	0.015 [j]	Yes	Yes [g]
Bis(2-ethylhexyl) phthalate	0.57	9,380	0.6	0.36	Yes	Yes [g]
Carbazole	0.051	6,560	0.438	NA	No	--
Chrysene	1.5	1,800	0.12	0.1 [j]	Yes	Yes [g]
Dibenz(a,h)anthracene	0.059	180	0.03 [j]	0.03 [j]	Yes	Yes [g]
Fluoranthene	2.6	140,000	64	18.0	No	--
Fluorene	0.31	140,000	64	260	No	--
Indeno(1,2,3-cd) pyrene	0.35	180	0.33 [e]	0.33 [e]	Yes	Yes [g]
Phenanthrene [k]	1.6	1.05E+06	240	1,920	No	--
Pyrene	2.1	105,000	48	192	No	--

Table 4. Comparison of Maximum Contaminant Concentrations to Remedial Action Goals for the 300-257 Waste Site's Sediment Characterization Samples. (3 Pages)

COPC	Maximum Result (mg/kg)	Soil Cleanup Levels [a] (mg/kg)			Does the Maximum Result Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Industrial Direct Exposure	Protective of Groundwater	Protective of the River		
Polychlorinated Biphenyls						
Aroclor-1254	0.12	65.6	0.017 [c]	0.017 [c]	Yes	Yes [g]

[a] Lookup values and RAGs obtained from the 300 Area RDR/RAWP (DOE-RL 2009) as amended by Tri-Party Agreement Change Notice TPA-CN-407 (DOE-RL 2010) unless otherwise noted.

[b] Based on site-specific RESRAD modeling in Appendix A using input parameters and soil-partitioning coefficients from the 300 Area RDR/RAWP (DOE-RL 2009) for the 300-257 Overflow Structure (called "outfall structure" in Appendix A), the cumulative dose of residual concentrations of cesium-137, cobalt-60, europium-152, and strontium-90 in the 300-257 Overflow Structure will not exceed the allowable radiation dose above background of 15 mrem/yr.

[c] The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers.

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

[e] Where cleanup levels are less than background cleanup levels default to background per WAC 173-340-700(4)(d) (Ecology 1996).

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

[g] Based on generic RESRAD modeling using input parameters and soil-partitioning coefficients from the 300 Area RDR/RAWP (DOE-RL 2009) for the 3906 Lift Station, residual concentrations of cadmium, chromium (total), copper, molybdenum, nickel, silver, footnoted SVOCs, zinc, and aroclor-1254 are not expected to migrate more than 2 m (6.6 ft) vertically in 1,000 years (based on the contaminant with the lowest distribution coefficient [molybdenum] of 20 mL/g). The vadose zone underlying the soil below the 3906 Lift Station where these maximum concentrations are located is approximately 5 m (16 ft) thick based on an elevation at the base of the 3906 Lift Structure of 111 m (364 ft) and a groundwater elevation of approximately 106 m (348 ft) (*Hanford Site Groundwater Monitoring for 2011* [DOE-RL 2012]). Therefore, residual concentrations of the listed contaminants are predicted to be protective of groundwater and the Columbia River.

[h] Based on site-specific RESRAD modeling in Appendix A using input parameters and soil-partitioning coefficients from the 300 Area RDR/RAWP (DOE-RL 2009) for the 300-257 Overflow Structure, residual concentrations of chromium (total), copper, nickel, and zinc are not predicted to migrate vertically to groundwater within 1,000 years. Therefore, residual concentrations of the listed contaminants are predicted to be protective of groundwater and the Columbia River.

[i] The RESRAD model predicts that lead will not reach groundwater within 1,000 years based on a generic site profile (4.6-m [15-ft] contaminated zone and 6-m [19.6-ft] uncontaminated zone). Anomalous lead concentrations will be assessed at the time of final waste site closeout to verify protection of groundwater and river pathways (EPA 2004). See Tri-Party Agreement Change Notice TPA-CN-407 (DOE-RL 2010).

[j] Where cleanup levels are less than RDLs, cleanup levels default to required detection limits per Ecology (1996), WAC 173-340-707(2).

[k] Toxicity data for this chemical are not available. Cleanup levels are based on surrogate chemicals.
Contaminant: benzo(g,h,i)perylene; surrogate: pyrene.
Contaminant: phenanthrene; surrogate: anthracene.

-- = not applicable
BG = background
COPC = contaminant of potential concern
NA = not available
RAG = remedial action goal
RDR/RAWP = *Remedial Design Report/Remedial Action Work Plan for the 300 Area*
RESRAD = RESidual RADioactivity (dose model)
SVOC = semivolatile organic compound
TPH = total petroleum hydrocarbons
WAC = *Washington Administrative Code*

Table 5. Exceedances by Location of Remedial Action Goals in Table 4 for the 300-257 Waste Site. (2 Pages)

COPC	Overflow Structure Maximum Result (mg/kg)	Lift Station Maximum Result (mg/kg)	Soil Cleanup Levels [a] (mg/kg)		Does the Overflow Structure Maximum Result Exceed RAGs?	Does the Lift Station Maximum Result Exceed RAGs?
			Protective of Groundwater	Protective of the River		
Metals						
Cadmium	0.35	1.8	0.81	0.81	No	Yes
Chromium (total)	36.2	36.7	18.5	18.5	Yes	Yes
Copper	253	196	59.2	22.0	Yes	Yes
Molybdenum	4.3	48.2	8	NA	No	Yes
Nickel	39.9	47.9	19.1	27.4	Yes	Yes
Silver	0.25	6.9	8	0.73	No	Yes
Zinc	3350	526	480	67.8	Yes	Yes

Table 5. Exceedances by Location of Remedial Action Goals in Table 4 for the 300-257 Waste Site. (2 Pages)

COPC	Overflow Structure Maximum Result (mg/kg)	Lift Station Maximum Result (mg/kg)	Soil Cleanup Levels [a] (mg/kg)		Does the Overflow Structure Maximum Result Exceed RAGs?	Does the Lift Station Maximum Result Exceed RAGs?
			Protective of Groundwater	Protective of the River		
Semivolatile Organic Analytes						
Benzo(a)anthracene	NA	1.4	0.015	0.015	NA	Yes
Benzo(a)pyrene		0.90	0.015	0.015		Yes
Benzo(b)fluoranthene		1.3	0.015	0.015		Yes
Benzo(k)fluoranthene		0.50	0.015	0.015		Yes
Bis(2-ethylhexyl) phthalate		0.57	0.6	0.36		Yes
Chrysene		1.5	0.12	0.1		Yes
Dibenz(a,h)anthracene		0.059	0.03	0.03		Yes
Indeno(1,2,3-cd) pyrene		0.35	0.33	0.33		Yes
Aroclor-1254		0.12	0.017	0.017		Yes

[a] Lookup values and RAGs obtained from the 300 Area RDR/RAWP (DOE-RL 2009) as amended by Tri-Party Agreement Change Notice TPA-CN-407 (DOE-RL 2010) unless otherwise noted.

COPC = contaminant of potential concern
NA = not applicable
RAG = remedial action goal
RDR/RAWP = *Remedial Design Report/Remedial Action Work Plan for the 300 Area*

Field quality control samples consisted of one equipment blank sample, one field duplicate sample, and one split sample. All samples were submitted for full protocol laboratory analysis.

Sample Results

Five focused sediment samples, including a duplicate sample, were collected as described in the Sample Design section. Statistical analysis (e.g., calculation of a 95% upper confidence limit value) is not appropriate for evaluation of focused samples; therefore, the results from each sample were evaluated using the maximum detected result for each COPC and comparing the value directly to the cleanup level. Table 4 provides a comparison of the maximum results from the five focused samples, including the duplicate sample, against soil cleanup levels for direct exposure and groundwater and Columbia River protection. All individual focused sample results are provided in Appendix A.

Contaminants that were not detected by laboratory analysis are excluded from Table 4. Calculated cleanup levels for calcium, magnesium, potassium, silicon, and sodium are not presented in the 300 Area RDR/RAWP (DOE-RL 2009). Parameters to calculate cleanup levels for these constituents are not presented in the Cleanup Levels and Risk Calculations Database (Ecology 2013) under WAC 173-340-740(3) or other reference databases. The EPA's *Risk Assessment Guidance for Superfund* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COPCs and are also not included in Table 4. The laboratory-reported data results for all constituents are stored in the Environmental Restoration (ENRE) project-specific database prior to provision to the Hanford Environmental Information

System (HEIS) and are presented as an attachment to the relative percent difference (RPD) and direct contact hazard quotient calculation in Appendix A.

DATA EVALUATION

This section demonstrates that contaminant concentrations at the 300-257 waste site achieve the applicable RAGs developed to support industrial land use in the 300 Area as established in the 300-FF-2 ROD (EPA 2001) and documented in the 300 Area RDR/RAWP (DOE-RL 2009). Table 4 compares the cleanup verification focused sample results to the applicable soil RAGs for direct exposure, protection of groundwater, and protection of the Columbia River.

Nonradionuclide Direct Contact Hazard Quotient and Carcinogenic Risk RAGs Attained

Nonradionuclide risk requirements include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than 1×10^{-6}, and a cumulative carcinogenic risk of less than 1×10^{-5}. For the 300-257 waste site, these risk values were not calculated for constituents that were either not detected or were detected at concentrations below Hanford Site or Washington State background levels. The individual and cumulative hazard quotients for noncarcinogenic constituents were less than 1.0. The cumulative hazard quotient for those noncarcinogenic constituents above background or detected levels is 1.1×10^{-2}. Excess cancer risk values for individual nonradionuclide constituents are less than 1×10^{-6}. The total carcinogenic risk value for the carcinogenic constituents above background or detected levels is 8.6×10^{-8}, which is less than the criterion of 1×10^{-5}.

Nonradionuclide Soil RAGs for Groundwater and River Protection Attained

As shown by Table 5, some of the COPCs listed in Table 4 had exceedances of RAGs at both the 300-257 Overflow Structure and the 3906 Lift Station, and some exceedances occurred only at the 3906 Lift Station. Since site-specific RESidual RADioactivity (RESRAD) modeling was done for exceedances at the 300-257 Overflow Structure and generic RESRAD modeling was done for the 3906 Lift Station, two footnotes are used in Table 4 to describe the RESRAD modeling and two paragraphs below describe the RESRAD modeling as well.

All focused sample maximum results listed in Table 4 from characterization sampling of sediment at the 3906 Lift Station are below soil RAGs, except for soil cleanup levels protective of groundwater and the Columbia River for cadmium, chromium (total), copper, nickel, zinc, all but one footnoted SVOAs, and aroclor-1254; the river protection cleanup level for silver and bis(2-ethylnexyl)phthalate; and the groundwater protection cleanup level for molybdenum. Data were not collected on the vertical extent of these contaminants, but based on generic RESRAD input parameters and soil-partitioning coefficients from the 300 Area RDR/RAWP (DOE-RL 2009), residual concentrations of these contaminants are not expected to migrate more than 2 m (6.6 ft) vertically in 1,000 years based on molybdenum, the contaminant with the lowest distribution coefficient (K_d), with a value of 20 mL/g. The vadose zone underlying the 3906 Lift Station is approximately 5 m (16 ft) thick based on an elevation at the base of the 3906 Lift Station of 111 m (377 ft) mean sea level (msl) and a groundwater elevation of

approximately 106 m (348 ft) msl (DOE-RL 2012). Therefore, residual concentrations of these contaminants are predicted to be protective of groundwater and the Columbia River.

All focused sample maximum results listed in Table 4 from characterization sampling at the 300-257 Overflow Structure are below soil RAGs, except for soil cleanup levels protective of groundwater and the Columbia River for chromium (total), copper, nickel, and zinc. Site-specific RESRAD modeling was conducted for the nonradionuclide contaminant maximum results in the 300-257 Overflow Structure exceeding groundwater and/or Colombia River RAGs (see the RESRAD evaluation calculation brief in Appendix A). No nonradionuclide contaminants are predicted to reach groundwater within the 1,000 years of the RESRAD modeling evaluation of the 300-257 Overflow Structure. Therefore, the residual vadose zone concentrations of the nonradionuclide contaminants in the 300-257 Overflow Structure are predicted to be protective of groundwater and, thus, the Columbia River.

Attainment of Radionuclide Industrial Exposure RAGs

The generic sum-of-fractions radionuclide dose evaluation for the 300-257 waste site indicates that the maximum cumulative dose contributed by residual radionuclide populations will exceed the 15 mrem/yr above background criterion. Therefore, a site-specific RESRAD evaluation (see the RESRAD evaluation calculation brief in Appendix A) was performed to predict the radiological dose in an industrial scenario over a period of 1,000 years. The sum-of-fractions calculation is based on industrial direct exposure from a generic waste site with an assumed area of 10,000 m^2. The site-specific RESRAD evaluation was performed using the actual Overflow Structure area where all the radionuclide maximum results above background levels were found. (The Overflow Structure is referred to as the "outfall structure" in the calculation brief.) The maximum dose rate from the concrete outfall structure focused sample radionuclide concentrations is predicted to be 6.57 mrem/yr at year zero (2013), which does not exceed the 15 mrem/yr radiation dose above background criterion.

DATA QUALITY ASSESSMENT

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

The DQA for the 300-257 waste site established that the data are of the right type, quality, and quantity to support site decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. The characterization sample analytical data are stored in the ENRE project-specific database for data evaluation prior to archival in the HEIS and are provided as an attachment to the RPD and direct contact hazard quotient calculation in Appendix A. The detailed DQA is presented in Appendix B.

SUMMARY FOR INTERIM NO ACTION RECLASSIFICATION

The 300-257 waste site has been evaluated in accordance with the 300-FF-2 ROD (EPA 2001) and the 300 Area RDR/RAWP (DOE-RL 2009). Characterization sampling was performed, and the analytical results indicate that the residual concentrations of COPCs at this site meet the RAOs for industrial direct exposure, groundwater protection, and river protection. In accordance with this evaluation, the characterization sampling and modeling results support a reclassification of the 300-257 waste site to Interim No Action. The waste site is evaluated using the human health direct exposure cleanup levels for industrial land use and applicable standards for groundwater and river protection in the shallow zone (i.e., surface to 4.6 m [15 ft] deep). The 300-257 waste site does not meet the direct exposure RAGs and RAOs for unrestricted land use; therefore, institutional controls to maintain industrial land use of the site are required.

REFERENCES

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

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

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

DOE-RL, 2009, *Remedial Design Report/Remedial Action Work Plan for the 300 Area,* DOE/RL-2001-47, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2010, Tri-Agreement Change Notice TPA CN-407, December 2010, Modify *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (DOE/RL-2001-47, Rev. 3) on page 2-17 of the document, make corrections to Table 2-1 for "lead" as detailed in Attachment 1, add "Trichloroethylene" to Table 2-1 on page 2-17 as specified in Attachment 1, make corrections to Tables B-8a, B-8b, D-1, D-2, D-3, and D-4 per Attachment 1. U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2011, *Tri-Party Agreement Handbook Management Procedures,* RL-TPA-90-0001, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)," Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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Ecology, 1996, "Model Toxics Control Act – Cleanup," *Washington Administrative Code* (WAC) 173-340, Washington State Department of Ecology, Olympia, Washington.

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EPA, 2001, *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

EPA, 2004, *Explanation of Significant Differences for the 300-FF-2 Operable Unit Interim Record of Decision*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

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

WCH, 2013a, *300-257, 309 Process Sewer to River Waste Site Characterization and Sampling Plan,* 0300X-WI-G0040, Rev. 0, Washington Closure Hanford, Richland, Washington.

WCH, 2013b, *D4 Waste Site Sampling*, Logbook EL-1665, pp. 82 to 96, Washington Closure Hanford, Richland, Washington.

WDOH, 1997, *Hanford Guidance for Radiological Cleanup*, WDOH/320-015, Rev. 1, Washington State Department of Health, Olympia, Washington.

APPENDIX A

CALCULATIONS

APPENDIX A

CALCULATION BRIEF

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

300-257 *RESRAD Industrial Evaluation of Dose and Groundwater Protection,* 0300X-CA-V0172, Rev. 0, Washington Closure Hanford, Richland, Washington.

300-257 *Waste Site RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculation,* 0300X-CA-V0174, Rev. 0, Washington Closure Hanford, Richland, Washington.

DISCLAIMER FOR CALCULATIONS

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

CALCULATION COVER SHEET

Project Title: 300 Area Field Remediation **Job No. 14655**

Area: 300 Area

Discipline: Environmental *Calculation No: 0300X-CA-V0172

Subject: 300-257 RESRAD Industrial Evaluation of Dose and Groundwater Protection

Computer Program: RESRAD Program No: Version 6.5

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover – 1 pg Summary – 5 pg Attm. 1 - 19 pg Attm. 2 - 26 pg Attm. 3 - 17 pg Total – 68 pages	S. W. Clark	M. W. Perrott	J. R. Davidson	T. Q. Howell	4/4/13

SUMMARY OF REVISION

WCH-DE-018 *Obtain Calc. No. from Document Control and Form from Intranet

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	4/1/13	Calc. No.:	0300X-CA-V0172	Rev.:	0
Project:	300 Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	4/1/13
Subject:	300-257 RESRAD Evaluation of Dose and Groundwater Protection					Sheet No. 1 of 5	

PURPOSE:

Perform RESRAD calculations of the radiological dose contributions in the 300 Area industrial land use scenario over a period of 1,000 years from the activities of radionuclides at a focused sampling site in the 300-257, 309 Process Sewer to River waste site where a sum-of-fractions evaluation of radionuclide dose exceeded the 15 mrem/yr allowable radiation dose above background.

Predict concentrations of nonradionuclides (copper, chromium (total), lead, nickel, and zinc) in groundwater within 1,000 years due to contaminant concentrations at a focused sampling site in the 300-257, 309 Process Sewer to River waste site. Soil concentrations of copper, chromium (total), lead, nickel, and zinc exceed soil lookup values for groundwater protection in the focused samples from a concrete overflow structure at the 300-257 waste site.

GIVEN/REFERENCES:

1) Focused samples were collected from the 300-257 waste site. A sum-of-fractions evaluation described in Appendix B of the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (300 Area RDR/RAWP), DOE/RL-2001-47, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2009), performed for maximum concentrations of radionuclides in a focused sample exceeded the 15 mrem/yr allowable radiation dose above background. Therefore, the analyses were evaluated by RESidual RADioactivity (RESRAD) modeling for radionuclides as described in Appendix D of the 300 Area RDR/RAWP (DOE-RL 2009). Site-specific RESRAD calculations were performed to predict the radiological dose in an industrial scenario over a period of 1,000 years.
2) Focused samples were collected from the 300-257 waste site. Lookup values for vadose zone soil concentrations to be protective of groundwater were exceeded for five nonradionuclides (copper, chromium (total), lead, nickel, and zinc). Cleanup levels (i.e., lookup values) are determined in Appendix D of the 300 Area RDR/RAWP (DOE-RL 2009). The copper, chromium (total), lead, nickel, and zinc analyses were evaluated by RESidual RADioactivity (RESRAD) modeling for nonradionuclides using input parameters and soil-partitioning coefficients from Appendix B of the 300 Area RDR/RAWP (DOE-RL 2009). Site-specific RESRAD calculations were performed to predict the concentrations in groundwater due to nonradionuclides at the 300-257 waste site over a period of 1,000 years.
3) For the purpose of performing RESRAD calculations, nonradionuclide soil analyses for the contaminants of the 300-257 waste site focused sampling sites were obtained from the *Remaining Sites Verification Package for the 300-257, 309 Process Sewer to River*, Attachment to Waste Site Reclassification Form 2013-033, Washington Closure Hanford, Richland, Washington (WCH 2013).
4) The RESidual RADioactivity (RESRAD) computer code, version 6.5, was developed for the U.S. Department of Energy by the Environmental Assessment Division of Argonne National Laboratory, Argonne, Illinois, to calculate compliance with residual radioactivity guidelines and may be accessed at < http://www.ead.anl.gov/resrad >. Use of site-specific RESRAD evaluations with surrogate radionuclides to predict nonradionuclide concentrations in

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	4/1/13	Calc. No.:	0300X-CA-V0172	Rev.:	0
Project:	300 Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	4/1/13
Subject:	300-257 RESRAD Evaluation of Dose and Groundwater Protection					Sheet No. 2 of 5	

groundwater due to concentrations in the soil uses input parameters from Appendix D of the 300 Area RDR/RAWP (DOE-RL 2009).

5) The focused sample in this evaluation was collected from sludge/sediment in a concrete sump at the discharge of the 309 Process Sewer to a pipeline into the Columbia River. Therefore, distribution coefficients (Kd values) specific to concrete were used to evaluate protection of groundwater. These were obtained from Appendix C of the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (100-N Area RDR/RAWP), DOE/RL-2005-93, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2006).

SOLUTION:

1) A RESRAD run was performed to predict the radiological dose in an industrial scenario from the sediment and sludge in the 300-257 concrete outfall structure. Table 1 shows the waste site area and thickness for RESRAD modeling. Table 2 shows the radionuclide analyses used in the RESRAD evaluations. Input factors for each run are also shown in the "Summary" sections of the RESRAD "Mixture Sums and Single Radionuclide Guidelines" printouts in Attachment 1 to this Calculation Summary.
2) As discussed in Section 2.4 of the 300 Area RDR/RAWP (DOE-RL 2009), site-specific factors such as the concentration contaminants, the type of waste site (solid or liquid), and contaminant distribution coefficient (K_d) values are used to verify that remaining concentrations of contaminants are protective of groundwater and the Columbia River. A site-specific contaminant distribution model was developed to more accurately describe actual site conditions. The information obtained from RESRAD modeling is used to determine if the residual concentrations of contaminants are protective of groundwater and the river, or if remedial action was required.
3) A RESRAD run was performed to predict if concentrations of radionuclides and nonradionuclides in the sludge and sediment in the concrete outfall structure are protective of groundwater, accounting for the fact that the contamination is contained in a 3.3 m by 3.3 m by3.3 m (10 ft by 10 ft by 10 ft) concrete outfall structure located at the ordinary high water mark of the groundwater and the Columbia River. The uncontaminated vadose zone is the 0.3 m (1 ft) thickness of the concrete in the bottom of the outfall structure. Table 1 reports the waste site area and vadose zone soil thickness for RESRAD modeling. Table 2 shows the radionuclide and nonradionuclide analyses, the K_d values, and the surrogate radionuclides for the nonradionuclides. Input factors for each run are also shown in the "Summary" sections of the RESRAD "Mixture Sums and Single Radionuclide Guidelines" printouts in Attachment 3 to this Calculation Summary.

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	4/1/13	Calc. No.:	0300X-CA-V0172	Rev.:	0
Project:	300 Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	4/1/13
Subject:	300-257 RESRAD Evaluation of Dose and Groundwater Protection					Sheet No. 3 of 5	

Table 1. 300-257 Waste Site Dimensions for RESRAD Modeling of Groundwater Protection

Parameter	Units	300-257 Waste Site Dimensions
Contaminated Zone Dimensions		
Cover Depth	m	0
Area of Contaminated Zone (CZ)	m^2	9.3
Length Parallel to Aquifer Flow	m	3.3
Thickness of Vadose Zone Horizons		
Thickness: Contaminated Zone	m	0.3
Thickness: Unsaturated, Uncontaminated Zone	m	0.3

Table 2. 300-257 Nonradionuclide Analyses for RESRAD Modeling of Radiological Dose and Nonradionuclide Groundwater Protection

Contaminant	Focused Sample Analyses [a] (pCi/g for radionuclides or mg/kg for nonradionuclides)	K_d Values in Concrete (mL/g)	K_d Values in Soil (mL/g)	Surrogate Radionuclides [b]
Cobalt-60	0.225	100 [c]	50	NA
Cesium-137	25	100 [c]	50	NA
Europium-152	0.437	1,000 [c]	200	NA
Strontium-90	0.317	200 [c]	25	NA
Copper	253	100 [c]	22	Al-26
Chromium (Total)	36.2	870	200	Gd-152
Lead	423	500 [c]	30	Cl-36
Nickel	39.9	100 [c]	30	Cm-248
Zinc	3,350	30 [c]	30	Np-237

[a] From *Remaining Sites Verification Package for the 300-257, 309 Process Sewer to River*, Attachment to Waste Site Reclassification Form 2013-033, Washington Closure Hanford, Richland, Washington (WCH 2013).
[b] As discussed in Appendix C of the *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2009).
[c] Distribution coefficient (K_d) values for concrete are from the 3rd column of Table C-3 of the 100-N Area RDR/RAWP (DOE-RL 2006).

4) The year when the peak dose (or concentration) occurs from each individual radionuclide and nonradionuclide COC and layer was determined by a preliminary run. This year was then added for all horizons for the final RESRAD runs. For the concrete outfall structure, no contaminants are predicted to reach groundwater within the 1,000 years of the RESRAD modeling evaluation.

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	4/1/13	Calc. No.:	0300X-CA-V0172	Rev.:	0
Project:	300 Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	4/1/13
Subject:	300-257 RESRAD Evaluation of Dose and Groundwater Protection					Sheet No. 4 of 5	

METHODOLOGY:

A RESRAD run was completed to predict the dose due to the radionuclide analyses of the sediment and sludge in the 300-257 concrete outfall structure in Table 2. RESRAD numerical output reports for radionuclide dose are presented in the Attachment 1 this calculation summary.

RESRAD modeling was used to predict if vadose zone soil concentrations of radionuclide and nonradionuclide contaminants are protective of groundwater using the input parameters and soil-partitioning coefficients from the 300 Area RDR/RAWP (DOE-RL 2009). Runs of RESRAD version 6.5 were completed for the waste site dimensions in Table 1 and the contaminant concentrations in Table 2. Long half-life radionuclide surrogates were used to represent the nonradionuclide concentrations as shown in Table 2. Radionuclide surrogate parameters were replaced with parameters specific to nonradionuclide contaminants. RESRAD numerical output reports of predicted radionuclide and nonradionuclide concentrations in groundwater are presented in Table 3, below, and in Attachment 3 to this calculation summary.

RESULTS: Radionuclide Industrial Scenario Dose Rate

The dose rates for an industrial scenario at the 300-257 waste site are shown in Table 3. The maximum dose rate from the concrete outfall structure focused sample radionuclide concentrations is 6.57 mrem/yr at year zero (2013) which does not exceed the allowable radiation dose above background of 15 mrem/yr.

Table 3. Industrial Scenario Dose Rate (mrem/yr)

RESRAD Run	Industrial Scenario Dose Contributions in mrem/yr at Each Time Slice (yr)							
	0	1	3	10	30	100	300	1000
Concrete Outfall Structure Focused Sample	6.57E+00	6.39E+00	6.04E+00	5.02E+00	3.06E+00	5.80E-01	5.20E-03	3.58E-10

RESULTS: Groundwater Protection

The radionuclide and nonradionuclide contaminant concentrations in groundwater at different time intervals up to 1,000 years were calculated by the RESRAD model using radionuclide surrogates to represent nonradionuclides. RESRAD output is presented in Attachment 3 and summarized in Table 4, below. For the concrete outfall structure, no contaminants are predicted to reach groundwater within the 1,000 years of the RESRAD modeling evaluation.

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	4/1/13	Calc. No.:	0300X-CA-V0172	Rev.:	0
Project:	300 Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	4/1/13
Subject:	300-257 RESRAD Evaluation of Dose and Groundwater Protection					Sheet No. 5 of 5	

Table 4. Predicted Groundwater Concentrations Due to 300-257 Sediment and Sludge Contaminants in Concrete Outfall Structure

Contaminant	Predicted Groundwater Concentrations in ug/L at Each Time Interval (yr)								RAGs
	0	1	3	10	30	100	300	1000	
Cobalt-60	0	0	0	0	0	0	0	0	100 pCi/L [a]
Cesium-137	0	0	0	0	0	0	0	0	60 pCi/L [a]
Europium-152	0	0	0	0	0	0	0	0	200 pCi/L [a]
Strontium-90	0	0	0	0	0	0	0	0	8 pCi/L [a]
Copper	0	0	0	0	0	0	0	0	592 ug/L [b]
Chromium (Total)	0	0	0	0	0	0	0	0	100 ug/L [b]
Lead	0	0	0	0	0	0	0	0	15 ug/L [b]
Nickel	0	0	0	0	0	0	0	0	100 ug/L [b]
Zinc	0	0	0	0	0	0	0	0	4,800 ug/L [b]

[a] Groundwater cleanup level or MCL from Appendix D, Table D-6 of the 300 Area RDR/RAWP (DOE-RL 2009).
[b] Groundwater cleanup level or MCL from Appendix D, Table D-1 of the 300 Area RDR/RAWP (DOE-RL 2009).
RAGs = Remedial Action Goals
MCL = Maximum Contaminant Level (EPA standard for drinking water)

CONCLUSIONS:

- The dose rates for an industrial scenario at the 300-257 waste site are shown in Table 3. The maximum dose rate from the concrete outfall structure focused sample radionuclide concentrations is 6.57 mrem/yr at year zero (2013), which does not exceed the allowable radiation dose above background (i.e., 15 mrem/yr).

- No radionuclide or nonradionuclide contaminants are predicted to reach groundwater within the 1,000 years of the RESRAD modeling evaluation of the concrete outfall structure. Therefore, the residual vadose zone concentrations of the radionuclide and nonradionuclide contaminants are predicted to be protective of groundwater and, thus, the Columbia River.

ATTACHMENTS:

1. RESRAD Output: 300-257 RESRAD Evaluation of Industrial Dose – Mixture Sums and Single Radionuclide Guidelines (19 pages).
2. RESRAD Output: 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection – Mixture Sums and Single Radionuclide Guidelines (26 pages).
3. RESRAD Output: 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection – Concentration of Radionuclides, (17 pages).

ATTACHMENT 1

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1RESRAD, Version 6.5      T« Limit = 180 days        03/25/2013  12:43  Page   1
 Summary : 300-257 RESRAD Evaluation of Industrial Dose
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD
```

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Chk'd By M. W. Perrott Date 4/1//2013
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 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD
```

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 12 & FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	Ba-137m (Source: FGR 12)	3.606E+00	3.606E+00	DCF1(1)
A-1	Co-60 (Source: FGR 12)	1.622E+01	1.622E+01	DCF1(2)
A-1	Cs-137 (Source: FGR 12)	7.510E-04	7.510E-04	DCF1(3)
A-1	Eu-152 (Source: FGR 12)	7.006E+00	7.006E+00	DCF1(4)
A-1	Gd-152 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(5)
A-1	Sr-90 (Source: FGR 12)	7.043E-04	7.043E-04	DCF1(6)
A-1	Y-90 (Source: FGR 12)	2.391E-02	2.391E-02	DCF1(7)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Co-60	2.190E-04	2.190E-04	DCF2(1)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(2)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(3)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(5)
B-1	Sr-90+D	1.308E-03	1.300E-03	DCF2(6)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Co-60	2.690E-05	2.690E-05	DCF3(1)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(2)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(3)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(5)
D-1	Sr-90+D	1.528E-04	1.420E-04	DCF3(6)
D-34	Food transfer factors:			
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(1,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(1,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(1,3)
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(2,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(2,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(2,3)
D-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(3,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(3,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-05	5.000E-05	RTF(3,3)
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(5,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(5,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(5,3)
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(6,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(6,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(6,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Co-60 , fish	3.000E+02	3.000E+02	BIOFAC(1,1)
D-5	Co-60 , crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(1,2)
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(2,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(2,2)

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Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
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ATTACHMENT 1

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1RESRAD, Version 6.5      T« Limit = 180 days      03/25/2013  12:43  Page   3
 Summary : 300-257 RESRAD Evaluation of Industrial Dose
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD

                Dose Conversion Factor (and Related) Parameter Summary (continued)
                                  Dose Library: FGR 12 & FGR 11
0     ³                                                    ³  Current  ³   Base    ³  Parameter
Menu ³                    Parameter                        ³   Value#  ³   Case*   ³    Name
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
D-5  ³ Eu-152     , fish                                   ³ 5.000E+01 ³ 5.000E+01 ³ BIOFAC(  3,1)
D-5  ³ Eu-152     , crustacea and mollusks                 ³ 1.000E+03 ³ 1.000E+03 ³ BIOFAC(  3,2)
D-5  ³                                                     ³           ³           ³
D-5  ³ Gd-152     , fish                                   ³ 2.500E+01 ³ 2.500E+01 ³ BIOFAC(  5,1)
D-5  ³ Gd-152     , crustacea and mollusks                 ³ 1.000E+03 ³ 1.000E+03 ³ BIOFAC(  5,2)
D-5  ³                                                     ³           ³           ³
D-5  ³ Sr-90+D    , fish                                   ³ 6.000E+01 ³ 6.000E+01 ³ BIOFAC(  6,1)
D-5  ³ Sr-90+D    , crustacea and mollusks                 ³ 1.000E+02 ³ 1.000E+02 ³ BIOFAC(  6,2)
ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
#For DCF1(xxx) only, factors are for infinite depth & area.  See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.
```

Attachment 1	Sheet No. 3 of 19
Originator: S. W. Clark	Date 4/1/2013
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1RESRAD, Version 6.5 T« Limit = 180 days 03/25/2013 12:43 Page 4
Summary : 300-257 RESRAD Evaluation of Industrial Dose
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	9.300E+00	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.000E-01	2.000E+00	---	THICKO
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+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)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Co-60	2.250E-01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Cs-137	2.500E+01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Eu-152	4.370E-01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Sr-90	3.170E-01	0.000E+00	---	S1(6)
R012	Concentration in groundwater (pCi/L): Co-60	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Eu-152	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(6)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.500E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.200E-03	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	1.500E+01	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)	1.524E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	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)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT

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1RESRAD, Version 6.5      T« Limit = 180 days       03/25/2013  12:43  Page   5
 Summary : 300-257 RESRAD Evaluation of Industrial Dose
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD
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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
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+03	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.555E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	5.000E+01	4.600E+03	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	4.600E+03	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	4.600E+03	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.555E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.142E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	2.500E+01	3.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	not used	3.000E+01	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	not used	3.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.076E-04	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.771E-05	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)

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1RESRAD, Version 6.5 T« Limit = 180 days 03/25/2013 12:43 Page 6
Summary : 300-257 RESRAD Evaluation of Industrial Dose
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-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	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	1.650E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	5.500E-02	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)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	2.500E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT

Attachment 1 Sheet No. 6 of 19
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 1

1RESRAD, Version 6.5 T« Limit = 180 days 03/25/2013 12:43 Page 7
Summary : 300-257 RESRAD Evaluation of Industrial Dose
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
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)

Attachment 1 Sheet No. 7 of 19
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 1

1RESRAD, Version 6.5 T« Limit = 180 days 03/25/2013 12:43 Page 8
Summary : 300-257 RESRAD Evaluation of Industrial Dose
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD

Site-Specific Parameter Summary (continued)

O Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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	1	---	---	LYMAX
TITL	Maximum number of integration points for risk	5	---	---	KYMAX

Summary of Pathway Selections

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

Attachment	1	Sheet No.	8 of 19
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

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1RESRAD, Version 6.5      T« Limit = 180 days       03/25/2013  12:43  Page   9
 Summary : 300-257 RESRAD Evaluation of Industrial Dose
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD

      Contaminated Zone Dimensions            Initial Soil Concentrations, pCi/g
      ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ            ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
        Area:       9.30 square meters              Co-60      2.250E-01
   Thickness:       0.30 meters                     Cs-137     2.500E+01
 Cover Depth:       0.00 meters                     Eu-152     4.370E-01
                                                    Sr-90      3.170E-01
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)
             ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
    t (years):  0.000E+00  1.000E+00  3.000E+00  1.000E+01  3.000E+01  1.000E+02  3.000E+02  1.000E+03
     TDOSE(t):  6.570E+00  6.386E+00  6.040E+00  5.017E+00  3.060E+00  5.796E-01  5.198E-03  3.575E-10
        M(t):  4.380E-01  4.257E-01  4.027E-01  3.345E-01  2.040E-01  3.864E-02  3.465E-04  2.383E-11
0Maximum TDOSE(t):  6.570E+00 mrem/yr   at t = 0.000E+00 years
```

Attachment	1	Sheet No.	9 of 19
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
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1RESRAD, Version 6.5      T½ Limit = 180 days        03/25/2013  12:43  Page  10
 Summary : 300-257 RESRAD Evaluation of Industrial Dose
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.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-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
Co-60	2.522E-01	0.0384	5.979E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.096E-07	0.0000
Cs-137	6.101E+00	0.9287	9.677E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.394E-05	0.0000
Eu-152	2.159E-01	0.0329	1.172E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.448E-07	0.0000
Sr-90	5.579E-04	0.0001	5.033E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.478E-06	0.0000
ßßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß
Total	6.570E+00	1.0000	1.648E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.687E-05	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 = 0.000E+00 years
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
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	2.522E-01	0.0384
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	6.101E+00	0.9287
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	2.159E-01	0.0329
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	5.654E-04	0.0001
ßßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß
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	6.570E+00	1.0000

0*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	10 of 19
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

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1RESRAD, Version 6.5 T« Limit = 180 days 03/25/2013 12:43 Page 11
Summary : 300-257 RESRAD Evaluation of Industrial Dose
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.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 = 1.000E+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.
Co-60	2.210E-01	0.0346	5.240E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.713E-07	0.0000
Cs-137	5.959E+00	0.9332	9.451E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.245E-05	0.0000
Eu-152	2.049E-01	0.0321	1.112E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.375E-07	0.0000
Sr-90	5.443E-04	0.0001	4.910E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.417E-06	0.0000
Total	6.386E+00	1.0000	1.600E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.527E-05	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
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.
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	2.210E-01	0.0346
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	5.959E+00	0.9332
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	2.049E-01	0.0321
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	5.516E-04	0.0001
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	6.386E+00	1.0000

*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	11 of 19
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

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1RESRAD, Version 6.5 T« Limit = 180 days 03/25/2013 12:43 Page 12
Summary : 300-257 RESRAD Evaluation of Industrial Dose
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.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+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.
Co-60	1.697E-01	0.0281	4.024E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.084E-07	0.0000
Cs-137	5.685E+00	0.9412	9.016E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.957E-05	0.0000
Eu-152	1.846E-01	0.0306	1.002E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.239E-07	0.0000
Sr-90	5.180E-04	0.0001	4.673E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.301E-06	0.0000
Total	6.040E+00	1.0000	1.509E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.221E-05	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+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.
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	1.697E-01	0.0281
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	5.685E+00	0.9412
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	1.846E-01	0.0306
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	5.250E-04	0.0001
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	6.040E+00	1.0000

0*Sum of all water independent and dependent pathways.

Attachment 1 Sheet No. 12 of 19
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 1

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1RESRAD, Version 6.5      T« Limit = 180 days       03/25/2013  12:43  Page  13
 Summary : 300-257 RESRAD Evaluation of Industrial Dose
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.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 = 1.000E+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.
Co-60	6.740E-02	0.0134	1.598E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.274E-08	0.0000
Cs-137	4.821E+00	0.9609	7.645E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.052E-05	0.0000
Eu-152	1.282E-01	0.0256	6.959E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.602E-08	0.0000
Sr-90	4.357E-04	0.0001	3.931E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.935E-06	0.0000
Total	5.017E+00	1.0000	1.243E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.262E-05	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+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.
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	6.740E-02	0.0134
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	4.821E+00	0.9609
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	1.282E-01	0.0256
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	4.416E-04	0.0001
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	5.017E+00	1.0000

*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	13 of 19
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

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1RESRAD, Version 6.5      T« Limit = 180 days        03/25/2013  12:43  Page  14
 Summary : 300-257 RESRAD Evaluation of Industrial Dose
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD
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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+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.
Co-60	4.814E-03	0.0016	1.141E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.909E-09	0.0000
Cs-137	3.009E+00	0.9836	4.773E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.153E-05	0.0000
Eu-152	4.521E-02	0.0148	2.454E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.033E-08	0.0000
Sr-90	2.658E-04	0.0001	2.398E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.181E-06	0.0000
Total	3.060E+00	1.0000	7.427E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.275E-05	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+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.
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	4.814E-03	0.0016
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	3.009E+00	0.9836
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	4.521E-02	0.0148
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	2.694E-04	0.0001
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	3.060E+00	1.0000

*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	14 of 19
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T« Limit = 180 days       03/25/2013  12:43  Page  15
 Summary : 300-257 RESRAD Evaluation of Industrial Dose
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD
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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+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.
Co-60	4.687E-07	0.0000	1.111E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.754E-13	0.0000
Cs-137	5.784E-01	0.9979	9.173E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.061E-06	0.0000
Eu-152	1.177E-03	0.0020	6.392E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.900E-10	0.0000
Sr-90	4.714E-05	0.0001	4.252E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.093E-07	0.0000
Total	5.796E-01	1.0000	1.349E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.271E-06	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+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.
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	4.687E-07	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	5.784E-01	0.9979
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	1.177E-03	0.0020
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	4.777E-05	0.0001
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	5.796E-01	1.0000

*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	15 of 19
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

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1RESRAD, Version 6.5 T« Limit = 180 days 03/25/2013 12:43 Page 16
Summary : 300-257 RESRAD Evaluation of Industrial Dose
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.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-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
Co-60	1.619E-18	0.0000	3.838E-24	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.987E-24	0.0000
Cs-137	5.197E-03	0.9999	8.243E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.446E-08	0.0000
Eu-152	3.503E-08	0.0000	1.902E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.350E-14	0.0000
Sr-90	3.365E-07	0.0001	3.036E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.495E-09	0.0000
ßßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß
Total	5.198E-03	1.0000	1.128E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.596E-08	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-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
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	1.619E-18	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	5.197E-03	0.9999
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	3.503E-08	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	3.411E-07	0.0001
ßßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß	ßßßßßßßßß	ßßßßßß
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	5.198E-03	1.0000

0*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	16 of 19
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T« Limit = 180 days        03/25/2013  12:43  Page  17
 Summary : 300-257 RESRAD Evaluation of Industrial Dose
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD
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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-	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.
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	3.575E-10	1.0000	5.670E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.746E-15	0.0000
Eu-152	5.031E-24	0.0000	4.312E-17	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.204E-19	0.0000
Sr-90	1.035E-14	0.0000	9.334E-17	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.595E-17	0.0000
Total	3.575E-10	1.0000	7.034E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.792E-15	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-	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.
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	3.575E-10	1.0000
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	4.324E-17	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	1.049E-14	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	3.575E-10	1.0000

0*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	17 of 19
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 1

```
1RESRAD, Version 6.5      T« Limit = 180 days        03/25/2013  12:43  Page  18
 Summary : 300-257 RESRAD Evaluation of Industrial Dose
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD

                                Dose/Source Ratios Summed Over All Pathways
                          Parent and Progeny Principal Radionuclide Contributions Indicated
0  Parent     Product    Thread                 DSR(j,t) At Time in Years   (mrem/yr)/(pCi/g)
    (i)        (j)      Fraction   0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 1.000E+03
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 Co-60      Co-60      1.000E+00  1.121E+00 9.823E-01 7.544E-01 2.995E-01 2.139E-02 2.083E-06 7.195E-18 0.000E+00
0Cs-137+D   Cs-137+D   1.000E+00  2.441E-01 2.384E-01 2.274E-01 1.928E-01 1.204E-01 2.314E-02 2.079E-04 1.430E-11
0Eu-152     Eµ-152     7.208E-01  3.560E-01 3.380E-01 3.045E-01 2.114E-01 7.456E-02 1.942E-03 5.778E-08 8.299E-24
0Eu-152     Eu-152     2.792E-01  1.379E-01 1.309E-01 1.180E-01 8.190E-02 2.888E-02 7.522E-04 2.238E-08 3.214E-24
 Eu-152     Gd-152     2.792E-01  0.000E+00 5.162E-18 1.471E-17 4.129E-17 8.033E-17 1.009E-16 1.009E-16 9.894E-17
 Eu-152     äDSR(j)               1.379E-01 1.309E-01 1.180E-01 8.190E-02 2.888E-02 7.522E-04 2.238E-08 9.894E-17
0Sr-90+D    Sr-90+D    1.000E+00  1.784E-03 1.740E-03 1.656E-03 1.393E-03 8.498E-04 1.507E-04 1.076E-06 3.308E-14
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 The DSR includes contributions from associated (half-life ó 180 days) daughters.
0
                          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   1.000E+01   3.000E+01   1.000E+02   3.000E+02   1.000E+03
 ÄÄÄÄÄÄÄ    ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ
 Co-60      1.338E+01  1.527E+01  1.988E+01  5.008E+01  7.011E+02  7.201E+06 *1.132E+15 *1.132E+15
 Cs-137     6.146E+01  6.293E+01  6.596E+01  7.779E+01  1.246E+02  6.484E+02  7.215E+04  1.049E+12
 Eu-152     3.037E+01  3.199E+01  3.551E+01  5.114E+01  1.450E+02  5.567E+03  1.871E+08 *1.765E+14
 Sr-90      8.410E+03  8.621E+03  9.057E+03  1.077E+04  1.765E+04  9.953E+04  1.394E+07 *1.365E+14
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 *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  Initial        tmin        DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
   (i)    (pCi/g)      (years)                   (pCi/g)               (pCi/g)
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ
 Co-60   2.250E-01    0.000E+00    1.121E+00 1.338E+01 1.121E+00 1.338E+01
 Cs-137  2.500E+01    0.000E+00    2.441E-01 6.146E+01 2.441E-01 6.146E+01
 Eu-152  4.370E-01    0.000E+00    4.940E-01 3.037E+01 4.940E-01 3.037E+01
 Sr-90   3.170E-01    0.000E+00    1.784E-03 8.410E+03 1.784E-03 8.410E+03
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Attachment	1	Sheet No. 18 of 19	
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5       T« Limit = 180 days        03/25/2013  12:43  Page  19
 Summary : 300-257 RESRAD Evaluation of Industrial Dose
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_RAD_DOSE.RAD

                                Individual Nuclide Dose Summed Over All Pathways
                                  Parent Nuclide and Branch Fraction Indicated
ONuclide Parent   THF(i)                                  DOSE(j,t), mrem/yr
   (j)     (i)                t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 1.000E+03
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ     ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ
 Co-60   Co-60   1.000E+00     2.522E-01 2.210E-01 1.697E-01 6.740E-03 4.814E-03 4.687E-07 1.619E-18 0.000E+00
OCs-137  Cs-137  1.000E+00     6.101E+00 5.959E+00 5.685E+00 4.821E+00 3.009E+00 5.784E-01 5.197E-03 3.575E-10
OEu-152  Eu-152  7.208E-01     1.556E-01 1.477E-01 1.331E-01 9.240E-02 3.258E-02 8.487E-04 2.525E-08 3.627E-24
 Eu-152  Eu-152  2.792E-01     6.027E-02 5.721E-02 5.155E-02 3.579E-02 1.262E-02 3.287E-04 9.780E-09 1.405E-24
 Eu-152  äDOSE(j)             2.159E-01 2.049E-01 1.846E-01 1.282E-01 4.521E-02 1.177E-03 3.503E-08 5.031E-24
OGd-152  Eu-152  2.792E-01     0.000E+00 2.256E-18 6.430E-18 1.804E-17 3.511E-17 4.409E-17 4.408E-17 4.324E-17
OSr-90   Sr-90   1.000E+00     5.654E-04 5.516E-04 5.250E-04 4.416E-04 2.694E-04 4.777E-05 3.411E-07 1.049E-14
 ßßßßßßß ßßßßßßß ßßßßßßßßß     ßßßßßßßßß ßßßßßßßßß ßßßßßßßßß ßßßßßßßßß ßßßßßßßßß ßßßßßßßßß ßßßßßßßßß ßßßßßßßßß
 THF(i) is the thread fraction of the parent nuclide.


                                Individual Nuclide Soil Concentration
                                  Parent Nuclide and Branch Fraction Indicated
ONuclide Parent   THF(i)                                   S(j,t), pCi/g
   (j)     (i)                t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 1.000E+03
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ     ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ
 Co-60   Co-60   1.000E+00     2.250E-01 1.972E-01 1.514E-01 6.013E-02 4.295E-03 4.182E-07 1.444E-18 0.000E+00
OCs-137  Cs-137  1.000E+00     2.500E+01 2.442E+01 2.329E+01 1.975E+01 1.233E+01 2.370E+00 2.130E-02 1.465E-09
OEu-152  Eu-152  7.208E-01     3.150E-01 2.990E-01 2.694E-01 1.871E-01 6.597E-02 1.718E-03 5.112E-08 7.342E-24
 Eu-152  Eu-152  2.792E-01     1.220E-01 1.158E-01 1.044E-01 7.246E-02 2.555E-02 6.655E-04 1.980E-08 2.844E-24
 Eu-152  äS(j):               4.370E-01 4.148E-01 3.738E-01 2.595E-01 9.152E-02 2.384E-03 7.091E-08 1.019E-23
OGd-152  Eu-152  2.792E-01     0.000E+00 7.630E-16 2.175E-15 6.102E-15 1.187E-14 1.491E-14 1.491E-14 1.462E-14
OSr-90   Sr-90   1.000E+00     3.170E-01 3.093E-01 2.943E-01 2.476E-01 1.510E-01 2.678E-02 1.912E-04 5.879E-12
 ßßßßßßß ßßßßßßß ßßßßßßßßß     ßßßßßßßßß ßßßßßßßßß ßßßßßßßßß ßßßßßßßßß ßßßßßßßßß ßßßßßßßßß ßßßßßßßßß ßßßßßßßßß
 THF(i) is the thread fraction of the parent nuclide.
ORESCALC.EXE execution time =    0.89 seconds
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Attachment	1	Sheet No.	19 of 19
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 2

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1RESRAD, Version 6.5      T« Limit = 180 days        03/28/2013  08:54  Page   1
 Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD
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Attachment 2 Sheet No. 1 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 2
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 12 & FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	Ac-225 (Source: FGR 12)	6.371E-02	6.371E-02	DCF1(1)
A-1	Ac-228 (Source: FGR 12)	5.978E+00	5.978E+00	DCF1(2)
A-1	Al-26 (Source: FGR 12)	1.741E+01	1.741E+01	DCF1(3)
A-1	At-217 (Source: FGR 12)	1.773E-03	1.773E-03	DCF1(4)
A-1	Ba-137m (Source: FGR 12)	3.606E+00	3.606E+00	DCF1(5)
A-1	Bi-212 (Source: FGR 12)	1.171E+00	1.171E+00	DCF1(6)
A-1	Bi-213 (Source: FGR 12)	7.660E-01	7.660E-01	DCF1(7)
A-1	Cl-36 (Source: FGR 12)	2.391E-03	2.391E-03	DCF1(8)
A-1	Cm-248 (Source: FGR 12)	8.781E-05	8.781E-05	DCF1(9)
A-1	Co-60 (Source: FGR 12)	1.622E+01	1.622E+01	DCF1(10)
A-1	Cs-137 (Source: FGR 12)	7.510E-04	7.510E-04	DCF1(11)
A-1	Eu-152 (Source: FGR 12)	7.006E+00	7.006E+00	DCF1(12)
A-1	Fr-221 (Source: FGR 12)	1.536E-01	1.536E-01	DCF1(13)
A-1	Gd-152 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(14)
A-1	Np-237 (Source: FGR 12)	7.790E-02	7.790E-02	DCF1(15)
A-1	Np-240m (Source: FGR 12)	2.018E+00	2.018E+00	DCF1(16)
A-1	Pa-233 (Source: FGR 12)	1.020E+00	1.020E+00	DCF1(17)
A-1	Pb-209 (Source: FGR 12)	7.734E-04	7.734E-04	DCF1(18)
A-1	Pb-212 (Source: FGR 12)	7.043E-01	7.043E-01	DCF1(19)
A-1	Po-212 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(20)
A-1	Po-213 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(21)
A-1	Po-216 (Source: FGR 12)	1.042E-04	1.042E-04	DCF1(22)
A-1	Pu-240 (Source: FGR 12)	1.467E-04	1.467E-04	DCF1(23)
A-1	Pu-244 (Source: FGR 12)	7.548E-05	7.548E-05	DCF1(24)
A-1	Ra-224 (Source: FGR 12)	5.119E-02	5.119E-02	DCF1(25)
A-1	Ra-225 (Source: FGR 12)	1.102E-02	1.102E-02	DCF1(26)
A-1	Ra-228 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(27)
A-1	Rn-220 (Source: FGR 12)	2.298E-03	2.298E-03	DCF1(28)
A-1	Sr-90 (Source: FGR 12)	7.043E-04	7.043E-04	DCF1(29)
A-1	Th-228 (Source: FGR 12)	7.940E-03	7.940E-03	DCF1(30)
A-1	Th-229 (Source: FGR 12)	3.213E-01	3.213E-01	DCF1(31)
A-1	Th-232 (Source: FGR 12)	5.212E-04	5.212E-04	DCF1(32)
A-1	Tl-208 (Source: FGR 12)	2.298E+01	2.298E+01	DCF1(33)
A-1	Tl-209 (Source: FGR 12)	1.293E+01	1.293E+01	DCF1(34)
A-1	U-233 (Source: FGR 12)	1.397E-03	1.397E-03	DCF1(35)
A-1	U-236 (Source: FGR 12)	2.148E-04	2.148E-04	DCF1(36)
A-1	U-240 (Source: FGR 12)	1.424E-03	1.424E-03	DCF1(37)
A-1	Y-90 (Source: FGR 12)	2.391E-02	2.391E-02	DCF1(38)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Al-26	7.960E-05	7.960E-05	DCF2(1)
B-1	Cl-36	2.190E-05	2.190E-05	DCF2(2)
B-1	Cm-248	1.650E+00	1.650E+00	DCF2(3)
B-1	Co-60	2.190E-04	2.190E-04	DCF2(7)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(8)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(9)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(11)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(12)
B-1	Pu-240	4.290E-01	4.290E-01	DCF2(13)

Attachment 2 Sheet No. 2 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 3
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
B-1	Pu-244	4.030E-01	4.030E-01	DCF2(15)
B-1	Pu-244+D	4.030E-01	4.030E-01	DCF2(16)
B-1	Ra-228+D	5.078E-03	4.770E-03	DCF2(18)
B-1	Sr-90+D	1.308E-03	1.300E-03	DCF2(19)
B-1	Th-228+D	3.454E-01	3.420E-01	DCF2(20)
B-1	Th-229+D	2.169E+00	2.150E+00	DCF2(21)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(22)
B-1	U-233	1.350E-01	1.350E-01	DCF2(23)
B-1	U-236	1.250E-01	1.250E-01	DCF2(24)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Al-26	1.460E-05	1.460E-05	DCF3(1)
D-1	Cl-36	3.030E-06	3.030E-06	DCF3(2)
D-1	Cm-248	1.360E-02	1.360E-02	DCF3(3)
D-1	Co-60	2.690E-05	2.690E-05	DCF3(7)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(8)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(9)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(11)
D-1	Np-237+D	4.444E-03	4.440E-03	DCF3(12)
D-1	Pu-240	3.540E-03	3.540E-03	DCF3(13)
D-1	Pu-244	3.320E-03	3.320E-03	DCF3(15)
D-1	Pu-244+D	3.324E-03	3.320E-03	DCF3(16)
D-1	Ra-228+D	1.442E-03	1.440E-03	DCF3(18)
D-1	Sr-90+D	1.528E-04	1.420E-04	DCF3(19)
D-1	Th-228+D	8.086E-04	3.960E-04	DCF3(20)
D-1	Th-229+D	4.027E-03	3.530E-03	DCF3(21)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(22)
D-1	U-233	2.890E-04	2.890E-04	DCF3(23)
D-1	U-236	2.690E-04	2.690E-04	DCF3(24)
D-34	Food transfer factors:			
D-34	Al-26 , plant/soil concentration ratio, dimensionless	4.000E-03	4.000E-03	RTF(1,1)
D-34	Al-26 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-04	5.000E-04	RTF(1,2)
D-34	Al-26 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-04	2.000E-04	RTF(1,3)
D-34				
D-34	Cl-36 , plant/soil concentration ratio, dimensionless	2.000E+01	2.000E+01	RTF(2,1)
D-34	Cl-36 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	6.000E-02	6.000E-02	RTF(2,2)
D-34	Cl-36 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-02	2.000E-02	RTF(2,3)
D-34				
D-34	Cm-248 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(3,1)
D-34	Cm-248 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(3,2)
D-34	Cm-248 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(3,3)
D-34				
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(7,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(7,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(7,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(8,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(8,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(8,3)

Attachment 2 Sheet No. 3 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

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1RESRAD, Version 6.5      T« Limit = 180 days        03/28/2013  08:54  Page   4
 Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD
```

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(9,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-05	5.000E-05	RTF(9,3)
D-34				
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(11,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(11,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	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				
D-34	Pu-240 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(13,1)
D-34	Pu-240 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(13,2)
D-34	Pu-240 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(13,3)
D-34				
D-34	Pu-244 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(15,1)
D-34	Pu-244 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(15,2)
D-34	Pu-244 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(15,3)
D-34				
D-34	Pu-244+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(16,1)
D-34	Pu-244+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(16,2)
D-34	Pu-244+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(16,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(18,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(18,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(18,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(19,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(19,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-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-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(22,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(22,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(22,3)
D-34				
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(23,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(23,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(23,3)
D-34				

Attachment	2	Sheet No.	4 of 26
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 5
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

Menu	Parameter		Current Value#	Base Case*	Parameter Name
D-34	U-236	, plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(24,1)
D-34	U-236	, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(24,2)
D-34	U-236	, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(24,3)
D-5	Bioaccumulation factors, fresh water, L/kg:				
D-5	Al-26	, fish	5.000E+02	5.000E+02	BIOFAC(1,1)
D-5	Al-26	, crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5					
D-5	Cl-36	, fish	1.000E+03	1.000E+03	BIOFAC(2,1)
D-5	Cl-36	, crustacea and mollusks	1.900E+02	1.900E+02	BIOFAC(2,2)
D-5					
D-5	Cm-248	, fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Cm-248	, crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(3,2)
D-5					
D-5	Co-60	, fish	3.000E+02	3.000E+02	BIOFAC(7,1)
D-5	Co-60	, crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(7,2)
D-5					
D-5	Cs-137+D	, fish	2.000E+03	2.000E+03	BIOFAC(8,1)
D-5	Cs-137+D	, crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(8,2)
D-5					
D-5	Eu-152	, fish	5.000E+01	5.000E+01	BIOFAC(9,1)
D-5	Eu-152	, 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(11,1)
D-5	Gd-152	, crustacea and mollusks	1.000E+03	1.000E+03	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	Pu-240	, fish	3.000E+01	3.000E+01	BIOFAC(13,1)
D-5	Pu-240	, crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(13,2)
D-5					
D-5	Pu-244	, fish	3.000E+01	3.000E+01	BIOFAC(15,1)
D-5	Pu-244	, crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(15,2)
D-5					
D-5	Pu-244+D	, fish	3.000E+01	3.000E+01	BIOFAC(16,1)
D-5	Pu-244+D	, crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(16,2)
D-5					
D-5	Ra-228+D	, fish	5.000E+01	5.000E+01	BIOFAC(18,1)
D-5	Ra-228+D	, crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(18,2)
D-5					
D-5	Sr-90+D	, fish	6.000E+01	6.000E+01	BIOFAC(19,1)
D-5	Sr-90+D	, crustacea and mollusks	1.000E+02	1.000E+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					

Attachment 2 Sheet No. 5 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

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1RESRAD, Version 6.5      T« Limit = 180 days       03/28/2013  08:54  Page   6
 Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD
```

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(22,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(22,2)
D-5				
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(23,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(23,2)
D-5				
D-5	U-236 , fish	1.000E+01	1.000E+01	BIOFAC(24,1)
D-5	U-236 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(24,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Attachment 2 Sheet No. 6 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 7
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	9.300E+00	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.000E-01	2.000E+00	---	THICK0
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	3.300E+00	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+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)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Al-26	2.530E+02	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Cl-36	4.230E+02	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Cm-248	3.990E+01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Co-60	2.250E-01	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g): Cs-137	2.500E+01	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g): Eu-152	4.370E-01	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): Gd-152	3.620E+01	0.000E+00	---	S1(11)
R012	Initial principal radionuclide (pCi/g): Np-237	3.350E+03	0.000E+00	---	S1(12)
R012	Initial principal radionuclide (pCi/g): Sr-90	3.170E-01	0.000E+00	---	S1(19)
R012	Concentration in groundwater (pCi/L): Al-26	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Cl-36	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Cm-248	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Co-60	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): Eu-152	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): Gd-152	not used	0.000E+00	---	W1(11)
R012	Concentration in groundwater (pCi/L): Np-237	not used	0.000E+00	---	W1(12)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(19)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.500E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	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
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH

Attachment 2 Sheet No. 7 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
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ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 8
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)	3.000E-01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	2.400E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	1.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	5.000E-02	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	5.000E-02	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	4.500E+03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Al-26				
R016	Contaminated zone (cm**3/g)	2.200E+01	0.000E+00	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	0.000E+00	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.200E+01	0.000E+00	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.086E-03	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Cl-36				
R016	Contaminated zone (cm**3/g)	3.000E+01	1.000E-01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+02	1.000E-01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	3.000E+01	1.000E-01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.973E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Cm-248				
R016	Contaminated zone (cm**3/g)	3.000E+01	-1.000E+00	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	-1.000E+00	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	3.000E+01	-1.000E+00	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.973E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)

Attachment 2 Sheet No. 8 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 9
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

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 Co-60				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+03	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.790E-04	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	5.000E+01	4.600E+03	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	4.600E+03	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	5.000E+01	4.600E+03	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.790E-04	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+03	-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	1.199E-04	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for Gd-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	8.700E+02	-1.000E+00	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.199E-04	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)
R016	Distribution coefficients for Np-237				
R016	Contaminated zone (cm**3/g)	3.000E+01	-1.000E+00	---	DCNUCC(12)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+01	-1.000E+00	---	DCNUCU(12,1)
R016	Saturated zone (cm**3/g)	3.000E+01	-1.000E+00	---	DCNUCS(12)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.973E-04	ALEACH(12)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(12)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	2.500E+01	3.000E+01	---	DCNUCC(19)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	3.000E+01	---	DCNUCU(19,1)
R016	Saturated zone (cm**3/g)	2.500E+01	3.000E+01	---	DCNUCS(19)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.561E-04	ALEACH(19)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(19)
R016	Distribution coefficients for daughter Pu-240				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(13)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCU(13,1)
R016	Saturated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCS(13)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.200E-05	ALEACH(13)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(13)

Attachment 2 Sheet No. 9 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.5 T½ Limit = 180 days 03/28/2013 08:54 Page 10
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

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 Pu-244				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(15)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCU(15,1)
R016	Saturated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCS(15)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.200E-05	ALEACH(15)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(15)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(18)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(18,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(18)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.424E-04	ALEACH(18)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(18)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(20)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(20,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(20)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.000E-07	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)	6.000E+04	6.000E+04	---	DCNUCC(21)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(21,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(21)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.000E-07	ALEACH(21)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(21)
R016	Distribution coefficients for daughter Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(22)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(22,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(22)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.000E-07	ALEACH(22)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(22)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(23)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(23,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(23)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.790E-04	ALEACH(23)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(23)
R016	Distribution coefficients for daughter U-236				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(24)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(24,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(24)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.790E-04	ALEACH(24)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(24)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR

Attachment 2 Sheet No. 10 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 11
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)
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	0.465E-02	FPLANT
R018	Contamination fraction of meat	-1	-1	0.465E-03	FMEAT

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Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 12
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Contamination fraction of milk	-1	-1	0.465E-03	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)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
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)

Attachment 2 Sheet No. 12 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

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1RESRAD, Version 6.5      T« Limit = 180 days        03/28/2013  08:54  Page  13
 Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD
```

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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	1	---	---	LYMAX
TITL	Maximum number of integration points for risk	5	---	---	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	suppressed

Attachment	2	Sheet No.	13 of 26
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 2

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1RESRAD, Version 6.5      T« Limit = 180 days       03/28/2013  08:54  Page  14
 Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

     Contaminated Zone Dimensions           Initial Soil Concentrations, pCi/g
     ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ           ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
       Area:       9.30 square meters            Al-26      2.530E+02
  Thickness:       0.30 meters                   Cl-36      4.230E+02
Cover Depth:       0.00 meters                   Cm-248     3.990E+01
                                                 Co-60      2.250E-01
                                                 Cs-137     2.500E+01
                                                 Eu-152     4.370E-01
                                                 Gd-152     3.620E+01
                                                 Np-237     3.350E+03
                                                 Sr-90      3.170E-01
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)
                  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
   t (years):  0.000E+00  1.000E+00  3.000E+00  1.000E+01  3.000E+01  1.000E+02  3.000E+02  1.000E+03
    TDOSE(t):  2.449E+03  2.446E+03  2.440E+03  2.420E+03  2.367E+03  2.207E+03  1.828E+03  9.556E+02
        M(t):  1.632E+02  1.630E+02  1.626E+02  1.613E+02  1.578E+02  1.472E+02  1.219E+02  6.371E+01
0Maximum TDOSE(t):  2.449E+03 mrem/yr    at t = 0.000E+00 years
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Attachment 2	Sheet No. 14 of 26
Originator: S. W. Clark	Date 4/1/2013
Chk'd By M. W. Perrott	Date 4/1//2013
Calc. No. 0300X-CA-V0172	Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.5 T∝ Limit = 180 days 03/28/2013 08:54 Page 15
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.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.
Al-26	1.200E+03	0.4901	3.861E-04	0.0000	0.000E+00	0.0000	2.582E-03	0.0000	1.827E-05	0.0000	1.970E-05	0.0000	2.006E-03	0.0000
Cl-36	3.087E-01	0.0001	1.776E-04	0.0000	0.000E+00	0.0000	4.478E+00	0.0018	5.842E-01	0.0002	4.377E-01	0.0002	6.961E-04	0.0000
Cm-248	1.444E-03	0.0000	1.262E+00	0.0005	0.000E+00	0.0000	9.489E-02	0.0000	9.498E-05	0.0000	2.616E-05	0.0000	2.947E-01	0.0001
Co-60	1.006E+00	0.0004	9.447E-07	0.0000	0.000E+00	0.0000	8.458E-05	0.0000	4.688E-06	0.0000	1.107E-06	0.0000	3.287E-06	0.0000
Cs-137	2.433E+01	0.0099	1.529E-05	0.0000	0.000E+00	0.0000	8.734E-03	0.0000	8.831E-04	0.0000	5.735E-04	0.0000	6.789E-04	0.0000
Eu-152	8.609E-01	0.0004	1.852E-06	0.0000	0.000E+00	0.0000	1.237E-06	0.0000	5.279E-08	0.0000	3.594E-09	0.0000	1.538E-06	0.0000
Gd-152	0.000E+00	0.0000	1.686E-01	0.0001	0.000E+00	0.0000	2.546E-03	0.0000	1.086E-04	0.0000	2.959E-06	0.0000	3.165E-03	0.0000
Np-237	1.120E+03	0.4573	3.468E+01	0.0142	0.000E+00	0.0000	5.201E+01	0.0212	2.376E-01	0.0001	3.000E-03	0.0000	8.085E+00	0.0033
Sr-90	2.225E-03	0.0000	7.952E-06	0.0000	0.000E+00	0.0000	2.538E-03	0.0000	4.735E-05	0.0000	2.703E-05	0.0000	2.631E-05	0.0000
Total	2.346E+03	0.9582	3.611E+01	0.0147	0.000E+00	0.0000	5.660E+01	0.0231	8.230E-01	0.0003	4.413E-01	0.0002	8.386E+00	0.0034

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.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.200E+03	0.4901
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.809E+00	0.0024
Cm-248	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.653E+00	0.0007
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	1.006E+00	0.0004
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	2.434E+01	0.0099
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	8.609E-01	0.0004
Gd-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	1.745E-01	0.0001
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.215E+03	0.4961
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	4.872E-03	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	2.449E+03	1.0000

0*Sum of all water independent and dependent pathways.

Attachment	2	Sheet No.	15 of 26
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 16
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.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 = 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.
Al-26	1.199E+03	0.4901	3.857E-04	0.0000	0.000E+00	0.0000	2.579E-03	0.0000	1.825E-05	0.0000	1.968E-05	0.0000	2.004E-03	0.0000
Cl-36	3.085E-01	0.0001	1.775E-04	0.0000	0.000E+00	0.0000	4.474E+00	0.0018	5.839E-01	0.0002	4.373E-01	0.0002	6.956E-04	0.0000
Cm-248	1.443E-03	0.0000	1.261E+00	0.0005	0.000E+00	0.0000	9.482E-02	0.0000	9.491E-05	0.0000	2.614E-05	0.0000	2.945E-01	0.0001
Co-60	8.814E-01	0.0004	8.279E-07	0.0000	0.000E+00	0.0000	7.413E-05	0.0000	4.109E-06	0.0000	9.702E-07	0.0000	2.881E-06	0.0000
Cs-137	2.377E+01	0.0097	1.493E-05	0.0000	0.000E+00	0.0000	8.531E-03	0.0000	8.626E-04	0.0000	5.602E-04	0.0000	6.631E-04	0.0000
Eu-152	8.172E-01	0.0003	1.758E-06	0.0000	0.000E+00	0.0000	1.174E-06	0.0000	5.011E-08	0.0000	3.412E-09	0.0000	1.460E-06	0.0000
Gd-152	0.000E+00	0.0000	1.686E-01	0.0001	0.000E+00	0.0000	2.546E-03	0.0000	1.086E-04	0.0000	2.959E-06	0.0000	3.165E-03	0.0000
Np-237	1.119E+03	0.4575	3.466E+01	0.0142	0.000E+00	0.0000	5.197E+01	0.0213	2.374E-01	0.0001	2.998E-03	0.0000	8.079E+00	0.0033
Sr-90	2.171E-03	0.0000	7.758E-06	0.0000	0.000E+00	0.0000	2.476E-03	0.0000	4.620E-05	0.0000	2.637E-05	0.0000	2.566E-05	0.0000
Total	2.343E+03	0.9582	3.609E+01	0.0148	0.000E+00	0.0000	5.656E+01	0.0231	8.224E-01	0.0003	4.410E-01	0.0002	8.380E+00	0.0034

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.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.199E+03	0.4901
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.805E+00	0.0024
Cm-248	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.652E+00	0.0007
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	8.815E-01	0.0004
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	2.378E+01	0.0097
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	8.172E-01	0.0003
Gd-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	1.745E-01	0.0001
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.214E+03	0.4963
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	4.753E-03	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	2.446E+03	1.0000

0*Sum of all water independent and dependent pathways.

Attachment	2	Sheet No.	16 of 26
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 17
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.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+00 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.
Al-26	1.196E+03	0.4903	3.848E-04	0.0000	0.000E+00	0.0000	2.573E-03	0.0000	1.821E-05	0.0000	1.963E-05	0.0000	2.000E-03	0.0000
Cl-36	3.080E-01	0.0001	1.772E-04	0.0000	0.000E+00	0.0000	4.467E+00	0.0018	5.829E-01	0.0002	4.366E-01	0.0002	6.944E-04	0.0000
Cm-248	1.441E-03	0.0000	1.259E+00	0.0005	0.000E+00	0.0000	9.467E-02	0.0000	9.475E-05	0.0000	2.610E-05	0.0000	2.940E-01	0.0001
Co-60	6.769E-01	0.0003	6.358E-07	0.0000	0.000E+00	0.0000	5.693E-05	0.0000	3.155E-06	0.0000	7.451E-07	0.0000	2.212E-06	0.0000
Cs-137	2.267E+01	0.0093	1.425E-05	0.0000	0.000E+00	0.0000	8.138E-03	0.0000	8.228E-04	0.0000	5.344E-04	0.0000	6.325E-04	0.0000
Eu-152	7.363E-01	0.0003	1.584E-06	0.0000	0.000E+00	0.0000	1.058E-06	0.0000	4.515E-08	0.0000	3.074E-09	0.0000	1.315E-06	0.0000
Gd-152	0.000E+00	0.0000	1.686E-01	0.0001	0.000E+00	0.0000	2.545E-03	0.0000	1.086E-04	0.0000	2.958E-06	0.0000	3.164E-03	0.0000
Np-237	1.117E+03	0.4579	3.460E+01	0.0142	0.000E+00	0.0000	5.189E+01	0.0213	2.370E-01	0.0001	2.993E-03	0.0000	8.066E+00	0.0033
Sr-90	2.066E-03	0.0000	7.383E-06	0.0000	0.000E+00	0.0000	2.357E-03	0.0000	4.397E-05	0.0000	2.510E-05	0.0000	2.442E-05	0.0000
Total	2.338E+03	0.9581	3.603E+01	0.0148	0.000E+00	0.0000	5.647E+01	0.0231	8.211E-01	0.0003	4.403E-01	0.0002	8.366E+00	0.0034

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
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.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.196E+03	0.4903
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.796E+00	0.0024
Cm-248	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.649E+00	0.0007
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	6.770E-01	0.0003
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	2.268E+01	0.0093
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	7.363E-01	0.0003
Gd-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	1.744E-01	0.0001
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.212E+03	0.4967
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	4.523E-03	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	2.440E+03	1.0000

0*Sum of all water independent and dependent pathways.

Attachment	2	Sheet No.	17 of 26
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 18
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.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 = 1.000E+01 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.
Al-26	1.187E+03	0.4906	3.819E-04	0.0000	0.000E+00	0.0000	2.554E-03	0.0000	1.807E-05	0.0000	1.949E-05	0.0000	1.984E-03	0.0000
Cl-36	3.063E-01	0.0001	1.762E-04	0.0000	0.000E+00	0.0000	4.442E+00	0.0018	5.797E-01	0.0002	4.342E-01	0.0002	6.906E-04	0.0000
Cm-248	1.434E-03	0.0000	1.252E+00	0.0005	0.000E+00	0.0000	9.414E-02	0.0000	9.423E-05	0.0000	2.595E-05	0.0000	2.924E-01	0.0001
Co-60	2.687E-01	0.0001	2.524E-07	0.0000	0.000E+00	0.0000	2.260E-05	0.0000	1.253E-06	0.0000	2.958E-07	0.0000	8.783E-07	0.0000
Cs-137	1.922E+01	0.0079	1.208E-05	0.0000	0.000E+00	0.0000	6.900E-03	0.0000	6.976E-04	0.0000	4.531E-04	0.0000	5.363E-04	0.0000
Eu-152	5.112E-01	0.0002	1.100E-06	0.0000	0.000E+00	0.0000	7.347E-07	0.0000	3.135E-08	0.0000	2.134E-09	0.0000	9.133E-07	0.0000
Gd-152	0.000E+00	0.0000	1.684E-01	0.0001	0.000E+00	0.0000	2.543E-03	0.0000	1.085E-04	0.0000	2.956E-06	0.0000	3.162E-03	0.0000
Np-237	1.111E+03	0.4591	3.441E+01	0.0142	0.000E+00	0.0000	5.160E+01	0.0213	2.357E-01	0.0001	2.977E-03	0.0000	8.021E+00	0.0033
Sr-90	1.737E-03	0.0000	6.208E-06	0.0000	0.000E+00	0.0000	1.982E-03	0.0000	3.697E-05	0.0000	2.110E-05	0.0000	2.054E-05	0.0000
Total	2.318E+03	0.9580	3.583E+01	0.0148	0.000E+00	0.0000	5.615E+01	0.0232	8.163E-01	0.0003	4.377E-01	0.0002	8.320E+00	0.0034

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+01 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.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.187E+03	0.4906
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.763E+00	0.0024
Cm-248	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.640E+00	0.0007
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	2.688E-01	0.0001
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	1.923E+01	0.0079
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	5.112E-01	0.0002
Gd-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	1.743E-01	0.0001
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.205E+03	0.4980
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	3.804E-03	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	2.420E+03	1.0000

0*Sum of all water independent and dependent pathways.

Attachment	2	Sheet No.	18 of 26
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 19
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.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+01 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.
Al-26	1.162E+03	0.4907	3.737E-04	0.0000	0.000E+00	0.0000	2.499E-03	0.0000	1.768E-05	0.0000	1.907E-05	0.0000	1.942E-03	0.0000
Cl-36	3.014E-01	0.0001	1.734E-04	0.0000	0.000E+00	0.0000	4.372E+00	0.0018	5.705E-01	0.0002	4.273E-01	0.0002	6.796E-04	0.0000
Cm-248	1.415E-03	0.0000	1.232E+00	0.0005	0.000E+00	0.0000	9.265E-02	0.0000	9.273E-05	0.0000	2.554E-05	0.0000	2.877E-01	0.0001
Co-60	1.918E-02	0.0000	1.802E-08	0.0000	0.000E+00	0.0000	1.613E-06	0.0000	8.942E-08	0.0000	2.112E-08	0.0000	6.270E-08	0.0000
Cs-137	1.199E+01	0.0051	7.536E-06	0.0000	0.000E+00	0.0000	4.305E-03	0.0000	4.353E-04	0.0000	2.827E-04	0.0000	3.346E-04	0.0000
Eu-152	1.803E-01	0.0001	3.877E-07	0.0000	0.000E+00	0.0000	2.591E-07	0.0000	1.105E-08	0.0000	7.526E-10	0.0000	3.220E-07	0.0000
Gd-152	0.000E+00	0.0000	1.680E-01	0.0001	0.000E+00	0.0000	2.537E-03	0.0000	1.083E-04	0.0000	2.948E-06	0.0000	3.154E-03	0.0000
Np-237	1.093E+03	0.4618	3.386E+01	0.0143	0.000E+00	0.0000	5.078E+01	0.0215	2.320E-01	0.0001	2.931E-03	0.0000	7.894E+00	0.0033
Sr-90	1.059E-03	0.0000	3.784E-06	0.0000	0.000E+00	0.0000	1.208E-03	0.0000	2.253E-05	0.0000	1.286E-05	0.0000	1.252E-05	0.0000
Total	2.267E+03	0.9578	3.527E+01	0.0149	0.000E+00	0.0000	5.526E+01	0.0233	8.031E-01	0.0003	4.306E-01	0.0002	8.188E+00	0.0035

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+01 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.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.162E+03	0.4907
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.672E+00	0.0024
Cm-248	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.614E+00	0.0007
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	1.919E-02	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	1.200E+01	0.0051
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	1.803E-01	0.0001
Gd-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	1.738E-01	0.0001
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.186E+03	0.5010
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	2.318E-03	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	2.367E+03	1.0000

0*Sum of all water independent and dependent pathways.

Attachment	2	Sheet No.	19 of 26
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 20
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.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 = 1.000E+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.
Al-26	1.076E+03	0.4876	3.463E-04	0.0000	0.000E+00	0.0000	2.316E-03	0.0000	1.639E-05	0.0000	1.767E-05	0.0000	1.800E-03	0.0000
Cl-36	2.850E-01	0.0001	1.640E-04	0.0000	0.000E+00	0.0000	4.134E+00	0.0019	5.394E-01	0.0002	4.041E-01	0.0002	6.426E-04	0.0000
Cm-248	1.350E-03	0.0000	1.165E+00	0.0005	0.000E+00	0.0000	8.760E-02	0.0000	8.768E-05	0.0000	2.415E-05	0.0000	2.721E-01	0.0001
Co-60	1.865E-06	0.0000	1.752E-12	0.0000	0.000E+00	0.0000	1.568E-10	0.0000	8.693E-12	0.0000	2.053E-12	0.0000	6.095E-12	0.0000
Cs-137	2.301E+00	0.0010	1.446E-06	0.0000	0.000E+00	0.0000	8.261E-04	0.0000	8.352E-05	0.0000	5.424E-05	0.0000	6.420E-05	0.0000
Eu-152	4.693E-03	0.0000	1.009E-08	0.0000	0.000E+00	0.0000	6.744E-09	0.0000	2.878E-10	0.0000	1.959E-11	0.0000	8.384E-09	0.0000
Gd-152	0.000E+00	0.0000	1.666E-01	0.0001	0.000E+00	0.0000	2.516E-03	0.0000	1.073E-04	0.0000	2.924E-06	0.0000	3.128E-03	0.0000
Np-237	1.034E+03	0.4684	3.203E+01	0.0145	0.000E+00	0.0000	4.802E+01	0.0218	2.194E-01	0.0001	2.776E-03	0.0000	7.465E+00	0.0034
Sr-90	1.871E-04	0.0000	6.687E-07	0.0000	0.000E+00	0.0000	2.135E-04	0.0000	3.982E-06	0.0000	2.273E-06	0.0000	2.212E-06	0.0000
Total	2.113E+03	0.9572	3.336E+01	0.0151	0.000E+00	0.0000	5.225E+01	0.0237	7.591E-01	0.0003	4.069E-01	0.0002	7.743E+00	0.0035

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+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.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.076E+03	0.4876
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.363E+00	0.0024
Cm-248	0.000E+00	0.0000	0.000E+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+00	0.0007
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	1.865E-06	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	2.302E+00	0.0010
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	4.693E-03	0.0000
Gd-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	1.724E-01	0.0001
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.122E+03	0.5081
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	4.097E-04	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	2.207E+03	1.0000

0*Sum of all water independent and dependent pathways.

Attachment 2 Sheet No. 20 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 21
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.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 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.
Al-26	8.661E+02	0.4737	2.787E-04	0.0000	0.000E+00	0.0000	1.863E-03	0.0000	1.318E-05	0.0000	1.422E-05	0.0000	1.448E-03	0.0000
Cl-36	2.429E-01	0.0001	1.397E-04	0.0000	0.000E+00	0.0000	3.523E+00	0.0019	4.597E-01	0.0003	3.443E-01	0.0002	5.476E-04	0.0000
Cm-248	1.183E-03	0.0000	9.931E-01	0.0005	0.000E+00	0.0000	7.466E-02	0.0000	7.473E-05	0.0000	2.058E-05	0.0000	2.319E-01	0.0001
Co-60	6.411E-18	0.0000	6.021E-24	0.0000	0.000E+00	0.0000	5.391E-22	0.0000	2.988E-23	0.0000	7.057E-24	0.0000	2.095E-23	0.0000
Cs-137	2.058E-02	0.0000	1.293E-08	0.0000	0.000E+00	0.0000	7.388E-06	0.0000	7.470E-07	0.0000	4.851E-07	0.0000	5.742E-07	0.0000
Eu-152	1.395E-07	0.0000	3.000E-13	0.0000	0.000E+00	0.0000	2.004E-13	0.0000	8.551E-15	0.0000	5.823E-16	0.0000	2.491E-13	0.0000
Gd-152	0.000E+00	0.0000	1.627E-01	0.0001	0.000E+00	0.0000	2.456E-03	0.0000	1.048E-04	0.0000	2.854E-06	0.0000	3.054E-03	0.0000
Np-237	8.815E+02	0.4821	2.731E+01	0.0149	0.000E+00	0.0000	4.094E+01	0.0224	1.871E-01	0.0001	2.378E-03	0.0000	6.365E+00	0.0035
Sr-90	1.323E-06	0.0000	4.728E-09	0.0000	0.000E+00	0.0000	1.509E-06	0.0000	2.816E-08	0.0000	1.607E-08	0.0000	1.564E-08	0.0000
Total	1.748E+03	0.9559	2.847E+01	0.0156	0.000E+00	0.0000	4.455E+01	0.0244	6.469E-01	0.0004	3.468E-01	0.0002	6.602E+00	0.0036

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 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.
Al-26	0.000E+00	0.0000	0.000E+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+02	0.4737
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.571E+00	0.0025
Cm-248	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.301E+00	0.0007
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	6.411E-18	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	2.059E-02	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	1.395E-07	0.0000
Gd-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	1.683E-01	0.0001
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.563E+02	0.5230
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	2.897E-06	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	1.828E+03	1.0000

0*Sum of all water independent and dependent pathways.

Attachment 2 Sheet No. 21 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 22
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.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 = 1.000E+03 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.
Al-26	4.047E+02	0.4235	1.302E-04	0.0000	0.000E+00	0.0000	8.708E-04	0.0000	6.161E-06	0.0000	6.644E-06	0.0000	6.766E-04	0.0000
Cl-36	1.388E-01	0.0001	7.984E-05	0.0000	0.000E+00	0.0000	2.013E+00	0.0021	2.627E-01	0.0003	1.967E-01	0.0002	3.129E-04	0.0000
Cm-248	7.704E-04	0.0000	5.675E-01	0.0006	0.000E+00	0.0000	4.267E-02	0.0000	4.271E-05	0.0000	1.176E-05	0.0000	1.325E-01	0.0001
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	1.393E-09	0.0000	8.750E-16	0.0000	0.000E+00	0.0000	4.999E-13	0.0000	5.054E-14	0.0000	3.283E-14	0.0000	3.885E-14	0.0000
Eu-152	1.995E-23	0.0000	6.223E-17	0.0000	0.000E+00	0.0000	9.396E-19	0.0000	4.009E-20	0.0000	1.092E-21	0.0000	1.168E-18	0.0000
Gd-152	0.000E+00	0.0000	1.496E-01	0.0002	0.000E+00	0.0000	2.259E-03	0.0000	9.637E-05	0.0000	2.625E-06	0.0000	2.808E-03	0.0000
Np-237	5.046E+02	0.5280	1.566E+01	0.0164	0.000E+00	0.0000	2.343E+01	0.0245	1.070E-01	0.0001	1.386E-03	0.0000	3.644E+00	0.0038
Sr-90	3.931E-14	0.0000	1.405E-16	0.0000	0.000E+00	0.0000	4.485E-14	0.0000	8.368E-16	0.0000	4.776E-16	0.0000	4.648E-16	0.0000
Total	9.094E+02	0.9516	1.638E+01	0.0171	0.000E+00	0.0000	2.549E+01	0.0267	3.698E-01	0.0004	1.982E-01	0.0002	3.780E+00	0.0040

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-	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.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.047E+02	0.4235
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.611E+00	0.0027
Cm-248	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.435E-01	0.0008
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	1.393E-09	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	6.438E-17	0.0000
Gd-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	1.548E-01	0.0002
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.474E+02	0.5728
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	8.608E-14	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	9.556E+02	1.0000

0*Sum of all water independent and dependent pathways.

Attachment	2	Sheet No.	22 of 26
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
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ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 23
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

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

0 Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ
Al-26	Al-26	1.000E+00	4.743E+00	4.738E+00	4.728E+00	4.692E+00	4.591E+00	4.255E+00	3.423E+00	1.600E+00
0Cl-36	Cl-36	1.000E+00	1.373E-02	1.372E-02	1.370E-02	1.362E-02	1.341E-02	1.268E-02	1.081E-02	6.174E-03
0Cm-248	Cm-248	8.260E-02	3.423E-03	3.420E-03	3.415E-03	3.396E-03	3.342E-03	3.160E-03	2.693E-03	1.539E-03
0Cm-248	Cm-248	1.147E-03	4.752E-05	4.748E-05	4.741E-05	4.714E-05	4.639E-05	4.387E-05	3.739E-05	2.137E-05
Cm-248	Pu-244	1.147E-03	0.000E+00	9.758E-14	2.925E-13	9.722E-13	2.893E-12	9.376E-12	2.599E-11	6.676E-11
Cm-248	äDSR(j)		4.752E-05	4.748E-05	4.741E-05	4.714E-05	4.639E-05	4.387E-05	3.739E-05	2.137E-05
0Cm-248	Cm-248	4.535E-08	1.879E-09	1.878E-09	1.875E-09	1.864E-09	1.835E-09	1.735E-09	1.479E-09	8.450E-10
Cm-248	Pu-244+D	4.535E-08	0.000E+00	2.235E-16	6.699E-16	2.227E-15	6.627E-15	2.148E-14	5.953E-14	1.529E-13
Cm-248	Pu-240	4.535E-08	0.000E+00	2.184E-22	1.964E-21	2.178E-20	1.948E-19	2.118E-18	1.794E-17	1.626E-16
Cm-248	äDSR(j)		1.879E-09	1.878E-09	1.875E-09	1.864E-09	1.835E-09	1.735E-09	1.479E-09	8.452E-10
0Cm-248	Cm-248	9.163E-01	3.797E-02	3.794E-02	3.788E-02	3.767E-02	3.707E-02	3.505E-02	2.987E-02	1.707E-02
Cm-248	Pu-244+D	9.163E-01	0.000E+00	4.515E-09	1.353E-08	4.499E-08	1.339E-07	4.338E-07	1.203E-06	3.089E-06
Cm-248	Pu-240	9.163E-01	0.000E+00	4.412E-15	3.968E-14	4.399E-13	3.935E-12	4.279E-11	3.624E-10	3.285E-09
Cm-248	U-236	9.163E-01	0.000E+00	1.097E-23	2.969E-22	1.098E-20	2.945E-19	1.064E-17	2.681E-16	7.828E-15
Cm-248	Th-232	9.163E-01	0.000E+00	1.670E-33	1.350E-31	1.662E-29	1.338E-27	1.620E-25	1.241E-23	1.267E-21
Cm-248	Ra-228+D	9.163E-01	0.000E+00	1.971E-33	4.606E-31	1.664E-28	2.954E-26	5.991E-24	5.583E-22	6.141E-20
Cm-248	Th-228+D	9.163E-01	0.000E+00	1.840E-34	1.176E-31	1.074E-28	3.292E-26	8.659E-24	8.716E-22	9.842E-20
Cm-248	äDSR(j)		3.797E-02	3.794E-02	3.788E-02	3.767E-02	3.707E-02	3.505E-02	2.987E-02	1.707E-02
0Co-60	Co-60	1.000E+00	4.471E+00	3.918E+00	3.009E+00	1.194E+00	8.527E-02	8.289E-06	2.850E-17	0.000E+00
0Cs-137+D	Cs-137+D	1.000E+00	9.738E-01	9.511E-01	9.073E-01	7.692E-01	4.800E-01	9.209E-02	8.237E-04	5.573E-11
0Eu-152	Eu-152	7.208E-01	1.420E+00	1.348E+00	1.214E+00	8.432E-01	2.973E-01	7.741E-03	2.300E-07	3.291E-23
0Eu-152	Eu-152	2.792E-01	5.500E-01	5.221E-01	4.704E-01	3.266E-01	1.152E-01	2.998E-03	8.910E-08	1.275E-23
Eu-152	Gd-152	2.792E-01	0.000E+00	8.415E-18	2.398E-17	6.726E-17	1.307E-16	1.632E-16	1.602E-16	1.473E-16
Eu-152	äDSR(j)		5.500E-01	5.221E-01	4.704E-01	3.266E-01	1.152E-01	2.998E-03	8.910E-08	1.473E-16
0Gd-152	Gd-152	1.000E+00	4.820E-03	4.819E-03	4.818E-03	4.814E-03	4.802E-03	4.762E-03	4.649E-03	4.275E-03
0Np-237+D	Np-237+D	1.000E+00	3.626E-01	3.623E-01	3.618E-01	3.597E-01	3.541E-01	3.348E-01	2.855E-01	1.633E-01
Np-237+D	U-233	1.000E+00	0.000E+00	1.465E-08	4.359E-08	1.443E-07	4.271E-07	1.361E-06	3.593E-06	7.678E-06
Np-237+D	Th-229+D	1.000E+00	0.000E+00	1.076E-10	9.671E-10	1.071E-08	9.552E-08	1.028E-06	8.447E-06	6.873E-05
Np-237+D	äDSR(j)		3.626E-01	3.623E-01	3.618E-01	3.597E-01	3.541E-01	3.348E-01	2.855E-01	1.634E-01
0Sr-90+D	Sr-90+D	1.000E+00	1.537E-02	1.499E-02	1.427E-02	1.200E-02	7.313E-03	1.292E-03	9.137E-06	2.716E-13
ßßßßßßßßß	ßßßßßßßßß	ßßßßßßßßß	ßßßßßßßßß	ßßßßßßßßß	ßßßßßßßßß	ßßßßßßßßß	ßßßßßßßßß	ßßßßßßßßß	ßßßßßßßßß	ßßßßßßßßß

The DSR includes contributions from associated (half-life ó 180 days) daughters.

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Chk'd By	M. W. Perrott	Date	4/1//2013
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ATTACHMENT 2

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 24
Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

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

ONuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ
Al-26	3.162E+00	3.166E+00	3.173E+00	3.197E+00	3.267E+00	3.526E+00	4.382E+00	9.377E+00
Cl-36	1.092E+03	1.093E+03	1.095E+03	1.101E+03	1.119E+03	1.183E+03	1.388E+03	2.430E+03
Cm-248	3.620E+02	3.623E+02	3.629E+02	3.649E+02	3.708E+02	3.921E+02	4.601E+02	8.050E+02
Co-60	3.355E+00	3.829E+00	4.985E+00	1.256E+01	1.759E+02	1.810E+06	*1.132E+15	*1.132E+15
Cs-137	1.540E+01	1.577E+01	1.653E+01	1.950E+01	3.125E+01	1.629E+02	1.821E+04	2.691E+11
Eu-152	7.614E+00	8.021E+00	8.903E+00	1.282E+01	3.636E+01	1.397E+03	4.700E+07	*1.765E+14
Gd-152	*2.179E+01	*2.179E+01	*2.179E+01	*2.179E+01	*2.179E+01	*2.179E+01	*2.179E+01	*2.179E+01
Np-237	4.137E+01	4.140E+01	4.146E+01	4.170E+01	4.237E+01	4.480E+01	5.255E+01	9.180E+01
Sr-90	9.760E+02	1.000E+03	1.051E+03	1.250E+03	2.051E+03	1.161E+04	1.642E+06	5.524E+13
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ

*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

ONuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ
Al-26	2.530E+02	0.000E+00	4.743E+00	3.162E+00	4.743E+00	3.162E+00
Cl-36	4.230E+02	0.000E+00	1.373E-02	1.092E+03	1.373E-02	1.092E+03
Cm-248	3.990E+01	0.000E+00	4.144E-02	3.620E+02	4.144E-02	3.620E+02
Co-60	2.250E-01	0.000E+00	4.471E+00	3.355E+00	4.471E+00	3.355E+00
Cs-137	2.500E+01	0.000E+00	9.738E-01	1.540E+01	9.738E-01	1.540E+01
Eu-152	4.370E-01	0.000E+00	1.970E+00	7.614E+00	1.970E+00	7.614E+00
Gd-152	3.620E+01	0.000E+00	4.820E-03	*2.179E+01	4.820E-03	*2.179E+01
Np-237	3.350E+03	0.000E+00	3.626E-01	4.137E+01	3.626E-01	4.137E+01
Sr-90	3.170E-01	0.000E+00	1.537E-02	9.760E+02	1.537E-02	9.760E+02
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ

*At specific activity limit

Attachment	2	Sheet No.	24 of 26
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 2

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1RESRAD, Version 6.5      T« Limit = 180 days        03/28/2013  08:54  Page  25
 Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD
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Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

ONuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Al-26	Al-26	1.000E+00	1.200E+03	1.199E+03	1.196E+03	1.187E+03	1.162E+03	1.076E+03	8.661E+02	4.047E+02
OCl-36	Cl-36	1.000E+00	5.809E+00	5.805E+00	5.796E+00	5.763E+00	5.672E+00	5.363E+00	4.571E+00	2.611E+00
OCm-248	Cm-248	8.260E-02	1.366E-01	1.365E-01	1.362E-01	1.355E-01	1.333E-01	1.261E-01	1.075E-01	6.140E-02
Cm-248	Cm-248	1.147E-03	1.896E-03	1.894E-03	1.891E-03	1.881E-03	1.851E-03	1.750E-03	1.492E-03	8.525E-04
Cm-248	äDOSE(j)		1.385E-01	1.384E-01	1.381E-01	1.374E-01	1.352E-01	1.278E-01	1.089E-01	6.226E-02
OPu-244	Cm-248	1.147E-03	0.000E+00	3.893E-12	1.167E-11	3.879E-11	1.154E-10	3.741E-10	1.037E-09	2.664E-09
Pu-244	Cm-248	4.535E-08	0.000E+00	8.917E-15	2.673E-14	8.885E-14	2.644E-13	8.569E-13	2.375E-12	6.101E-12
Pu-244	äDOSE(j)		0.000E+00	3.902E-12	1.170E-11	3.888E-11	1.157E-10	3.750E-10	1.039E-09	2.670E-09
OCm-248	Cm-248	4.535E-08	7.499E-08	7.493E-08	7.481E-08	7.439E-08	7.321E-08	6.923E-08	5.900E-08	3.372E-08
Cm-248	Cm-248	9.163E-01	1.515E+00	1.514E+00	1.511E+00	1.503E+00	1.479E+00	1.399E+00	1.192E+00	6.811E-01
Cm-248	äDOSE(j)		1.515E+00	1.514E+00	1.511E+00	1.503E+00	1.479E+00	1.399E+00	1.192E+00	6.811E-01
OPu-240	Cm-248	4.535E-08	0.000E+00	8.713E-21	7.837E-20	8.689E-19	7.772E-18	8.451E-17	7.158E-16	6.489E-15
Pu-240	Cm-248	9.163E-01	0.000E+00	1.760E-13	1.583E-12	1.755E-11	1.570E-10	1.707E-09	1.446E-08	1.311E-07
Pu-240	äDOSE(j)		0.000E+00	1.760E-13	1.583E-12	1.755E-11	1.570E-10	1.707E-09	1.446E-08	1.311E-07
OPu-244	Cm-248	9.163E-01	0.000E+00	1.802E-07	5.400E-07	1.795E-06	5.341E-06	1.731E-05	4.798E-05	1.233E-04
OU-236	Cm-248	9.163E-01	0.000E+00	4.377E-22	1.185E-20	4.382E-19	1.175E-17	4.247E-16	1.070E-14	3.123E-13
OTh-232	Cm-248	9.163E-01	0.000E+00	0.000E+00	0.000E+00	6.206E-28	5.339E-26	6.463E-24	4.951E-22	5.055E-20
ORa-228	Cm-248	9.163E-01	0.000E+00	0.000E+00	0.000E+00	6.597E-27	1.179E-24	2.390E-22	2.228E-20	2.450E-18
OTh-228	Cm-248	9.163E-01	0.000E+00	0.000E+00	0.000E+00	4.274E-27	1.313E-24	3.455E-22	3.478E-20	3.927E-18
OCo-60	Co-60	1.000E+00	1.006E+00	8.815E-01	6.770E-01	2.688E-01	1.919E-02	1.865E-06	6.411E-18	0.000E+00
OCs-137	Cs-137	1.000E+00	2.434E+01	2.378E+01	2.268E+01	1.923E+01	1.200E+01	2.302E+00	2.059E-02	1.393E-09
OEu-152	Eu-152	7.208E-01	6.205E-01	5.890E-01	5.307E-01	3.685E-01	1.299E-01	3.383E-03	1.005E-07	1.438E-23
Eu-152	Eu-152	2.792E-01	2.404E-01	2.282E-01	2.056E-01	1.427E-01	5.033E-02	1.310E-03	3.894E-08	5.570E-24
Eu-152	äDOSE(j)		8.609E-01	8.172E-01	7.363E-01	5.112E-01	1.803E-01	4.693E-03	1.395E-07	1.995E-23
OGd-152	Eu-152	2.792E-01	0.000E+00	3.677E-18	1.048E-17	2.939E-17	5.712E-17	7.132E-17	7.002E-17	6.438E-17
Gd-152	Gd-152	1.000E+00	1.745E-01	1.745E-01	1.744E-01	1.743E-01	1.738E-01	1.724E-01	1.683E-01	1.548E-01
Gd-152	äDOSE(j)		1.745E-01	1.745E-01	1.744E-01	1.743E-01	1.738E-01	1.724E-01	1.683E-01	1.548E-01
ONp-237	Np-237	1.000E+00	1.215E+03	1.214E+03	1.212E+03	1.205E+03	1.186E+03	1.122E+03	9.563E+02	5.471E+02
OU-233	Np-237	1.000E+00	0.000E+00	4.906E-05	1.460E-04	4.834E-04	1.431E-03	4.559E-03	1.204E-02	2.572E-02
OTh-229	Np-237	1.000E+00	0.000E+00	3.604E-07	3.240E-06	3.588E-05	3.200E-04	3.443E-03	2.830E-02	2.302E-01
OSr-90	Sr-90	1.000E+00	4.872E-03	4.753E-03	4.523E-03	3.804E-03	2.318E-03	4.097E-04	2.897E-06	8.608E-14

THF(i) is the thread fraction of the parent nuclide.

Attachment 2 Sheet No. 25 of 26
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 2

```
1RESRAD, Version 6.5      T« Limit = 180 days        03/28/2013  08:54  Page  26
 Summary : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD
```

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

ONuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Al-26	Al-26	1.000E+00	2.530E+02	2.527E+02	2.522E+02	2.503E+02	2.449E+02	2.269E+02	1.826E+02	8.533E+01
OCl-36	Cl-36	1.000E+00	4.230E+02	4.227E+02	4.220E+02	4.196E+02	4.130E+02	3.905E+02	3.328E+02	1.901E+02
OCm-248	Cm-248	8.260E-02	3.296E+00	3.293E+00	3.288E+00	3.270E+00	3.218E+00	3.043E+00	2.593E+00	1.482E+00
Cm-248	Cm-248	1.147E-03	4.576E-02	4.572E-02	4.565E-02	4.539E-02	4.467E-02	4.224E-02	3.600E-02	2.057E-02
Cm-248	äS(j):		3.341E+00	3.339E+00	3.333E+00	3.315E+00	3.262E+00	3.085E+00	2.629E+00	1.502E+00
OPu-244	Cm-248	1.147E-03	0.000E+00	3.838E-10	1.150E-09	3.824E-09	1.138E-08	3.688E-08	1.022E-07	2.626E-07
Pu-244	Cm-248	4.535E-08	0.000E+00	1.518E-14	4.550E-14	1.512E-13	4.501E-13	1.459E-12	4.043E-12	1.039E-11
Pu-244	äS(j):		0.000E+00	3.838E-10	1.151E-09	3.824E-09	1.138E-08	3.688E-08	1.022E-07	2.626E-07
OCm-248	Cm-248	4.535E-08	1.810E-06	1.808E-06	1.805E-06	1.795E-06	1.767E-06	1.671E-06	1.424E-06	8.137E-07
Cm-248	Cm-248	9.163E-01	3.656E+01	3.653E+01	3.647E+01	3.627E+01	3.569E+01	3.375E+01	2.876E+01	1.644E+01
Cm-248	äS(j):		3.656E+01	3.653E+01	3.647E+01	3.627E+01	3.569E+01	3.375E+01	2.876E+01	1.644E+01
OPu-240	Cm-248	4.535E-08	0.000E+00	8.049E-19	7.239E-18	8.026E-17	7.179E-16	7.807E-15	6.612E-14	5.994E-13
Pu-240	Cm-248	9.163E-01	0.000E+00	1.626E-11	1.462E-10	1.621E-09	1.450E-08	1.577E-07	1.336E-06	1.211E-05
Pu-240	äS(j):		0.000E+00	1.626E-11	1.462E-10	1.621E-09	1.450E-08	1.577E-07	1.336E-06	1.211E-05
OPu-244	Cm-248	9.163E-01	0.000E+00	3.067E-07	9.192E-07	3.055E-06	9.092E-06	2.947E-05	8.168E-05	2.098E-04
OU-236	Cm-248	9.163E-01	0.000E+00	1.604E-19	4.329E-18	1.599E-16	4.288E-15	1.550E-13	3.902E-12	1.139E-10
OTh-232	Cm-248	9.163E-01	0.000E+00	1.979E-30	1.602E-28	1.974E-26	1.590E-24	1.925E-22	1.474E-20	1.505E-18
ORa-228	Cm-248	9.163E-01	0.000E+00	4.677E-32	1.092E-29	3.945E-27	7.003E-25	1.420E-22	1.324E-20	1.456E-18
OTh-228	Cm-248	9.163E-01	0.000E+00	2.692E-33	1.722E-30	1.572E-27	4.818E-25	1.268E-22	1.276E-20	1.441E-18
OCo-60	Co-60	1.000E+00	2.250E-01	1.972E-01	1.514E-01	6.012E-02	4.292E-03	4.172E-07	1.434E-18	0.000E+00
OCs-137	Cs-137	1.000E+00	2.500E+01	2.442E+01	2.329E+01	1.975E+01	1.232E+01	2.364E+00	2.115E-02	1.431E-09
OEu-152	Eu-152	7.208E-01	3.150E-01	2.990E-01	2.694E-01	1.870E-01	6.595E-02	1.717E-03	5.103E-08	7.300E-24
Eu-152	Eu-152	2.792E-01	1.220E-01	1.158E-01	1.043E-01	7.245E-02	2.555E-02	6.651E-04	1.977E-08	2.828E-24
Eu-152	äS(j):		4.370E-01	4.148E-01	3.737E-01	2.595E-01	9.150E-02	2.382E-03	7.079E-08	1.013E-23
OGd-152	Eu-152	2.792E-01	0.000E+00	7.630E-16	2.174E-15	6.099E-15	1.185E-14	1.480E-14	1.453E-14	1.336E-14
Gd-152	Gd-152	1.000E+00	3.620E+01	3.620E+01	3.619E+01	3.616E+01	3.607E+01	3.577E+01	3.492E+01	3.211E+01
Gd-152	äS(j):		3.620E+01	3.620E+01	3.619E+01	3.616E+01	3.607E+01	3.577E+01	3.492E+01	3.211E+01
ONp-237	Np-237	1.000E+00	3.350E+03	3.347E+03	3.342E+03	3.323E+03	3.271E+03	3.093E+03	2.637E+03	1.509E+03
OU-233	Np-237	1.000E+00	0.000E+00	1.464E-02	4.387E-02	1.456E-01	4.311E-01	1.374E+00	3.628E+00	7.753E+00
OTh-229	Np-237	1.000E+00	0.000E+00	6.914E-07	6.217E-06	6.886E-05	6.141E-04	6.608E-03	5.430E-02	4.418E-01
OSr-90	Sr-90	1.000E+00	3.170E-01	3.092E-01	2.943E-01	2.475E-01	1.508E-01	2.666E-02	1.885E-04	5.601E-12

THF(i) is the thread fraction of the parent nuclide.
ORESCALC.EXE execution time = 1.25 seconds

Attachment	2	Sheet No.	26 of 26
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 3

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1RESRAD, Version 6.5      T« Limit = 180 days       03/28/2013  08:54  Page   1
 Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

                    Table of Contents
                    ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
          Part IV: Concentration of Radionuclides
          ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ

 Concentration of radionuclides in different media
      Time= 0.000E+00 ..................................  2
      Time= 1.000E+00 ..................................  4
      Time= 3.000E+00 ..................................  6
      Time= 1.000E+01 ..................................  8
      Time= 3.000E+01 ..................................  10
      Time= 1.000E+02 ..................................  12
      Time= 3.000E+02 ..................................  14
      Time= 1.000E+03 ..................................  16
```

Attachment 3	Sheet No. 1 of 17
Originator: S. W. Clark	Date 4/1/2013
Chk'd By M. W. Perrott	Date 4/1//2013
Calc. No. 0300X-CA-V0172	Rev. No. 0

ATTACHMENT 3

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1RESRAD, Version 6.5      T« Limit = 180 days        03/28/2013  08:54  Page   2
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD
```

Concentration of radionuclides in environmental media
at t = 0.000E+00 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Al-26	2.530E+02	2.530E+02	1.510E-03	0.000E+00	0.000E+00
Cl-36	4.230E+02	4.230E+02	2.525E-03	0.000E+00	0.000E+00
Cm-248	3.990E+01	3.990E+01	2.382E-04	0.000E+00	0.000E+00
Co-60	2.250E-01	2.250E-01	1.343E-06	0.000E+00	0.000E+00
Cs-137	2.500E+01	2.500E+01	1.492E-04	0.000E+00	0.000E+00
Eu-152	4.370E-01	4.370E-01	2.608E-06	0.000E+00	0.000E+00
Gd-152	3.620E+01	3.620E+01	2.161E-04	0.000E+00	0.000E+00
Np-237	3.350E+03	3.350E+03	2.000E-02	0.000E+00	0.000E+00
Pu-240	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-244	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-228	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	3.170E-01	3.170E-01	1.892E-06	0.000E+00	0.000E+00
Th-228	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-229	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-232	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-236	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	3	Sheet No.	2 of 17
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 3

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 3
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in foodstuff media
at t = 0.000E+00 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Al-26	0.000E+00	3.374E+02	3.377E+02	3.378E+02	3.378E+02	7.473E+01	2.902E+01	0.000E+00	0.000E+00
Cl-36	0.000E+00	2.820E+06	2.820E+06	2.820E+06	2.820E+06	1.152E+07	3.106E+06	0.000E+00	0.000E+00
Cm-248	0.000E+00	1.331E+01	1.336E+01	1.337E+01	1.337E+01	4.172E-01	4.137E-02	0.000E+00	0.000E+00
Co-60	0.000E+00	6.000E+00	6.000E+00	6.000E+00	6.000E+00	1.041E+01	8.850E-01	0.000E+00	0.000E+00
Cs-137	0.000E+00	3.333E+02	3.334E+02	3.334E+02	3.334E+02	1.055E+03	2.467E+02	0.000E+00	0.000E+00
Eu-152	0.000E+00	3.643E-01	3.648E-01	3.649E-01	3.649E-01	4.866E-01	1.193E-02	0.000E+00	0.000E+00
Gd-152	0.000E+00	3.018E+01	3.022E+01	3.023E+01	3.023E+01	4.031E+01	3.953E-01	0.000E+00	0.000E+00
Np-237	0.000E+00	2.233E+04	2.234E+04	2.234E+04	2.234E+04	3.194E+03	1.452E+01	0.000E+00	0.000E+00
Pu-240	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-244	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
Ra-228	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
Sr-90	0.000E+00	3.170E+01	3.170E+01	3.170E+01	3.170E+01	1.851E+01	3.804E+00	0.000E+00	0.000E+00
Th-228	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
Th-229	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
Th-232	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
U-233	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
U-236	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 3 Sheet No. 3 of 17
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 3

1RESRAD, Version 6.5 T½ Limit = 180 days 03/28/2013 08:54 Page 4
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in environmental media
at t = 1.000E+00 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Al-26	2.527E+02	2.527E+02	1.508E-03	0.000E+00	0.000E+00
Cl-36	4.227E+02	4.227E+02	2.523E-03	0.000E+00	0.000E+00
Cm-248	3.987E+01	3.987E+01	2.380E-04	0.000E+00	0.000E+00
Co-60	1.972E-01	1.972E-01	1.177E-06	0.000E+00	0.000E+00
Cs-137	2.442E+01	2.442E+01	1.457E-04	0.000E+00	0.000E+00
Eu-152	4.148E-01	4.148E-01	2.476E-06	0.000E+00	0.000E+00
Gd-152	3.620E+01	3.620E+01	2.160E-04	0.000E+00	0.000E+00
Np-237	3.347E+03	3.347E+03	1.998E-02	0.000E+00	0.000E+00
Pu-240	1.626E-11	1.626E-11	9.705E-17	0.000E+00	0.000E+00
Pu-244	3.070E-07	3.070E-07	1.833E-12	0.000E+00	0.000E+00
Ra-228	4.677E-32	4.677E-32	2.792E-37	0.000E+00	0.000E+00
Sr-90	3.092E-01	3.092E-01	1.846E-06	0.000E+00	0.000E+00
Th-228	2.692E-33	2.692E-33	1.607E-38	0.000E+00	0.000E+00
Th-229	6.914E-07	6.914E-07	4.127E-12	0.000E+00	0.000E+00
Th-232	1.979E-30	1.979E-30	1.181E-35	0.000E+00	0.000E+00
U-233	1.464E-02	1.464E-02	8.739E-08	0.000E+00	0.000E+00
U-236	1.604E-19	1.604E-19	9.576E-25	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 3 Sheet No. 4 of 17
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 3

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 5
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in foodstuff media
at t = 1.000E+00 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Al-26	0.000E+00	3.371E+02	3.374E+02	3.375E+02	3.374E+02	7.466E+01	2.898E+01	0.000E+00	0.000E+00
Cl-36	0.000E+00	2.818E+06	2.818E+06	2.818E+06	2.818E+06	1.151E+07	3.104E+06	0.000E+00	0.000E+00
Cm-248	0.000E+00	1.330E+01	1.335E+01	1.336E+01	1.336E+01	4.169E-01	4.134E-02	0.000E+00	0.000E+00
Co-60	0.000E+00	5.258E+00	5.258E+00	5.297E+00	5.261E+00	9.124E+00	7.756E-01	0.000E+00	0.000E+00
Cs-137	0.000E+00	3.256E+02	3.256E+02	3.260E+02	3.256E+02	1.031E+03	2.409E+02	0.000E+00	0.000E+00
Eu-152	0.000E+00	3.458E-01	3.463E-01	3.474E-01	3.464E-01	4.619E-01	1.132E-02	0.000E+00	0.000E+00
Gd-152	0.000E+00	3.017E+01	3.022E+01	3.023E+01	3.023E+01	4.031E+01	3.952E-01	0.000E+00	0.000E+00
Np-237	0.000E+00	2.232E+04	2.232E+04	2.232E+04	2.232E+04	3.192E+03	1.451E+01	0.000E+00	0.000E+00
Pu-240	0.000E+00	5.427E-12	5.446E-12	4.868E-12	5.418E-12	8.480E-13	8.430E-15	0.000E+00	0.000E+00
Pu-244	0.000E+00	1.024E-07	1.028E-07	9.724E-08	1.026E-07	1.535E-08	1.596E-10	0.000E+00	0.000E+00
Ra-228	0.000E+00	5.155E-31	6.157E-31	2.396E-31	3.240E-31	3.451E-32	4.090E-32	0.000E+00	0.000E+00
Sr-90	0.000E+00	3.093E+01	3.093E+01	3.097E+01	3.093E+01	1.806E+01	3.711E+00	0.000E+00	0.000E+00
Th-228	0.000E+00	7.809E-33	1.498E-33	1.061E-32	1.439E-32	8.371E-34	5.113E-35	0.000E+00	0.000E+00
Th-229	0.000E+00	2.627E-07	2.335E-07	3.435E-07	3.713E-07	5.001E-08	3.148E-09	0.000E+00	0.000E+00
Th-232	0.000E+00	7.908E-31	6.738E-31	7.557E-31	9.309E-31	1.510E-31	1.200E-32	0.000E+00	0.000E+00
U-233	0.000E+00	1.548E-02	1.246E-02	2.208E-02	2.271E-02	3.628E-03	5.130E-03	0.000E+00	0.000E+00
U-236	0.000E+00	1.191E-19	1.329E-19	7.455E-20	8.957E-20	2.476E-20	5.071E-20	0.000E+00	0.000E+00

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 3 Sheet No. 5 of 17
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 3

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1RESRAD, Version 6.5      T« Limit = 180 days        03/28/2013  08:54  Page   6
 Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD
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Concentration of radionuclides in environmental media
at t = 3.000E+00 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Al-26	2.522E+02	2.522E+02	1.505E-03	0.000E+00	0.000E+00
Cl-36	4.220E+02	4.220E+02	2.519E-03	0.000E+00	0.000E+00
Cm-248	3.980E+01	3.980E+01	2.376E-04	0.000E+00	0.000E+00
Co-60	1.514E-01	1.514E-01	9.039E-07	0.000E+00	0.000E+00
Cs-137	2.329E+01	2.329E+01	1.390E-04	0.000E+00	0.000E+00
Eu-152	3.737E-01	3.737E-01	2.231E-06	0.000E+00	0.000E+00
Gd-152	3.619E+01	3.619E+01	2.160E-04	0.000E+00	0.000E+00
Np-237	3.342E+03	3.342E+03	1.995E-02	0.000E+00	0.000E+00
Pu-240	1.462E-10	1.462E-10	8.729E-16	0.000E+00	0.000E+00
Pu-244	9.204E-07	9.204E-07	5.494E-12	0.000E+00	0.000E+00
Ra-228	1.092E-29	1.092E-29	6.520E-35	0.000E+00	0.000E+00
Sr-90	2.943E-01	2.943E-01	1.757E-06	0.000E+00	0.000E+00
Th-228	1.722E-30	1.722E-30	1.028E-35	0.000E+00	0.000E+00
Th-229	6.217E-06	6.217E-06	3.711E-11	0.000E+00	0.000E+00
Th-232	1.602E-28	1.602E-28	9.562E-34	0.000E+00	0.000E+00
U-233	4.387E-02	4.387E-02	2.618E-07	0.000E+00	0.000E+00
U-236	4.329E-18	4.329E-18	2.584E-23	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	3	Sheet No.	6 of 17
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 3

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 7
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in foodstuff media
at t = 3.000E+00 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Al-26	0.000E+00	3.363E+02	3.366E+02	3.367E+02	3.367E+02	7.450E+01	2.892E+01	0.000E+00	0.000E+00
Cl-36	0.000E+00	2.813E+06	2.813E+06	2.814E+06	2.814E+06	1.149E+07	3.099E+06	0.000E+00	0.000E+00
Cm-248	0.000E+00	1.328E+01	1.333E+01	1.334E+01	1.334E+01	4.162E-01	4.127E-02	0.000E+00	0.000E+00
Co-60	0.000E+00	4.038E+00	4.039E+00	4.068E+00	4.040E+00	7.007E+00	5.957E-01	0.000E+00	0.000E+00
Cs-137	0.000E+00	3.106E+02	3.106E+02	3.110E+02	3.106E+02	9.831E+02	2.298E+02	0.000E+00	0.000E+00
Eu-152	0.000E+00	3.116E-01	3.120E-01	3.130E-01	3.121E-01	4.162E-01	1.020E-02	0.000E+00	0.000E+00
Gd-152	0.000E+00	3.017E+01	3.021E+01	3.022E+01	3.022E+01	4.030E+01	3.951E-01	0.000E+00	0.000E+00
Np-237	0.000E+00	2.228E+04	2.229E+04	2.229E+04	2.229E+04	3.187E+03	1.448E+01	0.000E+00	0.000E+00
Pu-240	0.000E+00	4.880E-11	4.898E-11	4.723E-11	4.891E-11	7.644E-12	7.582E-14	0.000E+00	0.000E+00
Pu-244	0.000E+00	3.071E-07	3.082E-07	3.027E-07	3.081E-07	4.741E-08	4.776E-10	0.000E+00	0.000E+00
Ra-228	0.000E+00	1.363E-28	1.450E-28	1.068E-28	1.169E-28	1.223E-29	1.186E-29	0.000E+00	0.000E+00
Sr-90	0.000E+00	2.943E+01	2.943E+01	2.947E+01	2.944E+01	1.719E+01	3.532E+00	0.000E+00	0.000E+00
Th-228	0.000E+00	2.409E-30	7.168E-31	5.068E-30	5.553E-30	3.500E-31	1.757E-32	0.000E+00	0.000E+00
Th-229	0.000E+00	2.159E-06	2.088E-06	2.314E-06	2.390E-06	3.607E-07	1.997E-08	0.000E+00	0.000E+00
Th-232	0.000E+00	5.735E-29	5.395E-29	6.032E-29	6.453E-29	9.921E-30	6.059E-31	0.000E+00	0.000E+00
U-233	0.000E+00	3.984E-02	3.686E-02	4.647E-02	4.710E-02	9.159E-03	1.470E-02	0.000E+00	0.000E+00
U-236	0.000E+00	3.473E-18	3.604E-18	3.009E-18	3.179E-18	7.659E-19	1.400E-18	0.000E+00	0.000E+00

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 3 Sheet No. 7 of 17
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 3

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 8
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in environmental media
at t = 1.000E+01 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Al-26	2.503E+02	2.503E+02	1.494E-03	0.000E+00	0.000E+00
Cl-36	4.196E+02	4.196E+02	2.505E-03	0.000E+00	0.000E+00
Cm-248	3.958E+01	3.958E+01	2.363E-04	0.000E+00	0.000E+00
Co-60	6.012E-02	6.012E-02	3.588E-07	0.000E+00	0.000E+00
Cs-137	1.975E+01	1.975E+01	1.179E-04	0.000E+00	0.000E+00
Eu-152	2.595E-01	2.595E-01	1.549E-06	0.000E+00	0.000E+00
Gd-152	3.616E+01	3.616E+01	2.158E-04	0.000E+00	0.000E+00
Np-237	3.323E+03	3.323E+03	1.984E-02	0.000E+00	0.000E+00
Pu-240	1.621E-09	1.621E-09	9.678E-15	0.000E+00	0.000E+00
Pu-244	3.059E-06	3.059E-06	1.826E-11	0.000E+00	0.000E+00
Ra-228	3.945E-27	3.945E-27	2.355E-32	0.000E+00	0.000E+00
Sr-90	2.475E-01	2.475E-01	1.477E-06	0.000E+00	0.000E+00
Th-228	1.572E-27	1.572E-27	9.385E-33	0.000E+00	0.000E+00
Th-229	6.886E-05	6.886E-05	4.110E-10	0.000E+00	0.000E+00
Th-232	1.974E-26	1.974E-26	1.178E-31	0.000E+00	0.000E+00
U-233	1.456E-01	1.456E-01	8.689E-07	0.000E+00	0.000E+00
U-236	1.599E-16	1.599E-16	9.546E-22	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	3	Sheet No.	8 of 17
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 3

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 9
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in foodstuff media
at t = 1.000E+01 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Al-26	0.000E+00	3.338E+02	3.341E+02	3.342E+02	3.342E+02	7.393E+01	2.870E+01	0.000E+00	0.000E+00
Cl-36	0.000E+00	2.798E+06	2.798E+06	2.798E+06	2.798E+06	1.143E+07	3.082E+06	0.000E+00	0.000E+00
Cm-248	0.000E+00	1.321E+01	1.326E+01	1.326E+01	1.326E+01	4.139E-01	4.104E-02	0.000E+00	0.000E+00
Co-60	0.000E+00	1.603E+00	1.603E+00	1.615E+00	1.604E+00	2.782E+00	2.365E-01	0.000E+00	0.000E+00
Cs-137	0.000E+00	2.633E+02	2.633E+02	2.637E+02	2.634E+02	8.335E+02	1.949E+02	0.000E+00	0.000E+00
Eu-152	0.000E+00	2.163E-01	2.167E-01	2.173E-01	2.167E-01	2.890E-01	7.083E-03	0.000E+00	0.000E+00
Gd-152	0.000E+00	3.014E+01	3.019E+01	3.019E+01	3.019E+01	4.026E+01	3.948E-01	0.000E+00	0.000E+00
Np-237	0.000E+00	2.216E+04	2.216E+04	2.216E+04	2.216E+04	3.169E+03	1.440E+01	0.000E+00	0.000E+00
Pu-240	0.000E+00	5.410E-10	5.430E-10	5.373E-10	5.430E-10	8.477E-11	8.406E-13	0.000E+00	0.000E+00
Pu-244	0.000E+00	1.021E-06	1.025E-06	1.019E-06	1.025E-06	1.592E-07	1.586E-09	0.000E+00	0.000E+00
Ra-228	0.000E+00	5.143E-26	5.253E-26	4.763E-26	4.886E-26	5.133E-27	4.656E-27	0.000E+00	0.000E+00
Sr-90	0.000E+00	2.475E+01	2.475E+01	2.478E+01	2.475E+01	1.446E+01	2.970E+00	0.000E+00	0.000E+00
Th-228	0.000E+00	1.217E-27	5.773E-28	2.549E-27	2.617E-27	1.929E-28	9.257E-30	0.000E+00	0.000E+00
Th-229	0.000E+00	2.324E-05	2.308E-05	2.372E-05	2.396E-05	3.712E-06	1.911E-07	0.000E+00	0.000E+00
Th-232	0.000E+00	6.735E-27	6.621E-27	6.925E-27	7.068E-27	1.093E-27	5.829E-29	0.000E+00	0.000E+00
U-233	0.000E+00	1.246E-01	1.218E-01	1.313E-01	1.320E-01	2.841E-02	4.801E-02	0.000E+00	0.000E+00
U-236	0.000E+00	1.318E-16	1.334E-16	1.266E-16	1.286E-16	2.967E-17	5.218E-17	0.000E+00	0.000E+00

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 3 Sheet No. 9 of 17
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 3

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 10
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in environmental media
at t = 3.000E+01 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Al-26	2.449E+02	2.449E+02	1.462E-03	0.000E+00	0.000E+00
Cl-36	4.130E+02	4.130E+02	2.465E-03	0.000E+00	0.000E+00
Cm-248	3.895E+01	3.895E+01	2.325E-04	0.000E+00	0.000E+00
Co-60	4.292E-03	4.292E-03	2.562E-08	0.000E+00	0.000E+00
Cs-137	1.232E+01	1.232E+01	7.355E-05	0.000E+00	0.000E+00
Eu-152	9.150E-02	9.150E-02	5.462E-07	0.000E+00	0.000E+00
Gd-152	3.607E+01	3.607E+01	2.153E-04	0.000E+00	0.000E+00
Np-237	3.271E+03	3.271E+03	1.952E-02	0.000E+00	0.000E+00
Pu-240	1.450E-08	1.450E-08	8.657E-14	0.000E+00	0.000E+00
Pu-244	9.104E-06	9.104E-06	5.434E-11	0.000E+00	0.000E+00
Ra-228	7.003E-25	7.003E-25	4.180E-30	0.000E+00	0.000E+00
Sr-90	1.508E-01	1.508E-01	9.003E-07	0.000E+00	0.000E+00
Th-228	4.818E-25	4.818E-25	2.876E-30	0.000E+00	0.000E+00
Th-229	6.141E-04	6.141E-04	3.665E-09	0.000E+00	0.000E+00
Th-232	1.590E-24	1.590E-24	9.490E-30	0.000E+00	0.000E+00
U-233	4.311E-01	4.311E-01	2.573E-06	0.000E+00	0.000E+00
U-236	4.288E-15	4.288E-15	2.559E-20	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 3 Sheet No. 10 of 17
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 3

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 11
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in foodstuff media
at t = 3.000E+01 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Al-26	0.000E+00	3.266E+02	3.269E+02	3.270E+02	3.270E+02	7.234E+01	2.809E+01	0.000E+00	0.000E+00
Cl-36	0.000E+00	2.753E+06	2.753E+06	2.754E+06	2.753E+06	1.125E+07	3.033E+06	0.000E+00	0.000E+00
Cm-248	0.000E+00	1.300E+01	1.305E+01	1.305E+01	1.305E+01	4.073E-01	4.039E-02	0.000E+00	0.000E+00
Co-60	0.000E+00	1.144E-01	1.145E-01	1.153E-01	1.145E-01	1.986E-01	1.688E-02	0.000E+00	0.000E+00
Cs-137	0.000E+00	1.643E+02	1.643E+02	1.645E+02	1.643E+02	5.201E+02	1.216E+02	0.000E+00	0.000E+00
Eu-152	0.000E+00	7.628E-02	7.639E-02	7.663E-02	7.642E-02	1.019E-01	2.498E-03	0.000E+00	0.000E+00
Gd-152	0.000E+00	3.007E+01	3.011E+01	3.012E+01	3.012E+01	4.017E+01	3.938E-01	0.000E+00	0.000E+00
Np-237	0.000E+00	2.181E+04	2.181E+04	2.181E+04	2.181E+04	3.119E+03	1.418E+01	0.000E+00	0.000E+00
Pu-240	0.000E+00	4.839E-09	4.857E-09	4.842E-09	4.858E-09	7.582E-10	7.519E-12	0.000E+00	0.000E+00
Pu-244	0.000E+00	3.038E-06	3.049E-06	3.045E-06	3.050E-06	4.752E-07	4.720E-09	0.000E+00	0.000E+00
Ra-228	0.000E+00	9.243E-24	9.332E-24	8.962E-24	9.033E-24	9.509E-25	8.466E-25	0.000E+00	0.000E+00
Sr-90	0.000E+00	1.508E+01	1.508E+01	1.511E+01	1.509E+01	8.810E+00	1.810E+00	0.000E+00	0.000E+00
Th-228	0.000E+00	2.853E-25	1.704E-25	5.439E-25	5.483E-25	4.577E-26	2.193E-27	0.000E+00	0.000E+00
Th-229	0.000E+00	2.057E-04	2.057E-04	2.076E-04	2.083E-04	3.243E-05	1.629E-06	0.000E+00	0.000E+00
Th-232	0.000E+00	5.345E-25	5.327E-25	5.416E-25	5.453E-25	8.478E-26	4.313E-27	0.000E+00	0.000E+00
U-233	0.000E+00	3.626E-01	3.602E-01	3.697E-01	3.703E-01	8.246E-02	1.416E-01	0.000E+00	0.000E+00
U-236	0.000E+00	3.561E-15	3.579E-15	3.517E-15	3.536E-15	8.063E-16	1.403E-15	0.000E+00	0.000E+00

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 3 Sheet No. 11 of 17
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 3

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 12
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in environmental media
at t = 1.000E+02 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Al-26	2.269E+02	2.269E+02	1.355E-03	0.000E+00	0.000E+00
Cl-36	3.905E+02	3.905E+02	2.331E-03	0.000E+00	0.000E+00
Cm-248	3.683E+01	3.683E+01	2.199E-04	0.000E+00	0.000E+00
Co-60	4.172E-07	4.172E-07	2.490E-12	0.000E+00	0.000E+00
Cs-137	2.364E+00	2.364E+00	1.411E-05	0.000E+00	0.000E+00
Eu-152	2.382E-03	2.382E-03	1.422E-08	0.000E+00	0.000E+00
Gd-152	3.577E+01	3.577E+01	2.135E-04	0.000E+00	0.000E+00
Np-237	3.093E+03	3.093E+03	1.846E-02	0.000E+00	0.000E+00
Pu-240	1.577E-07	1.577E-07	9.414E-13	0.000E+00	0.000E+00
Pu-244	2.950E-05	2.950E-05	1.761E-10	0.000E+00	0.000E+00
Ra-228	1.420E-22	1.420E-22	8.477E-28	0.000E+00	0.000E+00
Sr-90	2.666E-02	2.666E-02	1.591E-07	0.000E+00	0.000E+00
Th-228	1.268E-22	1.268E-22	7.566E-28	0.000E+00	0.000E+00
Th-229	6.608E-03	6.608E-03	3.944E-08	0.000E+00	0.000E+00
Th-232	1.925E-22	1.925E-22	1.149E-27	0.000E+00	0.000E+00
U-233	1.374E+00	1.374E+00	8.202E-06	0.000E+00	0.000E+00
U-236	1.550E-13	1.550E-13	9.249E-19	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 3 Sheet No. 12 of 17
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 3

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 13
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in foodstuff media
at t = 1.000E+02 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Al-26	0.000E+00	3.027E+02	3.029E+02	3.030E+02	3.030E+02	6.704E+01	2.603E+01	0.000E+00	0.000E+00
Cl-36	0.000E+00	2.603E+06	2.603E+06	2.604E+06	2.604E+06	1.063E+07	2.868E+06	0.000E+00	0.000E+00
Cm-248	0.000E+00	1.229E+01	1.234E+01	1.234E+01	1.234E+01	3.852E-01	3.819E-02	0.000E+00	0.000E+00
Co-60	0.000E+00	1.113E-05	1.113E-05	1.121E-05	1.113E-05	1.930E-05	1.641E-06	0.000E+00	0.000E+00
Cs-137	0.000E+00	3.153E+01	3.153E+01	3.157E+01	3.153E+01	9.979E+01	2.333E+01	0.000E+00	0.000E+00
Eu-152	0.000E+00	1.986E-03	1.989E-03	1.995E-03	1.990E-03	2.653E-03	6.503E-05	0.000E+00	0.000E+00
Gd-152	0.000E+00	2.982E+01	2.986E+01	2.987E+01	2.987E+01	3.983E+01	3.905E-01	0.000E+00	0.000E+00
Np-237	0.000E+00	2.062E+04	2.063E+04	2.063E+04	2.063E+04	2.949E+03	1.341E+01	0.000E+00	0.000E+00
Pu-240	0.000E+00	5.262E-08	5.282E-08	5.278E-08	5.284E-08	8.245E-09	8.176E-11	0.000E+00	0.000E+00
Pu-244	0.000E+00	9.844E-06	9.881E-06	9.880E-06	9.885E-06	1.542E-06	1.530E-08	0.000E+00	0.000E+00
Ra-228	0.000E+00	1.882E-21	1.893E-21	1.853E-21	1.857E-21	1.956E-22	1.731E-22	0.000E+00	0.000E+00
Sr-90	0.000E+00	2.666E+00	2.666E+00	2.669E+00	2.666E+00	1.557E+00	3.199E-01	0.000E+00	0.000E+00
Th-228	0.000E+00	6.766E-23	4.428E-23	1.218E-22	1.220E-22	1.086E-23	5.217E-25	0.000E+00	0.000E+00
Th-229	0.000E+00	2.207E-03	2.213E-03	2.220E-03	2.222E-03	3.465E-04	1.725E-05	0.000E+00	0.000E+00
Th-232	0.000E+00	6.436E-23	6.447E-23	6.481E-23	6.495E-23	1.012E-23	5.058E-25	0.000E+00	0.000E+00
U-233	0.000E+00	1.149E+00	1.148E+00	1.157E+00	1.157E+00	2.609E-01	4.504E-01	0.000E+00	0.000E+00
U-236	0.000E+00	1.290E-13	1.294E-13	1.287E-13	1.289E-13	2.928E-14	5.074E-14	0.000E+00	0.000E+00

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 3 Sheet No. 13 of 17
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 3

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 14
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in environmental media
at t = 3.000E+02 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Al-26	1.826E+02	1.826E+02	1.090E-03	0.000E+00	0.000E+00
Cl-36	3.328E+02	3.328E+02	1.986E-03	0.000E+00	0.000E+00
Cm-248	3.139E+01	3.139E+01	1.874E-04	0.000E+00	0.000E+0D
Co-60	1.434E-18	1.434E-18	8.560E-24	0.000E+00	0.000E+00
Cs-137	2.115E-02	2.115E-02	1.262E-07	0.000E+00	0.000E+00
Eu-152	7.079E-08	7.079E-08	4.226E-13	0.000E+00	0.000E+00
Gd-152	3.492E+01	3.492E+01	2.084E-04	0.000E+00	0.000E+00
Np-237	2.637E+03	2.637E+03	1.574E-02	0.000E+00	0.000E+00
Pu-240	1.336E-06	1.336E-06	7.973E-12	0.000E+00	0.000E+00
Pu-244	8.178E-05	8.178E-05	4.881E-10	0.000E+00	0.000E+00
Ra-228	1.324E-20	1.324E-20	7.900E-26	0.000E+00	0.000E+00
Sr-90	1.885E-04	1.885E-04	1.125E-09	0.000E+00	0.000E+00
Th-228	1.276E-20	1.276E-20	7.616E-26	0.000E+00	0.000E+00
Th-229	5.430E-02	5.430E-02	3.241E-07	0.000E+00	0.000E+00
Th-232	1.474E-20	1.474E-20	8.801E-26	0.000E+00	0.000E+00
U-233	3.628E+00	3.628E+00	2.166E-05	0.000E+00	0.000E+00
U-236	3.902E-12	3.902E-12	2.329E-17	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 3 Sheet No. 14 of 17
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

ATTACHMENT 3

1RESRAD, Version 6.5 T∝ Limit = 180 days 03/28/2013 08:54 Page 15
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in foodstuff media
at t = 3.000E+02 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Al-26	0.000E+00	2.435E+02	2.438E+02	2.438E+02	2.438E+02	5.394E+01	2.094E+01	0.000E+00	0.000E+00
Cl-36	0.000E+00	2.219E+06	2.219E+06	2.219E+06	2.219E+06	9.063E+06	2.444E+06	0.000E+00	0.000E+00
Cm-248	0.000E+00	1.047E+01	1.051E+01	1.052E+01	1.052E+01	3.282E-01	3.255E-02	0.000E+00	0.000E+00
Co-60	0.000E+00	3.824E-17	3.825E-17	3.853E-17	3.826E-17	6.636E-17	5.641E-18	0.000E+00	0.000E+00
Cs-137	0.000E+00	2.820E-01	2.820E-01	2.824E-01	2.820E-01	8.925E-01	2.087E-01	0.000E+00	0.000E+00
Eu-152	0.000E+00	5.902E-08	5.910E-08	5.928E-08	5.912E-08	7.883E-08	1.932E-09	0.000E+00	0.000E+00
Gd-152	0.000E+00	2.911E+01	2.916E+01	2.916E+01	2.916E+01	3.889E+01	3.813E-01	0.000E+00	0.000E+00
Np-237	0.000E+00	1.758E+04	1.758E+04	1.759E+04	1.759E+04	2.515E+03	1.143E+01	0.000E+00	0.000E+00
Pu-240	0.000E+00	4.457E-07	4.473E-07	4.474E-07	4.475E-07	6.983E-08	6.925E-10	0.000E+00	0.000E+00
Pu-244	0.000E+00	2.729E-05	2.739E-05	2.740E-05	2.740E-05	4.275E-06	4.240E-08	0.000E+00	0.000E+00
Ra-228	0.000E+00	1.756E-19	1.764E-19	1.736E-19	1.737E-19	1.830E-20	1.616E-20	0.000E+00	0.000E+00
Sr-90	0.000E+00	1.885E-02	1.885E-02	1.887E-02	1.885E-02	1.101E-02	2.262E-03	0.000E+00	0.000E+00
Th-228	0.000E+00	6.623E-21	4.443E-21	1.171E-20	1.172E-20	1.064E-21	5.111E-23	0.000E+00	0.000E+00
Th-229	0.000E+00	1.813E-02	1.819E-02	1.821E-02	1.822E-02	2.842E-03	1.411E-04	0.000E+00	0.000E+00
Th-232	0.000E+00	4.923E-21	4.938E-21	4.948E-21	4.952E-21	7.724E-22	3.840E-23	0.000E+00	0.000E+00
U-233	0.000E+00	3.027E+00	3.029E+00	3.038E+00	3.038E+00	6.875E-01	1.189E+00	0.000E+00	0.000E+00
U-236	0.000E+00	3.252E-12	3.258E-12	3.253E-12	3.255E-12	7.383E-13	1.278E-12	0.000E+00	0.000E+00

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	3	Sheet No.	15 of 17
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 3

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 16
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in environmental media
at t = 1.000E+03 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Al-26	8.533E+01	8.533E+01	5.093E-04	0.000E+00	0.000E+00
Cl-36	1.901E+02	1.901E+02	1.135E-03	0.000E+00	0.000E+00
Cm-248	1.794E+01	1.794E+01	1.071E-04	0.000E+00	0.000E+00
Co-60	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	1.431E-09	1.431E-09	8.540E-15	0.000E+00	0.000E+00
Eu-152	1.013E-23	1.013E-23	6.045E-29	0.000E+00	0.000E+00
Gd-152	3.211E+01	3.211E+01	1.917E-04	0.000E+00	0.000E+00
Np-237	1.509E+03	1.509E+03	9.006E-03	0.000E+00	0.000E+00
Pu-240	1.211E-05	1.211E-05	7.228E-11	0.000E+00	0.000E+00
Pu-244	2.101E-04	2.101E-04	1.254E-09	0.000E+00	0.000E+00
Ra-228	1.456E-18	1.456E-18	8.689E-24	0.000E+00	0.000E+00
Sr-90	5.601E-12	5.601E-12	3.343E-17	0.000E+00	0.000E+00
Th-228	1.441E-18	1.441E-18	8.599E-24	0.000E+00	0.000E+00
Th-229	4.418E-01	4.418E-01	2.637E-06	0.000E+00	0.000E+00
Th-232	1.505E-18	1.505E-18	8.985E-24	0.000E+00	0.000E+00
U-233	7.753E+00	7.753E+00	4.628E-05	0.000E+00	0.000E+00
U-236	1.139E-10	1.139E-10	6.801E-16	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	3	Sheet No.	16 of 17
Originator:	S. W. Clark	Date	4/1/2013
Chk'd By	M. W. Perrott	Date	4/1//2013
Calc. No.	0300X-CA-V0172	Rev. No.	0

ATTACHMENT 3

1RESRAD, Version 6.5 T« Limit = 180 days 03/28/2013 08:54 Page 17
Concent : 300-257 RESRAD Evaluation of Radionuclide and Nonradionuclide Groundwater Protection
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\300-257_GROUNDWATER_RAD_NONRAD.RAD

Concentration of radionuclides in foodstuff media
at t = 1.000E+03 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Al-26	0.000E+00	1.138E+02	1.139E+02	1.139E+02	1.139E+02	2.521E+01	9.786E+00	0.000E+00	0.000E+00
Cl-36	0.000E+00	1.268E+06	1.268E+06	1.268E+06	1.268E+06	5.178E+06	1.396E+06	0.000E+00	0.000E+00
Cm-248	0.000E+00	5.986E+00	6.008E+00	6.012E+00	6.011E+00	1.876E-01	1.860E-02	0.000E+00	0.000E+00
Co-60	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
Cs-137	0.000E+00	1.908E-08	1.908E-08	1.911E-08	1.908E-08	6.039E-08	1.412E-08	0.000E+00	0.000E+00
Eu-152	0.000E+00	8.443E-24	8.455E-24	8.481E-24	8.458E-24	1.128E-23	2.764E-25	0.000E+00	0.000E+00
Gd-152	0.000E+00	2.677E+01	2.681E+01	2.681E+01	2.681E+01	3.576E+01	3.506E-01	0.000E+00	0.000E+00
Np-237	0.000E+00	1.006E+04	1.006E+04	1.006E+04	1.006E+04	1.439E+03	6.539E+00	0.000E+00	0.000E+00
Pu-240	0.000E+00	4.040E-06	4.055E-06	4.057E-06	4.057E-06	6.330E-07	6.278E-09	0.000E+00	0.000E+00
Pu-244	0.000E+00	7.009E-05	7.035E-05	7.038E-05	7.038E-05	1.098E-05	1.089E-07	0.000E+00	0.000E+00
Ra-228	0.000E+00	1.932E-17	1.941E-17	1.912E-17	1.912E-17	2.015E-18	1.779E-18	0.000E+00	0.000E+00
Sr-90	0.000E+00	5.601E-10	5.601E-10	5.609E-10	5.602E-10	3.272E-10	6.722E-11	0.000E+00	0.000E+00
Th-228	0.000E+00	7.410E-19	5.012E-19	1.302E-18	1.302E-18	1.190E-19	5.720E-21	0.000E+00	0.000E+00
Th-229	0.000E+00	1.474E-01	1.480E-01	1.481E-01	1.481E-01	2.310E-02	1.146E-03	0.000E+00	0.000E+00
Th-232	0.000E+00	5.024E-19	5.041E-19	5.046E-19	5.047E-19	7.874E-20	3.907E-21	0.000E+00	0.000E+00
U-233	0.000E+00	6.465E+00	6.473E+00	6.479E+00	6.479E+00	1.468E+00	2.540E+00	0.000E+00	0.000E+00
U-236	0.000E+00	9.498E-11	9.513E-11	9.510E-11	9.512E-11	2.157E-11	3.732E-11	0.000E+00	0.000E+00

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 3 Sheet No. 17 of 17
Originator: S. W. Clark Date 4/1/2013
Chk'd By M. W. Perrott Date 4/1//2013
Calc. No. 0300X-CA-V0172 Rev. No. 0

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 300 Area Field Remediation **Job No. 14655**

Area: 300 Area Remaining Site

Discipline: Environmental Calculation No: 0300X-CA-V0174

Subject: 300-257 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculation

Computer Program: Excel Program No: Excel 2003

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Summary = 7 Attachment 1 = 6 Total = 14	N. K. Schiffern N K. Schiffern	J. D. Sloglie	I. B. Berezovskiy I B Berezovskiy	T. Q. Howell T Q Howell	7/10/13

SUMMARY OF REVISION

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

DE01-437.03

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern	Date:	5/6/2013	Calc. No.:	0300X-CA-V0174	Rev.:	0
Project:	300 Area Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	5/6/2013
Subject:	300-257 Waste Site RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 1 of 7	

PURPOSE:

Provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 300-257 waste site. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009), the following criteria must be met:

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

Also, calculate the relative percent difference (RPD) for primary-duplicate sample pairs from 300-257 waste site verification sampling, as necessary.

GIVEN/REFERENCES:

1) DOE-RL, 2009, *Remedial Design Report/Remedial Action Work Plan for the 300 Area,* DOE/RL-2001-47, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

2) DOE-RL, 2011, *300 Area Remedial Action Sampling and Analysis Plan,* DOE/RL-2001-48, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

3) EPA, 1994, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, U.S. Environmental Protection Agency, Washington, D.C.

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

5) WCH, 2013, *Remaining Sites Verification Package for the 300-257, 309 Process Sewer to River*, Attachment to Waste Site Reclassification Form 2013-033, Washington Closure Hanford, Inc., Richland, Washington.

SOLUTION:

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

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

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

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

5) Use data from Attachment 1 to perform the RPD calculations for primary-duplicate sample pairs, as required.

METHODOLOGY:

The 300-257 waste site underwent focused sampling at four locations for the purpose of verification sampling. One duplicate and one split sample were collected. The direct contact hazard quotient and carcinogenic risk calculations for the 300-257 waste site were conservatively calculated for the entire waste site using the greatest of the maximum soil sample results from Attachment 1. Of the contaminants of potential concern (COPCs) for this site, boron, molybdenum, aroclor-1254, cyanide, detected semivolatile organics(SVOCs), and detected polycyclic aromatic hydrocarbons (PAHs) require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. Cadmium, chromium, copper, nickel, silver, and zinc require HQ and risk calculations because these analyte were detected above a Washington State or Hanford Site background value. Arsenic was detected at/above background; however, arsenic cleanup level is not toxicity based, and therefore HQ and risk calculations for arsenic are not performed. Lead was detected above background; however, lead does not have a reference dose for calculation of a hazard quotient because toxic effects of lead are correlated with blood-lead levels rather than exposure levels or daily intake. All other site nonradionuclide COPCs were not detected or were quantified below background levels. Although total petroleum hydrocarbons (diesel range EXT) were detected and no background value is available, the risk associated with total petroleum hydrocarbons do not contribute to the cumulative toxicity calculation. Due to an exceedance of the residential carcinogenic risk criteria for lead, and multiple PAHs, the entire data set was evaluated against the industrial HQ and risk standards. An example of the HQ and risk calculations is presented below: An example of the HQ and risk calculations is presented below:

1) For example, the maximum value for boron is 4.0 mg/kg, divided by the noncarcinogenic RAG value of 700,000 mg/kg (calculated in accordance with the noncarcinogenic toxics effects formula in WAC 173-340-740[3]), is 5.7×10^{-6}. Comparing this value, and all other individual values, to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation. The sum of the HQ values is 1.1×10^{-2}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum value is divided by the carcinogenic RAG value, then multiplied by 1.0×10^{-6}. For example, the maximum value for cadmium is 1.8 mg/kg; divided

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by 139 mg/kg, and multiplied as indicated, is 1.3×10^{-8}. Comparing this value to the requirement of $<1 \times 10^{-6}$, this criterion is met.

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk is obtained by summing the individual values. The excess cancer risk for the carcinogenic constituents detected is 8.6×10^{-8}. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

5) The RPD is calculated when both the primary value and the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method and is listed for certain analytes in Table II-1 of the SAP (DOE-RL 2011). Other analytes will have their own pre-determined constituents and will have their own TDLs based on the laboratory and method used. Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

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

where, M = main sample value D = duplicate sample value

When an analyte is detected in the primary or duplicate sample, but was quantified at less than 5 times the TDL in one or both samples, an additional parameter is evaluated. In this case, if the difference between the primary and duplicate results exceeds a control limit of 2 times the TDL, further assessment regarding the usability of the data is performed. This assessment is provided in the data quality assessment section of the RSVP (WCH 2013).

For quality assurance/quality control (QA/QC) duplicate RPD calculations, a value less than 30% indicates the data compare favorably. For regulatory splits, a threshold of 35% is used (EPA 1994). If the RPD is greater than 30% (or 35% for regulatory split data), further investigation regarding the usability of the data is performed. No split samples were collected for the confirmatory sampling of the subject site. Additional discussion is provided in the data quality assessment section of the applicable RSVP (WCH 2013), as necessary.

RESULTS:

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

Table 1 shows the results of the residential direct contact calculations.

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5) The evaluation of the QA/QC duplicate RPD calculations are performed within the data quality assessment section of the RSVP.

Table 2 shows the results of the RPD calculations for the 300-257 waste site.

Table 1. Residential Direct Contact HQ and Excess Cancer Risk Results for the 300-257 Waste Site. (2 Pages)

Contaminants of Potential Concern	Maximum Value[a] (mg/kg)	Industrial Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Industrial Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Metals					
Arsenic[c]	10.3	1050	--	58	--
Boron	4.0	700,000	5.7E-06	--	--
Cadmium[d]	1.8	3,500	5.1E-04	139	1.3E-08
Chromium, total	36.7	5,250,000	7.0E-06	--	--
Copper	253	130,000	1.9E-03	--	--
Lead[e]	423	1,000	--	--	--
Molybdenum	48.2	17,500	2.8E-03	--	--
Nickel	47.9	70,000	6.8E-04	--	--
Silver	6.9	17,500	3.9E-04	--	--
Zinc	3350	1,050,000	3.2E-03	--	--
Semivolatiles					
Bis(2-ethylhexyl) phthalate	0.57	70,000	8.1E-06	9,380	6.1E-11
Carbazole	0.051	--	--	6,560	7.8E-12
Anions					
Cyanide	0.19	70,000	2.7E-06	--	--
Total Petroleum Hydrocarbons					
TPH - Diesel range EXT[f]	130	200	--	--	--
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	0.42	210,000	2.0E-06	--	--
Anthracene	0.40	1,050,000	3.8E-07	--	--
Benzo(a)anthracene	1.4	--	--	180	7.8E-09
Benzo(a)pyrene	0.90	--	--	18	5.0E-08
Benzo(b)fluoranthene	1.3	--	--	180	7.2E-09
Benzo(ghi)perylene[g]	0.69	105,000	6.6E-06	--	--
Benzo(k)fluoranthene	0.50	--	--	180	2.8E-09
Chrysene	1.5	--	--	1,800	8.3E-10
Dibenz(a,h)anthracene	0.059	--	--	180	3.3E-10
Fluoranthene	2.6	140,000	1.9E-05	--	--
Fluorene	0.31	140,000	2.2E-06	--	--
Indeno(1,2,3-cd)pyrene	0.35	--	--	180	1.9E-09
Phenanthrene[g]	1.6	1,050,000	1.5E-06	--	--
Pyrene	2.1	105,000	2.0E-05	--	--

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Table 1. Residential Direct Contact HQ and Excess Cancer Risk Results for the 300-257 Waste Site. (2 Pages)

Contaminants of Potential Concern	Maximum Value[a] (mg/kg)	Industrial Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Industrial Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Polychlorinated Biphenyls					
Aroclor-1254	0.12	70	1.7E-03	65.6	1.8E-09
Totals					
Cumulative Hazard Quotient:			**1.1E-02**		
Cumulative Excess Cancer Risk:					**8.6E-08**

Notes:

[a] = From Attachment 1

[b] = Value obtained from the RDR/RAWP (DOE-RL 2001-47) or *Washington Administrative Code* (WAC) 173-340-740(3), Method B, 1996, unless otherwise noted.

[c] = The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement Project Managers as discussed in Section 2.1.2.1 of the RDR/RAWP (DOE-RL 2009a).

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

[e] = Lead does not have a reference dose for calculation of a hazard quotient because toxic effects of lead are correlated with blood-lead levels rather than exposure levels or daily intake.

[f] = The risk associated with total petroleum hydrocarbons do not contribute to the cumulative toxicity calculation.

[g] = Toxicity data for these chemicals are not available. The cleanup levels are based on use of surrogate chemicals.

benzo(g,h,i)perylene surrogate: pyrene phenanthrene surrogate: anthracene

-- = not applicable RAG = remedial action goal

Table 2. Relative Percent Difference Calculations for the 300-257 Waste Site. (3 pages)

300-257 Waste Site Duplicate/Split Analysis

Sampling Area	HEIS Number	Sample Date	Cesium-137			Gross beta			Potassium-40			Radium-226			Total beta radiostrontium		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
FS-4 Floor	J1RF86	2/19/2013	19.1		0.0487	39.2		2.34	15.7		0.280	0.448		0.0962	0.317		0.125
Duplicate of J1RF86	J1RF89	2/19/2013	17.4		0.0401	38.9		2.23	14.6		0.249	0.581		0.0751	0.138		0.118
Split of J1RF86	J1RF91	2/19/2013	21.5		0.166	50.7		2.39	14.6		0.974	2.54	U	2.54	0.201	U	0.201

Analysis:

TDL		0.1	15	0.5	0.1	1
Duplicate Analysis	Both > POL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD	9.3%		7.3%		
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	No - acceptable	No - acceptable
Split Analysis	Both > POL?	Yes (continue)	Yes (continue)	Yes (continue)		
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)		
	RPD	11.8%		7.3%		
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable		

300-257 Waste Site Duplicate/Split Analysis

Sampling Area	HEIS Number	Sample Date	Aluminum			Arsenic			Barium			Beryllium			Boron		
			mg/kg	Q	POL	mg/kg	Q	POL	mg/kg	Q	POL	mg/kg	Q	POL	mg/kg	Q	POL
FS-4 Floor	J1RF86	2/19/2013	5860		1.7	3.0	M	0.73	60.2		0.084	0.36		0.036	4.0		1.1
Duplicate of J1RF86	J1RF89	2/19/2013	5690		1.6	3.7		0.69	57.2		0.079	0.33		0.034	3.7		1.0
Split of J1RF86	J1RF91	2/19/2013	5770		167	3.8	U	3.8	70.1	N	3.0	2.0	U	2.0	17.9	U	17.9

Analysis:

TDL		5	10	2	0.5	2
Duplicate Analysis	Both > POL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD	2.9%		5.1%		
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	No - acceptable	No - acceptable
Split Analysis	Both > POL?	Yes (continue)		Yes (continue)		
	Both >5xTDL?	Yes (calc RPD)		Yes (calc RPD)		
	RPD	1.5%		15.2%		
	Difference > 2 TDL?	Not applicable		Not applicable		

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Table 2. Relative Percent Difference Calculations for the 300-257 Waste Site. (3 pages)

300-257 Waste Site Duplicate/Split Analysis

Sampling Area	HEIS Number	Sample Date	Cadmium			Calcium			Chromium			Cobalt			Copper		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-4 Floor	J1RF86	2/19/2013	0.25		0.045	4730	X	15.5	15.0	M	0.064	7.0	X	0.11	41.2		0.24
Duplicate of J1RF86	J1RF89	2/19/2013	0.20	B	0.043	4730	X	14.7	15.8		0.060	7.5	X	0.10	47.0		0.23
Split of J1RF86	J1RF91	2/19/2013	1.2	U	1.2	5960		159	14.4	N	3.7	11.2	U	11.2	45.9		8.7

Analysis:

TDL		0.1	100	1	2	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)
	RPD		0.0%	5.2%		13.2%
	Difference > 2 TDL?	No - acceptable	Not applicable	Not applicable	No - acceptable	Not applicable
Split Analysis	Both > PQL?		Yes (continue)	Yes (continue)		Yes (continue)
	Both >5xTDL?		Yes (calc RPD)	Yes (calc RPD)		Yes (calc RPD)
	RPD		23.0%	4.1%		10.8%
	Difference > 2 TDL?		Not applicable	Not applicable		Not applicable

300-257 Waste Site Duplicate/Split Analysis

Sampling Area	HEIS Number	Sample Date	Iron			Lead			Lithium			Magnesium			Manganese		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-4 Floor	J1RF86	2/19/2013	24800		4.2	423	X	0.30	6.3		0.33	3450		4.1	286		0.11
Duplicate of J1RF86	J1RF89	2/19/2013	33000		4.0	402	X	0.28	6.0		0.31	3370		3.9	316		0.10
Split of J1RF86	J1RF91	2/19/2013	24200	N	35.4	538	N	2.0	7.8	U	7.8	4190	N	99	304	N	1.8

Analysis:

TDL		5	5	2.5	75	5
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD	28.4%	5.1%		2.3%	10.0%
	Difference > 2 TDL?	Not applicable	Not applicable	No - acceptable	Not applicable	Not applicable
Split Analysis	Both > PQL?	Yes (continue)	Yes (continue)		Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	Yes (calc RPD)		Yes (calc RPD)	Yes (calc RPD)
	RPD	2.4%	23.9%		19.4%	6.1%
	Difference > 2 TDL?	Not applicable	Not applicable		Not applicable	Not applicable

300-257 Waste Site Duplicate/Split Analysis

Sampling Area	HEIS Number	Sample Date	Mercury			Molybdenum			Nickel			Potassium			Silicon		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-4 Floor	J1RF86	2/19/2013	0.025	M	0.0072	0.42	B	0.29	10.1	X	0.14	1250		45.1	262		6.2
Duplicate of J1RF86	J1RF89	2/19/2013	0.020	B	0.0074	0.69	B	0.27	12.3	X	0.13	1220		42.7	213		5.9
Split of J1RF86	J1RF91	2/19/2013	0.035	B	0.013	3.8	U	3.8	14.5	B	2.7	4020	U	4020	1980	N	18.5

Analysis:

TDL		0.02	2	4	400	2
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)
	RPD					20.6%
	Difference > 2 TDL?	No - acceptable	No - acceptable	No - acceptable	No - acceptable	Not applicable
Split Analysis	Both > PQL?	Yes (continue)		Yes (continue)		Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)		No-Stop (acceptable)		Yes (calc RPD)
	RPD					153.3%
	Difference > 2 TDL?	No - acceptable		No - acceptable		Not applicable

300-257 Waste Site Duplicate/Split Analysis

Sampling Area	HEIS Number	Sample Date	Sodium			Uranium			Uranium (KPA)			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-4 Floor	J1RF86	2/19/2013	343		64.9	0.79		0.0018	1.28		0.139	40.9		0.10	110	X	0.44
Duplicate of J1RF86	J1RF89	2/19/2013	315		61.4	1.2		0.0019	1.31		0.138	38.4		0.098	102	X	0.41
Split of J1RF86	J1RF91	2/19/2013	561	UN	561	2.8	N	0.12				33.3	B	15	126	N	23.6

Analysis:

TDL		50	1	1	2.5	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD	8.5%			6.3%	7.5%
	Difference > 2 TDL?	Not applicable	No - acceptable	No - acceptable	Not applicable	Not applicable
Split Analysis	Both > PQL?		Yes (continue)		Yes (continue)	Yes (continue)
	Both >5xTDL?		No-Stop (acceptable)		Yes (calc RPD)	Yes (calc RPD)
	RPD				20.5%	13.6%
	Difference > 2 TDL?		Yes - assess further		Not applicable	Not applicable

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Table 2. Relative Percent Difference Calculations for the 300-257 Waste Site. (3 pages)

300-257 Waste Site Duplicate/Split Analysis

Sampling Area	HEIS Number	Sample Date	Zirconium mg/kg	Q	PQL
FS-4 Floor	J1RF86	2/19/2013	10.9		0.39
Duplicate of J1RF86	J1RF89	2/19/2013	9.3		0.37
Split of J1RF86	J1RF91	2/19/2013	12.6	N	1.3

Analysis:

TDL		2.5
Duplicate Analysis	Both > PQL?	**Yes (continue)**
	Both >5xTDL?	No-Stop (acceptable)
	RPD	
	Difference > 2 TDL?	No - acceptable
Split Analysis	Both > PQL?	**Yes (continue)**
	Both >5xTDL?	No-Stop (acceptable)
	RPD	
	Difference > 2 TDL?	No - acceptable

CONCLUSION:

The calculations in Tables 1 and 2 demonstrate that the 300-257 waste site meets the requirements for the industrial direct contact hazard quotients and carcinogenic (excess cancer) risk and RPDs, respectively, as identified in the RDR/RAWP (DOE-RL 2009). The hazard quotients and carcinogenic (excess cancer) risk and RPD calculations are for use in the RSVP for this site.

Attachment 1. 300-257 Waste Site Verification Sample Results (Radionuclides).

Sample Location	HEIS Number	Sample Date	Americium-241			Americium-241 (AEA)			Antimony-125			Bismuth-214			Carbon-14			Cerium-144		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
FS-4 Floor	J1RF86	2/19/2013	0.279	U	0.238				0.0174	U	0.214							-0.158	U	0.346
Duplicate of J1RF86	J1RF89	2/19/2013	0.196	U	0.310				0.115	U	0.153							0.0230	U	0.230
FS-2 S	J1RH84	3/7/2013	0.00364	UJ	0.0273	-0.0284	U	0.589	0.00220	U	0.0457				0.308	UJ	0.922	-0.00705	U	0.0830
FS-4 Pipe W	J1RF87	2/19/2013	0.0667	U	0.217				0.0675	U	0.195							-0.0615	U	0.311
FS-4 Pipe E	J1RF88	2/19/2013	0.00994	U	0.122				-0.131	U	0.269							-0.173	U	0.387
Split of J1RF86	J1RF91	2/19/2013	0.211	U	0.211				0.444	U	0.444	0.404		0.240				0.655	U	0.655

Sample Location	HEIS Number	Sample Date	Cesium-134			Cesium-137			Cobalt-60			Curium-242			Curium-244			Europium-152		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
FS-4 Floor	J1RF86	2/19/2013	0.0408	U	0.0402	19.1		0.0487	0.225		0.0317							-0.255	U	0.195
Duplicate of J1RF86	J1RF89	2/19/2013	0.0214	U	0.0342	17.4		0.0401	0.0156	U	0.0349							0.105	U	0.142
FS-2 S	J1RH84	3/7/2013	0.0184	U	0.0261	0.0590		0.0212	0.0178	U	0.0281	-0.00513	UJ	0.467	-0.0142	UJ	0.512	0.00479	U	0.0472
FS-4 Pipe W	J1RF87	2/19/2013	0.0440	U	0.0832	2.20		0.0762	0.0751	U	0.104							0.437		0.199
FS-4 Pipe E	J1RF88	2/19/2013	0.0110	U	0.0469	25.0		0.0614	0.0326	U	0.0509							-0.0326	U	0.246
Split of J1RF86	J1RF91	2/19/2013	0.136	U	0.136	21.5		0.166	0.0970	U	0.0970							0.428	U	0.428

Sample Location	HEIS Number	Sample Date	Europium-154			Europium-155			Gross alpha			Gross beta			Lead-212			Nickel-63		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
FS-4 Floor	J1RF86	2/19/2013	-0.0292	U	0.0979	-0.0327	U	0.173	1.67	U	6.96	39.2		2.34						
Duplicate of J1RF86	J1RF89	2/19/2013	-0.0211	U	0.0959	0.0119	U	0.122	1.01	U	6.45	38.9		2.23						
FS-2 S	J1RH84	3/7/2013	0.0261	U	0.0844	0.0202	U	0.0408	-0.838	U	6.58	7.38		2.29				-1.53	U	12.5
FS-4 Pipe W	J1RF87	2/19/2013	-0.0573	U	0.205	-0.0365	U	0.162	4.40	U	6.53	24.7		2.35						
FS-4 Pipe E	J1RF88	2/19/2013	0.0365	U	0.141	-0.134	U	0.183	5.79	U	6.88	44.6		2.56						
Split of J1RF86	J1RF91	2/19/2013	0.627	U	0.627	0.299	U	0.299	16.0		3.28	50.7		2.39	0.426		0.279			

Sample Location	HEIS Number	Sample Date	Niobium-94			Plutonium-238 (AEA)			Plutonium-239/240 (AEA)			Plutonium-241			Potassium-40			Radium-226		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
FS-4 Floor	J1RF86	2/19/2013													15.7		0.280	0.448		0.0962
Duplicate of J1RF86	J1RF89	2/19/2013													14.6		0.249	0.581		0.0751
FS-2 S	J1RH84	3/7/2013				-0.00323	UJ	0.0672	-0.00808	U	0.0850	-0.305	UJ	1.30	13.0		0.191	0.319		0.0378
FS-4 Pipe W	J1RF87	2/19/2013													9.11		0.651	0.290	U	0.207
FS-4 Pipe E	J1RF88	2/19/2013													14.1		0.340	0.523	U	0.175
Split of J1RF86	J1RF91	2/19/2013	0.0614	U	0.0614										14.6		0.974	2.54	U	2.54

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

Gray cells indicate not applicable.

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

AEA = alpha energy analysis

B = blank contamination (organic constituents) = Estimated (inorganic)

BJ = estimated, analyte concentration was greater than IDL but less than CRDL.

C = detected in both the sample and QC blank, sample concentration <= 5X blank concentration.

HEIS=Hanford Environmental Information System

J = estimated

KPA = kinetic phosphorescence analyzer

M = sample duplicate precision not met.

N = recovery exceeds upper and lower control limits.

MDA = minimum detectable activity

PQL = practical quantitation limit

Q = qualifier

U = undetected

Attachment	1	Sheet No.	1 of 6
Originator	N. K. Schiffern	Date	5/7/13
Checked	J. D. Skoglie	Date	5/7/13
Calc. No.	0300X-CA-V0174	Rev. No.	0

Attachment 1. 300-257 Waste Site Verification Sample Results (Radionuclides).

Sample Location	HEIS Number	Sample Date	Radium-228			Ruthenium-106			Technetium-99			Total beta radiostrontium			Tritium			Uranium-234 (AEA)		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
FS-4 Floor	J1RF86	2/19/2013	0.626	U	0.212	-0.0689	U	0.446				0.317		0.125						
Duplicate of J1RF86	J1RF89	2/19/2013	0.497		0.106	0.138	U	0.356				0.138		0.118						
FS-2 S	J1RH84	3/7/2013	0.462		0.0777	0.00893	U	0.181	0.439	U	0.611	0.0864	U	0.129	0.0205	UJ	0.0653	0.350		0.0729
FS-4 Pipe W	J1RF87	2/19/2013	0.342	U	0.349	-0.197	U	0.612				0.148		0.108						
FS-4 Pipe E	J1RF88	2/19/2013	0.486	U	0.255	-0.113	U	0.591				0.160		0.112						
Split of J1RF86	J1RF91	2/19/2013	0.379		0.273	1.01	U	1.01				0.201	U	0.201						

Sample Location	HEIS Number	Sample Date	Uranium-235 (AEA)			Uranium-235			Uranium-238			Uranium-238 (AEA)			Zinc-65		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
FS-4 Floor	J1RF86	2/19/2013				-0.0323	U	0.341	-2.47	U	1.43				-0.0452	U	0.0767
Duplicate of J1RF86	J1RF89	2/19/2013				0.0106	U	0.229	-0.464	U	1.67				-0.0403	U	0.0692
FS-2 S	J1RH84	3/7/2013	0.0136	UJ	0.0497	0.0314	U	0.0862	0.247		0.206	0.284		0.0654	0.00799	U	0.0541
FS-4 Pipe W	J1RF87	2/19/2013				-0.0886	U	0.328	-0.540	U	1.42				-0.110	U	0.185
FS-4 Pipe E	J1RF88	2/19/2013				0.0426	U	0.402	0.0389	U	0.896				-0.126	U	0.102
Split of J1RF86	J1RF91	2/19/2013				0.669	U	0.669	1.63	U	1.63				0.239	U	0.239

Attachment 1. 300-257 Waste Site Verification Sample Results (Radionuclides). Informational Purposes only

Sample Location	HEIS Number	Sample Date	Americium-241			Antimony-125			Cerium-144			Cesium-134			Cesium-137			Cobalt-60		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
FS-1	J1RF82	2/20/2013	0.870	U	3.75	-5.09	U	11.8	-0.776	U	14.5	2.02	U	5.85	12.7		5.93	0.664	U	6.91
FS-3 Floor	J1RF83	2/19/2013	-1.24	U	7.31	1.23	U	18.6	-5.47	U	32.6	5.49	U	9.87	-4.03	U	8.61	-0.820	U	9.99
FS-3 Pipe W	J1RF84	2/19/2013	2.79	U	4.57	2.02	U	13.8	-1.78	U	14.6	0.0502	U	5.56	1.88	U	6.58	-2.41	U	5.54
FS-3 Pipe N	J1RF85	2/19/2013	-15.5	U	41.9	4.23	U	20.9	0.206	U	38.9	-6.80	U	8.45	3.44	U	9.35	5.24	U	11.3

Sample Location	HEIS Number	Sample Date	Europium-152			Europium-154			Europium-155			Gross alpha			Gross beta			Potassium-40		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
FS-1	J1RF82	2/20/2013	-2.24	U	11.3	-3.65	U	13.8	1.19	U	6.92	10.0		3.24	31.9		6.03	-4.36	U	101
FS-3 Floor	J1RF83	2/19/2013	6.11	U	22.6	9.39	U	29.6	5.64	U	15.3	0.578	U	3.02	3.71	U	6.50	-203	U	228
FS-3 Pipe W	J1RF84	2/19/2013	-2.86	U	13.5	1.50	U	18.2	-0.878	U	6.97	2.96		2.24	6.84		6.00	6.07	U	117
FS-3 Pipe N	J1RF85	2/19/2013	1.80	U	22.3	-8.07	U	26.4	-2.77	U	18.0	-0.593	U	2.82	-2.99	U	6.59	-176	U	364

Sample Location	HEIS Number	Sample Date	Radium-226			Radium-228			Ruthenium-106			Total beta radiostrontium			Uranium-235			Uranium-238		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
FS-1	J1RF82	2/20/2013	-1.38	U	12.9	4.86	U	23.6	6.96	U	49.8	-0.140	U	2.48	-2.47	U	15.7	-12.1	U	30.4
FS-3 Floor	J1RF83	2/19/2013	-0.547	U	22.3	-3.83	U	39.8	13.8	U	76.5	0.471	U	2.26	-3.72	U	32.7	-7.67	U	58.0
FS-3 Pipe W	J1RF84	2/19/2013	-0.733	U	14.1	7.68	U	27.2	23.5	U	57.7	-0.393	U	2.68	-1.94	U	17.4	-5.80	U	32.6
FS-3 Pipe N	J1RF85	2/19/2013	-4.51	U	23.5	-10.1	U	48.1	-0.0581	U	69.6	0.840	U	2.49	3.98	U	39.4	-40.4	U	241

Sample Location	HEIS Number	Sample Date	Zinc-65		
			pCi/g	Q	MDA
FS-1	J1RF82	2/20/2013	2.87	U	13.8
FS-3 Floor	J1RF83	2/19/2013	-3.40	U	19.5
FS-3 Pipe W	J1RF84	2/19/2013	-1.46	U	12.6
FS-3 Pipe N	J1RF85	2/19/2013	-10.6	U	21.9

Attachment	1	Sheet No.	2 of 6
Originator	N. K. Schiffern	Date	5/6/13
Checked	I. B. Berezovskiy	Date	5/6/13
Calc. No.	0300X-CA-V0174	Rev. No.	0

Attachment 1. 300-257 Waste Site Verification Sample Results (Metals).

Sample Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium			Boron			Cadmium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-4 Floor	J1RF86	2/19/2013	5860		1.7	0.42	U	0.42	3.0	M	0.73	60.2		0.084	0.36		0.036	4.0		1.1	0.25		0.045
Replicate of J1RF86	J1RF89	2/19/2013	5690		1.6	0.40	U	0.40	3.7		0.69	57.2		0.079	0.33		0.034	3.7		1.0	0.20	B	0.043
FS-2 S	J1RH84	3/7/2013	4700		1.7	0.41	UJ	0.41	6.8	M	0.70	69.0		0.081	0.24		0.035	1.3	B	1.0	1.8	MJ	0.044
FS-4 Pipe W	J1RF87	2/19/2013	5630		1.4	0.35	U	0.35	10.3		0.62	69.9		0.071	0.32		0.031	3.4		0.92	0.35		0.038
FS-4 Pipe E	J1RF88	2/19/2013	5730		1.7	0.43	U	0.43	4.8		0.74	60.2		0.085	0.35		0.037	2.8		1.1	0.17	B	0.046
Split of J1RF86	J1RF91	2/19/2013	5770		167	7.6	U	7.6	3.8	U	3.8	70.1	N	3.0	2.0	U	2.0	17.9	U	17.9	1.2	U	1.2
Equipment Blank	J1RF90	2/19/2013	131		1.3	0.32	U	0.32	0.55	U	0.55	1.4		0.064	0.028	U	0.028	0.82	U	0.82	0.034	U	0.034

Sample Location	HEIS Number	Sample Date	Calcium			Chromium			Cobalt			Copper			Iron			Lead			Lithium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-4 Floor	J1RF86	2/19/2013	4730	X	15.5	15.0	M	0.064	7.0	X	0.11	41.2		0.24	24800		4.2	423	X	0.30	6.3		0.33
Replicate of J1RF86	J1RF89	2/19/2013	4730	X	14.7	15.8		0.060	7.5	X	0.10	47.0		0.23	33000		4.0	402	X	0.28	6.0		0.31
FS-2 S	J1RH84	3/7/2013	5330	X	15.1	36.7	MJ	0.062	9.2	MJ	0.11	196	MJ	0.23	62000	MJ	4.1	18.6		0.29	5.9		0.32
FS-4 Pipe W	J1RF87	2/19/2013	5680	X	13.2	36.2		0.054	9.9	X	0.093	253		0.20	146000		3.5	179	X	0.25	6.1		0.28
FS-4 Pipe E	J1RF88	2/19/2013	3870	X	15.8	16.3		0.065	14.9	X	0.11	61.0		0.24	53000		4.3	362	X	0.30	5.8		0.34
Split of J1RF86	J1RF91	2/19/2013	5960		159	14.4	N	3.7	11.2	U	11.2	45.9		8.7	24200	N	35.4	538	N	2.0	7.8	U	7.8
Equipment Blank	J1RF90	2/19/2013	756	X	11.8	0.077	B	0.049	0.084	UX	0.084	0.18	U	0.18	189		3.2	0.44	X	0.23	0.25	U	0.25

Sample Location	HEIS Number	Sample Date	Magnesium			Manganese			Mercury			Molybdenum			Nickel			Potassium			Selenium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-4 Floor	J1RF86	2/19/2013	3450		4.1	286		0.11	0.025	M	0.0072	0.42	B	0.29	10.1	X	0.14	1250		45.1	0.95	U	0.95
Replicate of J1RF86	J1RF89	2/19/2013	3370		3.9	316		0.10	0.020	B	0.0074	0.69	B	0.27	12.3	X	0.13	1220		42.7	0.89	U	0.89
FS-2 S	J1RH84	3/7/2013	2750		4.0	476	MJ	0.11	0.14		0.0059	48.2		0.28	47.9	MJ	0.13	785		43.8	0.92	U	0.92
FS-4 Pipe W	J1RF87	2/19/2013	3140		3.5	473		0.093	0.015	B	0.0067	4.3		0.24	39.9	X	0.11	1630		38.3	0.80	U	0.80
FS-4 Pipe E	J1RF88	2/19/2013	3330		4.2	379		0.11	0.021		0.0061	0.92	B	0.29	17.8	X	0.14	1280		46.0	0.96	U	0.96
Split of J1RF86	J1RF91	2/19/2013	4190	N	99	304	N	1.8	0.035	B	0.013	3.8	U	3.8	14.5	B	2.7	4020	U	4020	3.4	U	3.4
Equipment Blank	J1RF90	2/19/2013	198		3.1	4.8		0.084	0.0060	U	0.0060	0.22	U	0.22	0.12	BX	0.10	34.5	U	34.5	0.72	U	0.72

Sample Location	HEIS Number	Sample Date	Silicon			Silver			Sodium			Uranium			Uranium (KPA)			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-4 Floor	J1RF86	2/19/2013	262		6.2	0.18	U	0.18	343		64.9	0.79		0.0018	1.28		0.139	40.9		0.10	110	X	0.44
Replicate of J1RF86	J1RF89	2/19/2013	213		5.9	0.17	U	0.17	315		61.4	1.2		0.0019	1.31		0.138	38.4		0.098	102	X	0.41
FS-2 S	J1RH84	3/7/2013	172	NJ	6.0	6.9		0.17	410		63.0	1.6	M	0.0016	0.770		0.142	34.0		0.10	526	J	0.43
FS-4 Pipe W	J1RF87	2/19/2013	284		5.3	0.25		0.15	253		55.1	2.2		0.0016	1.43		0.138	34.5		0.088	3350	X	0.37
FS-4 Pipe E	J1RF88	2/19/2013	254		6.4	0.18	U	0.18	208		66.2	0.68		0.0018	0.957		0.134	40.9		0.11	111	X	0.45
Split of J1RF86	J1RF91	2/19/2013	1980	N	18.5	2.8	U	2.8	561	UN	561	2.8	N	0.12				33.3	B	15	126	N	23.6
Equipment Blank	J1RF90	2/19/2013	96.8		4.8	0.13	U	0.13	49.6	U	49.6	0.095	B	0.0015				0.27	B	0.079	0.94	X	0.33

Sample Location	HEIS Number	Sample Date	Zirconium		
			mg/kg	Q	PQL
FS-4 Floor	J1RF86	2/19/2013	10.9		0.39
Replicate of J1RF86	J1RF89	2/19/2013	9.3		0.37
FS-2 S	J1RH84	3/7/2013	10.8		0.38
FS-4 Pipe W	J1RF87	2/19/2013	13.6		0.33
FS-4 Pipe E	J1RF88	2/19/2013	12.0		0.40
Split of J1RF86	J1RF91	2/19/2013	12.6	N	1.3
Equipment Blank	J1RF90	2/19/2013	0.52	B	0.30

Attachment	1	Sheet No.	3 of 6
Originator	N. K. Schiffern	Date	5/13/13
Checked	J. D. Skoglie	Date	5/13/13
Calc. No.	0300X-CA-V0174	Rev. No.	0

Attachment 1. 300-257 Waste Site Verification Sample Results - Informational Purposes Only (Metals).

Sample Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium			Boron			Cadmium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-1	J1RF82	2/20/2013	1250		1.5	1.4	B	0.18	8.5	M	0.48	30.6	M	0.11	0.059	B	0.018	1.2	M	0.88	0.70	BM	0.040
FS-3 Floor	J1RF83	2/19/2013	1460		1.5	0.18	U	0.18	1.1	BC	0.48	16.9		0.11	0.052	B	0.018	2.5	BC	0.88	0.041	B	0.040
FS-3 Pipe W	J1RF84	2/19/2013	160		1.5	0.18	U	0.18	0.86	BC	0.48	2.7		0.11	0.018	U	0.018	2.2	BC	0.88	0.040	U	0.040
FS-3 Pipe N	J1RF85	2/19/2013	397		1.5	0.18	UJ	0.18	0.67	BC	0.48	4.2		0.11	0.018	U	0.018	2.1	BC	0.88	0.040	UJ	0.040

Sample Location	HEIS Number	Sample Date	Calcium			Chromium			Cobalt			Copper			Iron			Lead			Lithium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-1	J1RF82	2/20/2013	1080	M	6.3	32.8	M	0.12	9.4	M	0.042	132	M	0.18	97100	M	7.1	64.0	M	0.22	1.2	BM	0.47
FS-3 Floor	J1RF83	2/19/2013	1540		6.3	3.1		0.12	17.7		0.042	71.6		0.18	6030		7.1	3.8		0.22	1.4	B	0.47
FS-3 Pipe W	J1RF84	2/19/2013	261	B	6.3	0.70	B	0.12	2.2		0.042	12.1		0.18	2900		7.1	0.52	B	0.22	0.47	U	0.47
FS-3 Pipe N	J1RF85	2/19/2013	471	B	6.3	0.77	B	0.12	1.5		0.042	10.0		0.18	914		7.1	0.88	B	0.22	0.47	U	0.47

Sample Location	HEIS Number	Sample Date	Magnesium			Manganese			Molybdenum			Nickel			Potassium			Selenium			Silicon		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-1	J1RF82	2/20/2013	523	BC	14.9	604	M	0.045	6.2	M	0.056	35.4	M	0.075	153	BC	19.0	0.72	U	0.72	138	CM	4.2
FS-3 Floor	J1RF83	2/19/2013	1190		14.9	99.8		0.045	0.14	B	0.056	4.2		0.075	324	C	19.0	0.72	U	0.72	122	C	4.2
FS-3 Pipe W	J1RF84	2/19/2013	210	BC	14.9	19.6		0.045	0.066	B	0.056	0.90	B	0.075	68.0	BC	19.0	0.72	U	0.72	89.0	C	4.2
FS-3 Pipe N	J1RF85	2/19/2013	295	BC	14.9	22.2		0.045	0.06	B	0.056	0.76	B	0.075	115	BC	19.0	0.72	U	0.72	88.2	C	4.2

Sample Location	HEIS Number	Sample Date	Silver			Sodium			Uranium (KPA)			Vanadium			Zinc			Zirconium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-1	J1RF82	2/20/2013	0.25	B	0.12	314	BNC	42.3	0.334		0.138	6.9		0.11	7260	NM	12.6	2.9	NM	0.51
FS-3 Floor	J1RF83	2/19/2013	0.12	U	0.12	473	BNC	42.3	0.0317	U	0.138	5.9		0.11	233	NC	1.3	3.0	N	0.51
FS-3 Pipe W	J1RF84	2/19/2013	0.12	U	0.12	349	BNC	42.3	0.0402	U	0.138	0.59	B	0.11	142	NC	1.3	0.51	UN	0.51
FS-3 Pipe N	J1RF85	2/19/2013	0.12	U	0.12	364	BNC	42.3	0.0212	U	0.138	1.4	B	0.11	83.2	NC	1.3	0.83	BN	0.51

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Checked	I. B. Berezovskiy	Date	5/6/13
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Attachment 1. 300-257 Waste Site Verification Sample Results (Anions, TPH, and Physicals).

Sample Location	HEIS Number	Sample Date	Bromide			Chloride			Cyanide			Fluoride			Nitrogen in Nitrate			Nitrogen in Nitrite			Nitrogen in Nitrite and Nitrate		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-2 S	J1RH84	3/7/2013	0.47	U	0.47	116		2.4	0.19	B	0.13	0.99	U	0.99	0.59	B	0.38	0.41	U	0.41	0.38	U	0.38

Sample Location	HEIS Number	Sample Date	Phosphorous in phosphate			Sulfate			Sulfide			TPH - Diesel			TPH - Diesel EXT		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
FS-2 S	J1RH84	3/7/2013	7.9	N	1.5	40.4		2.1	2.9	U	2.9	92000	NJ	820	130000	NJ	1200

Sample Location	HEIS Number	Sample Date	Percent moisture			Percent Solids			pH Measurement		
			%	Q	PQL	%	Q	PQL	pH		PQL
FS-4 Floor	J1RF86	2/19/2013	18.8		0.10						
Replicate of J1RF86	J1RF89	2/19/2013	16.4		0.10						
FS-2 S	J1RH84	3/7/2013	17.9		0.10				8.2		0.1
FS-4 Pipe W	J1RF87	2/19/2013	5.3		0.10						
FS-4 Pipe E	J1RF88	2/19/2013	15.1		0.10						
Split of J1RF86	J1RF91	2/19/2013				81.5		0.1			
Equipment Blank	J1RF90	2/19/2013	0.10	U	0.10						

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Attachment 1. 300-257 Waste Site Verification Sample Results (Organics).

CONSTITUENT	CLASS	J1RH84, FS-2 S 3/7/2013		
		ug/kg	Q	PQL
1,2,4-Trichlorobenzene	SVOA	34	U	34
1,2-Dichlorobenzene	SVOA	26	U	26
1,3-Dichlorobenzene	SVOA	14	U	14
1,4-Dichlorobenzene	SVOA	16	U	16
2,4,5-Trichlorophenol	SVOA	12	U	12
2,4,6-Trichlorophenol	SVOA	12	U	12
2,4-Dichlorophenol	SVOA	12	U	12
2,4-Dimethylphenol	SVOA	79	UX	79
2,4-Dinitrophenol	SVOA	400	U	400
2,4-Dinitrotoluene	SVOA	79	U	79
2,6-Dinitrotoluene	SVOA	34	U	34
2-Chloronaphthalene	SVOA	12	U	12
2-Chlorophenol	SVOA	25	U	25
2-Methylnaphthalene	SVOA	23	U	23
2-Methylphenol (cresol, o-)	SVOA	16	U	16
2-Nitroaniline	SVOA	60	U	60
2-Nitrophenol	SVOA	12	U	12
3+4 Methylphenol (cresol, m+p)	SVOA	40	U	40
3,3'-Dichlorobenzidine	SVOA	110	U	110
3-Nitroaniline	SVOA	88	U	88
4,6-Dinitro-2-methylphenol	SVOA	400	U	400
4-Bromophenylphenyl ether	SVOA	23	U	23
4-Chloro-3-methylphenol	SVOA	79	U	79
4-Chloroaniline	SVOA	98	U	98
4-Chlorophenylphenyl ether	SVOA	25	U	25
4-Nitroaniline	SVOA	87	U	87
4-Nitrophenol	SVOA	120	U	120
Acenaphthene	SVOA	25	J	12
Acenaphthylene	SVOA	20	U	20
Anthracene	SVOA	62	J	20
Benzo(a)anthracene	SVOA	440	X	24
Benzo(a)pyrene	SVOA	310	J	24
Benzo(b)fluoranthene	SVOA	670	K	31
Benzo(ghi)perylene	SVOA	180	J	19
Benzo(k)fluoranthene	SVOA	48	UK	48
Bis(2-chloro-1-methylethyl)ether	SVOA	28	U	28
Bis(2-Chloroethoxy)methane	SVOA	28	U	28
Bis(2-chloroethyl) ether	SVOA	20	U	20
Bis(2-ethylhexyl) phthalate	SVOA	570	X	55
Butylbenzylphthalate	SVOA	52	U	52
Carbazole	SVOA	51	J	43
Chrysene	SVOA	530	X	32
Di-n-butylphthalate	SVOA	35	U	35
Di-n-octylphthalate	SVOA	17	U	17
Dibenz[a,h]anthracene	SVOA	23	U	23
Dibenzofuran	SVOA	24	U	24
Diethyl phthalate	SVOA	31	U	31
Dimethyl phthalate	SVOA	28	U	28
Fluoranthene	SVOA	750	X	43
Fluorene	SVOA	22	U	22
Hexachlorobenzene	SVOA	35	U	35
Hexachlorobutadiene	SVOA	12	U	12
Hexachlorocyclopentadiene	SVOA	60	U	60
Hexachloroethane	SVOA	26	U	26
Indeno(1,2,3-cd)pyrene	SVOA	170	J	26
Isophorone	SVOA	20	U	20
N-Nitroso-di-n-dipropylamine	SVOA	37	U	37
N-Nitrosodiphenylamine	SVOA	25	U	25
Naphthalene	SVOA	37	U	37
Nitrobenzene	SVOA	26	U	26
Pentachlorophenol	SVOA	400	U	400
Phenanthrene	SVOA	470	X	20
Phenol	SVOA	22	U	22
Pyrene	SVOA	650	X	15

CONSTITUENT	CLASS	J1RH84, FS-2 S 3/7/2013		
		ug/kg	Q	PQL
Acenaphthene	PAH	420	NXJ	12
Acenaphthylene	PAH	11	U	11
Anthracene	PAH	400	NJ	3.7
Benzo(a)anthracene	PAH	1400	NJ	3.9
Benzo(a)pyrene	PAH	900	NJ	7.8
Benzo(b)fluoranthene	PAH	1300	NJ	5.1
Benzo(ghi)perylene	PAH	690	N	8.8
Benzo(k)fluoranthene	PAH	500	NJ	4.8
Chrysene	PAH	1500	NJ	5.9
Dibenz[a,h]anthracene	PAH	59	X	13
Fluoranthene	PAH	2600	NJ	16
Fluorene	PAH	310	NJ	6.4
Indeno(1,2,3-cd)pyrene	PAH	350	NXJ	15
Naphthalene	PAH	15	UNJ	15
Phenanthrene	PAH	1600	NJ	15
Pyrene	PAH	2100	NJ	15
Aroclor-1016	PCB	3.3	UN	3.3
Aroclor-1221	PCB	9.6	U	9.6
Aroclor-1232	PCB	2.4	U	2.4
Aroclor-1242	PCB	5.6	U	5.6
Aroclor-1248	PCB	5.6	U	5.6
Aroclor-1254	PCB	120	J	3.1
Aroclor-1260	PCB	3.1	UNJ	3.1
1,1,1-Trichloroethane	VOA	0.62	UJ	0.62
1,1,2,2-Tetrachloroethane	VOA	0.73	UJ	0.73
1,1,2-Trichloroethane	VOA	1.1	UJ	1.1
1,1-Dichloroethane	VOA	0.25	UJ	0.25
1,1-Dichloroethene	VOA	0.71	UJ	0.71
1,2-Dichloroethane	VOA	0.84	UJ	0.84
1,2-Dichloroethene(Total)	VOA	0.47	UJ	0.47
1,2-Dichloropropane	VOA	0.66	UJ	0.66
2-Butanone	VOA	10	UJ	2.2
2-Hexanone	VOA	5.9	UJ	5.9
4-Methyl-2-Pentanone	VOA	5.2	UJ	5.2
Acetone	VOA	22	JBUJ	6.4
Benzene	VOA	0.56	UJ	0.56
Bromodichloromethane	VOA	0.26	UJ	0.26
Bromoform	VOA	10	UJ	0.28
Bromomethane	VOA	0.60	UJ	0.60
Carbon disulfide	VOA	0.50	UJ	0.50
Carbon tetrachloride	VOA	0.75	UJ	0.75
Chlorobenzene	VOA	0.65	UJ	0.65
Chloroethane	VOA	1.1	UJ	1.1
Chloroform	VOA	0.35	UJ	0.35
Chloromethane	VOA	0.92	UJ	0.92
cis-1,3-Dichloropropene	VOA	1.5	UJ	1.5
Dibromochloromethane	VOA	0.68	UJ	0.68
Ethylbenzene	VOA	0.80	UJ	0.80
Methylenechloride	VOA	10	UJ	1.9
Styrene	VOA	0.75	UJ	0.75
Tetrachloroethene	VOA	0.71	UJ	0.71
Toluene	VOA	0.83	UJ	0.83
trans-1,3-Dichloropropene	VOA	0.80	UJ	0.80
Trichloroethene	VOA	0.28	UJ	0.28
Vinyl chloride	VOA	1.6	UJ	1.6
Xylenes (total)	VOA	0.73	UJ	0.73

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APPENDIX B

DATA QUALITY ASSESSMENT

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DATA QUALITY ASSESSMENT

CHARACTERIZATION SAMPLING

A data quality assessment (DQA) was performed to compare the characterization sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WCH 2013b). This DQA was performed in accordance with site-specific data quality objectives found in the *300 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2011).

A review of the sample design (WCH 2013b), the field logbook (WCH 2013a), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design. To ensure quality data, the SAP data assurance requirements and the data validation procedures for chemical analysis and radiochemical analysis (BHI 2000a, 2000b) are used as appropriate. This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use (i.e., closeout decisions). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process (EPA 2006).

Characterization sample data collected at the 300-257 waste site were provided by the laboratories in three sample delivery groups (SDGs): SDG J01744, SDG JP0479, and SDG ZP0001. SDG J01744 was submitted for third-party validation. Major and minor deficiencies are discussed for the data set, as follows below. If no comments are made about a specific analysis, it should be assumed that no deficiencies affecting the quality of the data were found.

MAJOR DEFICIENCIES

An additional analysis for ion chromatograph (IC) anions was conducted in SDG J01744, although it was not required by the sample design (WCH 2013b). In IC anions analysis, the holding times for nitrate, nitrite, and orthophosphate in method 300.0 were exceeded by more than twice the limit. Third-party validation or the project qualified all undetected nitrate, nitrite, and orthophosphate in this SDG as rejected with "UR" flags.

These results were anticipated by the project. To obtain usable nitrate and nitrite data, method 353.2 was also run which has longer allowable holding time. These data effectively replace the rejected method 300.0 nitrate and nitrite data. Orthophosphate is not a regulated compound. Therefore, the resulting data set is sufficient for decision-making purposes.

MINOR DEFICIENCIES

SDG J01744

This SDG is composed of one focused sediment sample (J1RH84) from the 300-257 waste site and a second focused sediment sample (J1RH85) from the 300-15 waste site, collected on March 7, 2013. Only results affecting the 300-257 waste site (sample J1RH84) are discussed in this DQA.

Sample J1RH84 was analyzed for inductively coupled plasma (ICP) metals, inductively coupled plasma mass spectrometry (ICP-MS) (total uranium), mercury, total uranium by kinetic phosphorescence analysis (KPA), gamma energy analysis (GEA), gross alpha, and gross beta per the sample design (WCH 2013b). Additional analyses not required by the sample design (WCH 2013b), including isotopic plutonium, plutonium-241, isotopic uranium, americium-241/curium-244, technetium-99, tritium, carbon-14, nickel-63, strontium-90, IC anions, nitrate/nitrite, sulfide, total cyanide, semivolatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCBs), total petroleum hydrocarbon (TPH), pH, and volatile organic compounds (VOCs), were also performed. SDG J01744 was submitted for third-party validation. Minor deficiencies are as follows:

In the tritium, plutonium-241, and carbon-14 analyses, no matrix spike (MS) was performed. In the americium-241/curium-244, isotopic plutonium, and isotopic uranium analyses, no laboratory control sample (LCS) analysis was performed for curium-242, curium-243/244, plutonium-238, and uranium-235. Third-party validation qualified all curium-242, curium-243/244, tritium, plutonium-238, and uranium-235 results as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the americium-241/curium-244 analysis, the tracer yield was outside of quality control (QC) limits at 11%. Third-party validation qualified all americium-241, curium-242, and curium-243/244 results in J1RH84 as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the PCB analysis, the MS and matrix spike duplicate (MSD) recoveries were outside of QC limits for aroclor-1260 at 201% and 229%, respectively. The aroclor-1260 results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the PCB analysis, one of the surrogate recoveries was outside of laboratory QC limits for sample J1RH84. The aroclor-1254 result for J1RH84 was qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the VOC analysis, sample J1RH84 was not properly preserved and contained excessive headspace. Therefore, all VOC results in J1RH84 were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the VOC analysis, acetone, bromoform, 2-butanone, and methylene chloride contamination were detected in the method blank (MB). The results are not above applicable RAGs, and there is no impact on the evaluation of the 300-257 waste site. Due to the MB contamination, the acetone result in J1RH84 was qualified as undetected with a "U" flag by third-party validation. The 2-butanone, bromoform, and methylene chloride results in J1RH84 were qualified as undetected, raised to the required quantitation limit (RQL), and flagged with a "U" by third-party validation. The data are usable for decision-making purposes.

In the TPH analysis, the MSD recoveries were above QC limits for diesel range (164%) and diesel range extended (177%) hydrocarbons. Additionally, the surrogate recovery for J1RH84 in the TPH analysis was above laboratory QC limits. Therefore, the TPH results in J1RH84 were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the SVOA analysis, MS/MSD recoveries were outside of QC limits for bis(2-ethylhexyl)phthalate (301% [MSD only]), fluoranthene (191% and 153%), phenanthrene (190% [MS only]), and pyrene (179% [MS only]). The MS/MSD RPD calculations were above QC limits for bis(2-ethylhexyl)phthalate (68%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Due to MS/MSD recoveries and/or RPD calculations outside of QC limits, the bis(2-ethylhexyl)phthalate, fluoranthene, phenanthrene, and pyrene results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, all silicon (9%) results were qualified as estimated and flagged "J" by third-party validation due to LCS recovery outside of QC limits. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the RPD calculations for the laboratory duplicate were above QC limits for arsenic (76%), cadmium (95%), chromium (117%), cobalt (61%), copper (55%), iron (80%), manganese (78%), nickel (124%), and zinc (35%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. The cadmium, chromium, cobalt, copper, iron, manganese, nickel, and zinc results were qualified as estimated and flagged with a "J" by third-party validation. Although not qualified as estimated, the arsenic result may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the MS recovery for aluminum (546%), antimony (63%), copper (42%), iron (10,724%), manganese (152%), silicon (23%), and zinc (265%) were outside of QC limits. For aluminum, iron, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample. Antimony, copper, silicon, and zinc did not have mismatched spike and native concentrations in the MS. Due to MS recovery outside of QC limits, antimony and silicon results in J1RH84 were qualified as estimated and flagged with a "J" by third-party validation. Although not qualified for MS recoveries outside of QC limits, all aluminum, copper, iron, manganese, and zinc results may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the PAH analysis, the MS and MSD recoveries were above QC limits for acenaphthene (214% [MSD only]), anthracene (180% and 279%), benzo(a)anthracene (179% and 287%), benzo(a)pyrene (162% and 222%), benzo(b)fluoranthene (204% [MSD only]), benzo(k)fluoranthene (162% [MSD only]), chrysene (156% and 246%), fluoranthene (368% and 719%), fluorene (213% [MSD only]), indeno(1,2,3-cd)pyrene (166% and 210%), naphthalene (193% [MSD only]), phenanthrene (-60% and -37%), and pyrene (317% and 598%). The MS/MSD RPD calculations were above QC limits for acenaphthene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene. The surrogate recoveries for the MS and MSD were also above QC limits. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Due to MS/MSD recoveries and/or RPD calculations outside of QC limits, the acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene results in J1RH84 were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are usable for decision-making purposes.

In the IC anions analysis, holding times were exceeded by more than twice the specified holding time for nitrate, nitrite, and orthophosphate. The nondetected results for these analytes are discussed above in the Major Deficiencies section. Due to the holding time exceedance, detected nitrate, nitrite, and orthophosphate results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are acceptable for decision-making purposes.

In the IC anions analysis, the MS recovery for orthophosphate (69%) was outside of QC limits. Due to the MS recovery, the orthophosphate results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are acceptable for decision-making purposes.

In the sulfide analysis, holding times were exceeded by less than twice the specified holding time. Due to the holding time exceedance, the sulfide result in J1RH84 was qualified as estimated and flagged with a "J" by third-party validation. Estimated data are acceptable for decision-making purposes.

In the sulfide analysis, the MSD recovery was outside of QC limits at 68%. Due to the MSD recovery, the sulfide results were qualified as estimated and flagged with a "J" by third-party validation. Estimated data are acceptable for decision-making purposes.

SDG JP0479

This SDG is composed of four focused sediment samples (J1RF86 through J1RF89) collected on February 19, 2013, from the 300-257 waste site. This SDG includes a field duplicate pair (J1RF86/J1RF89). Although wipe samples from the 300-257 waste site were included in this SDG, only sediment samples are discussed in the DQA. The sediment samples were analyzed for ICP metals, ICP-MS metals (total uranium), mercury, total uranium by KPA, GEA, gross alpha, and gross beta per the sample design (WCH 2013b). An additional analysis for strontium-90 was performed, although this was not required by the sample design (WCH 2013b).

In addition, one equipment blank (J1RF90) was analyzed for ICP metals and mercury. Minor deficiencies are as follows:

In the isotopic uranium analyses, no LCS analysis was performed for uranium-235. Although not qualified for the lack of LCS analysis, all uranium-235 results may be considered estimated. Estimated data are usable for decision-making purposes.

In the total uranium analysis by KPA, the LCS recovery was below QC limits at 58%. Although not qualified for the LCS recovery, all uranium results by KPA may be considered estimated. The data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery was below the QC project criteria for silicon (12%). Although not qualified for the LCS recovery outside of QC limits, all silicon data may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the RPD calculation for the laboratory duplicate was above QC limits for arsenic (32%), chromium (46%), and iron (34%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the elevated RPD calculations, all arsenic, chromium, and iron results may be considered estimated. The data are usable for decision-making purposes.

In the ICP metals analysis, the MS recovery for aluminum (963%), antimony (64%), iron (8,423%), lead (170%), manganese (178%), and silicon (27%) were outside of QC limits. For aluminum, iron, lead, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample. Antimony and silicon did not have mismatched spike and native concentrations in the MS. Although not qualified for MS recoveries outside of QC limits, all aluminum, antimony, iron, lead, manganese, and silicon results may be considered estimated. Estimated data are acceptable for decision-making purposes.

SDG ZP0001

This SDG is composed of one sediment sample (J1RF91). Sample J1RF91 is a split of sample J1RF86 collected on February 19, 2013, from the 300-257 waste site. The sediment sample was analyzed for ICP metals, ICP-MS metals (total uranium and zirconium) mercury, GEA, gross alpha, and gross beta per the sample design (WCH 2013b). The analysis for total uranium by KPA was not performed; however, total uranium was quantified by ICP-MS analysis. An additional analysis for strontium-90 was performed, although this was not required by the sample design (WCH 2013b). Minor deficiencies are as follows:

In the ICP metals analysis, the LCS recovery was below the QC project criteria for aluminum (65%) and antimony (58%). Although not qualified for the LCS recovery outside of QC limits, all aluminum and antimony data may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the MS/MSD recoveries for aluminum (295% [MSD only]), calcium (162% and 136%), chromium (154% [MSD only], iron (-286% and 805%), lead (65% and 295%), magnesium (45% [MS only]), manganese (58% and 143%), silicon (134% [MSD only]), and zinc (149% [MSD only]) were outside of QC limits. For aluminum, calcium, iron, lead, magnesium, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample. Chromium, silicon, and zinc did not have mismatched spike and native concentrations in the MS. Although not qualified for MS recoveries outside of QC limits, all aluminum, calcium, chromium, iron, lead, magnesium, manganese, silicon, and zinc results may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, the RPD calculations for the laboratory duplicate were above QC limits for chromium (41%), iron (50%), and lead (38%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the elevated RPD calculations, all arsenic, chromium, and iron results may be considered estimated. The data are usable for decision-making purposes.

In the ICP metals analysis, barium was detected in the MB at less than twice the MDL. Method blank contamination of this magnitude has no significant impact on the field sample results. The data are usable for decision-making purposes.

In the ICP-MS analysis, the MS/MSD recoveries for zirconium (139% and 140%) and uranium (132% [MSD only]) were outside of QC limits. Although not qualified for MS/MSD recoveries outside of QC limits, all uranium and zirconium results may be considered estimated. Estimated data are acceptable for decision making purposes.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

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

Field quality assurance (QA)/QC measures are used to assess potential sources of error and cross contamination of samples that could bias results. Field QA/QC samples, listed in the field logbook (WCH 2013a), are shown in Table B-1. The main and QA/QC sample results are presented in Appendix A.

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

Sample Area	Main Sample	Duplicate Sample	Split Sample
FS-4 Floor	J1RF86	J1RF89	J1RF91

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

Split samples are collected to provide a relative measure of the 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 COPC to determine the usability of the characterization 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 2004), is used as an initial test of the data from the splits. Only analytes that had values above five times the contract-required quantitation limit for both the main and split sample were compared. The calculation brief in Appendix A provides details on split pair RPD calculation. The RPD acceptance criteria for project-split samples is $\leq$ 35% (less than or equal to 35%).

The calculated RPDs for the field QA/QC duplicate samples were within the acceptance criteria of 30%. All RPDs for the field QA/QC split samples were within the acceptance criteria of 35%, with the exception of silicon at 153.3%. Elevated RPDs in the analysis of environmental soil samples are largely attributed to heterogeneities in the soil matrix and only in small part attributed to precision and accuracy issues at the laboratory. The data are usable for decision-making purposes.

A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the TDL, including undetected analytes. In these cases, a control limit of ±2 times the TDL is used (Appendix A) to indicate that a visual check of the data is required by the reviewer. This check was required only for uranium by ICP-MS in the split sample. The result is attributed to heterogeneities in the sample matrix from which the samples were collected. A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are usable for decision-making purposes.

Summary

Limited, random, or sample matrix-specific influenced batch QC issues such as those discussed above are a potential for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 300-257 waste site characterization sampling data found that the analytical results are accurate within the standard errors associated with the analytical methods, sampling, and sample handling. The DQA review for the 300-257 waste site concludes that the reviewed data are of the right type,

quality, and quantity to support the intended use. The analytical data were found acceptable for decision-making purposes.

The characterization sample analytical data are stored in the Environmental Restoration project-specific database prior to being submitted for inclusion in the Hanford Environmental Information System database. The characterization sample analytical data are also summarized in Appendix A.

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