Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

0082540

09-AMRC-0153

JUL 14 2009

Mr. D. A. Faulk, Program Manager
Office of Environmental Cleanup
Hanford Project Office
U.S. Environmental Protection Agency
309 Bradley Boulevard, Suite 115
Richland, Washington 99352

Dear Mr. Faulk:

TRANSMITTAL OF THE APPROVED REMEDIAL DESIGN REPORT/REMEDIAL ACTION WORK PLAN (RDR/RAWP) FOR THE 300 AREA, DOE/RL-2001-47, REVISION 2

Please find attached a copy of the approved RDR/RAWP for the 300 Area for your files. By copy of this letter, the RDW/RAWP is placed in the Administrative Record. If you have questions, please contact me or your staff may contact Rudy Guercia, of my staff, on (509) 376-5494.

Sincerely,

for

Mark S. French, Federal Project Director
for the River Corridor Closure Project

AMRC:RFG

Attachment

cc w/attach:
L. E. Gadbois, EPA
Administrative Record, H6-08 (300-FF-2)

cc w/o attach:
D. E. Faulk, WCH

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JUL 17 2009
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DOE/RL-2001-47
Rev. 2

Remedial Design Report/ Remedial Action Work Plan for the 300 Area

United States
Department of Energy

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

______________________ 6/18/09
Signature Date

U.S. Environmental Protection Agency

Larry Gadbois 6-23-2009
Signature Date

DOE/RL-2001-47
Rev. 2

Remedial Design Report/ Remedial Action Work Plan for the 300 Area

June 2009

United States Department of Energy

P.O. Box 550, Richland, Washington 99352

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ACRONYMS

AOC	area of contamination
ARAR	applicable or relevant and appropriate requirement
BMP	Best Management Practice
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CTF	container transfer facility
CVP	cleanup verification package
DAF	dilution attenuation factor
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOT	U.S. Department of Transportation
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ESD	explanation of significant difference
ETF	Effluent Treatment Facility
FFS	focused feasibility study
FR	*Federal Register*
K_d	distribution coefficient
LDR	land disposal restricted
MAP	mitigation action plan
NCP	"National Oil and Hazardous Substances Contingency Plan"
NPL	National Priorities List
OU	operable unit
PCB	polychlorinated biphenyl
RAG	remedial action goal
RAO	remedial action objective
RCC	River Corridor Closure
RCCC	River Corridor Closure Contract
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR/RAWP	remedial design report/remedial action work plan
RESRAD	RESidual RADioactivity
RFP	request for proposal
ROD	Record of Decision
RSVP	remaining sites verification package
RTD	remove, treat as necessary, dispose
SAP	sampling and analysis plan
SSHASP	site-specific health and safety plan
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WAC	*Washington Administrative Code*
WBS	work breakdown structure

WCH	Washington Closure Hanford
WI	work instruction
WIDS	Waste Information Data System

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	Liters	liters	0.264	gallons
pints	0.47	Liters	cubic meters	35.315	cubic feet
quarts	0.95	Liters	cubic meters	1.308	cubic yards
gallons	3.8	Liters			
cubic feet	0.028	Cubic meters			
cubic yards	0.765	Cubic meters			
Temperature			**Temperature**		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			**Radioactivity**		
picocuries	37	millibecquerel	millibecquerels	0.027	picocuries

1.0 INTRODUCTION

The Hanford Site is a 1,517-km^2 (586-mi^2) Federal facility located along the Columbia River in southeastern Washington State. From 1943 until 1990, the primary mission of the Hanford Site was to produce nuclear materials for the nation's defense mission. In July 1989, the Hanford Site was listed on the National Priorities List (NPL) under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as amended by the *Superfund Amendments and Reauthorization Act of 1986.* The Hanford Site was divided and listed as four NPL sites: the 100 Area, the 200 Area, the 300 Area, and the 1100 Area. A portion of the 300 Area is the subject of this document.

The 300 Area, which encompasses approximately 1.35 km^2 (0.52 mi^2), is adjacent to the Columbia River and approximately 1.6 km (1 mi) north of the Richland city limits. The 300 Area began operations in 1943 as a fuels fabrication complex for the nuclear reactors located in the 100 Areas. Most of the facilities in the area were involved in the fabrication of nuclear reactor fuel elements. In addition to the fuel manufacturing processes, technical support, service support, and research and development related to fuels fabrication also occurred within the 300 Area. In the early 1950s, the Hanford laboratories were constructed for research and development. As the Hanford Site production reactors were shut down, fuel fabrication in the 300 Area ceased. Research and development activities have expanded over the years. The 300 Area contains a number of support facilities and other facilities necessary for research and development, environmental restoration, decontamination, and decommissioning. Approximately 150 buildings and structures are scheduled for decontamination and decommissioning by 2018. At the present time, the U.S. Department of Energy (DOE) plans to use a number of facilities with ongoing missions beyond the 2018 date.

Operations in the 300 Area created both liquid and solid wastes. Prior to 1994, liquid wastes were discharged to a series of unlined ponds and process trenches just north of the 300 Area. Prior to 1973, a series of unlined disposal sites, called burial grounds, were used for solid wastes and debris generated by the 300 Area operations. These burial grounds were located just north and west of the 300 Area complex and some contain drummed liquid wastes. Areas under and adjacent to buildings in the 300 Area complex also received both liquid and solid wastes, due to drainage, leaks, waste storage, etc. Waste sites that are uncovered as a result of decontamination and decommissioning will be surface stabilized to control dust and water infiltration using appropriate methods (e.g., gravel or crusting agents) as needed, or the building surface slab (foundation) will be left in place until remediation activities in accordance with the *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington* (hereinafter referred to as the 300-FF-2 ROD) (EPA 2001) or a future CERCLA decision document can be accomplished.

The 300 Area NPL site consists of the following operable units (OUs): 300-FF-1, 300-FF-2, and 300-FF-5 (Figure 1-1). The 300-FF-1 and 300-FF-2 OUs address contaminated soils in the unsaturated vadose zone, structures, debris, and burial grounds. The 300-FF-5 OU addresses the groundwater beneath 300-FF-1 and 300-FF-2. The OUs are currently in various stages of the CERCLA process. Since the last issuance of this document, the waste sites in the 300-FF-1 OU have been remediated. Therefore, this document addresses the remedial designs and remedial actions for waste sites in the Environmental Restoration Contract and River Corridor Closure Contract (RCCC) scope for the 300-FF-2 OU to implement the associated CERCLA Record of Decision (ROD) and explanation of significant differences (ESD). Future ESDs that add waste sites for confirmatory sampling and/or remove, treat, and dispose (RTD) to the 300-FF-2 ROD are considered to be included in this document without it requiring additional revisions.

1.1 PURPOSE AND OBJECTIVES

The primary purpose of this remedial design report/remedial action work plan (RDR/RAWP) is to describe the design and the implementation of the remedial action processes required by the 300-FF-2 ROD (EPA 2001). In addition, this document addresses the requirements for completion of the remedial action process and the closeout/verification process for the 300-FF-2 waste sites in accordance with the 300-FF-2 ROD and the *Explanation of Significant Difference for the 300-FF-2 Operable Unit Record of Decision, Hanford Site, Benton County, Washington* (hereinafter referred to as the 300-FF-2 ESD) (EPA 2004). The contents of this document will be reviewed and updated as appropriate to reflect addition of waste sites, anticipated schedules, and/or changes to the associated design and work plans for remedial action. In the meantime, any adjustments will be documented in the unit manager's meeting minutes, as necessary.

1.2 SCOPE

The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989) specifically lists the RDR and the RAWP as two separate documents. However, this document streamlines the requirements; the RDR and RAWP are combined to cover both the remedial designs and remedial actions. The scope of this document is summarized in the following subsections.

1.2.1 300-FF-2 Operable Unit

The 300-FF-2 OU is composed of waste sites that fall into four general categories: waste sites in the 300 Area industrial complex; outlying waste sites north and west of the 300 Area industrial complex; general content burial grounds; and transuranic-contaminated burial grounds. The selected remedy in the ROD included the following components:

- Removal of contaminated soil, structures, and associated debris
- Treatment, as necessary, to meet waste acceptance criteria at an acceptable disposal facility
- Disposal of contaminated materials at the Hanford Site's Environmental Restoration Disposal Facility (ERDF); the Waste Isolation Pilot Plant in Carlsbad, New Mexico; or other disposal facilities approved in advance by the U.S. Environmental Protection Agency (EPA)

- Recontouring and backfilling of excavated areas followed by infiltration control measures (e.g., revegetation)[1]
- Institutional controls as necessary to ensure that unanticipated changes in land use do not occur that could result in unacceptable exposures to residual contamination
- Ongoing groundwater and ecological monitoring through the 300-FF-5 OU to ensure effectiveness of the remedial actions and to support the final ROD and 5-year remedy reviews
- Regulatory framework for a "plug-in" or "analogous sites" approach for accelerating future remediation decisions.

The details associated with the components of the selected remedy from the 300-FF-2 ROD (EPA 2001) are presented in Table 1-1. This table also identifies how and where those components will be addressed.

Cleanup actions for the 300-FF-2 OU waste sites were initially based on an anticipated industrial land use scenario identified in the 300-FF-2 ROD (EPA 2001). For a selected group of waste sites, the 300-FF-2 ESD (EPA 2004) subsequently modified the land use scenario from industrial to unrestricted, based on geographical location and proximity to other waste sites. These sites are as follows:

- 300 Vitrification Test Site
- 316-4 Crib
- 600-47 Dumping Area
- 600-63 Lysimeter Facility[2]
- 600-259 Lysimeter Facility
- 618-7 Burial Ground
- 618-13 Burial Ground.

While it is expected that some facilities within the 300 Area main industrial complex will continue to be utilized for the foreseeable future, a permanent industrial use of the 300 Area is not being recommended by the Tri-Parties (DOE, EPA, and the Washington State Department of Ecology [Ecology]). Therefore, site cleanup activities are being evaluated against both industrial and unrestricted standards, although the required level of cleanup is based on the industrial-use scenario in accordance with the 300-FF-2 ROD, with the exception of the eight outlying sites identified in the 300-FF-2 ESD.

With the exception of waste generated as a result of characterization activities, the 618-10 and 618-11 Burial Grounds are not included within the scope of this RDR/RAWP because of the

[1] The Tri-Parties have determined that waste sites within the 300 Area "industrialized core zone and contiguous areas" will be regraded in a manner that will provide positive drainage away from areas where residual subsurface contamination could result in adverse groundwater impacts. The grading, to the extent practicable, will maximize the amount of large flat areas and minimize rolling contours or depressions where water may accumulate. Outlying sites should be backfilled and revegetated in a manner that matches local area contours.

[2] The 600-63 waste site adjacent to 600-259 was not included within the scope of the previous revision of this RDR/RAWP because it was expected to remain active in the foreseeable future.

additional requirements that will be necessary to address transuranic waste. It is anticipated that a separate RDR/RAWP and sampling and analysis plan (SAP) will be prepared for the remedial action work at these two burial grounds.

Appendix A provides additional detail for each waste site, as well as remedial action status. Figure 1-2 shows the locations of various 300-FF-2 waste sites to be addressed. Information on these sites can also be found in the *Focused Feasibility Study for the 300-FF-2 Operable Unit* (300-FF-2 FFS) (DOE-RL 2000a).

Twenty-four candidate sites (also referred to as "remaining sites") consistent with the 300-FF-2 OU waste profile have been identified, but additional site characterization data are required to evaluate the basis for action either through sampling or historical data. This site characterization effort is required by the 300-FF-2 ROD (EPA 2001) and will be presented in separate site-specific work instructions (WIs) as discussed in the *300 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2009). If site characterization results indicate that remedial action is needed, the waste sites will be plugged into the removal, treatment, and disposal remedy under this RDR/RAWP. If no remedial action is needed, the waste sites will be categorized as "no action." These candidate waste sites are also called confirmatory sampling sites. The 300-FF-2 ROD also provides the guidelines by which newly discovered sites may be designated for RTD or categorized as candidate sites for no action.

As it is determined that sites will remain active in the future, this document will require revision to reflect the changes in the remediation strategy and to update any previous information that has been changed because of new developments.

1.2.2 300-FF-1 Operable Unit

The 300-FF-1 OU covers an area of approximately 47.4 ha (117 acres) and consisted of solid waste and contaminated vadose zone soils for the major 300 Area liquid/process waste disposal sites, the 618-4 Burial Ground, and three small landfills. Remediation of these waste sites was completed in 2004. The 300-FF-1 liquid/process waste sites were unlined trenches and ponds that routinely received discharges of millions of gallons of contaminated wastewater from 300 Area operations between 1943 and 1994. These liquid/process waste sites are suspected to be the primary source of groundwater contamination addressed in the scope of the 300-FF-5 OU. The selected remedy in the *Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units, Hanford Site, Benton County, Washington* (300-FF-1 ROD) (EPA 1996) was essentially the same as that defined for the 300-FF-2 OU waste sites.

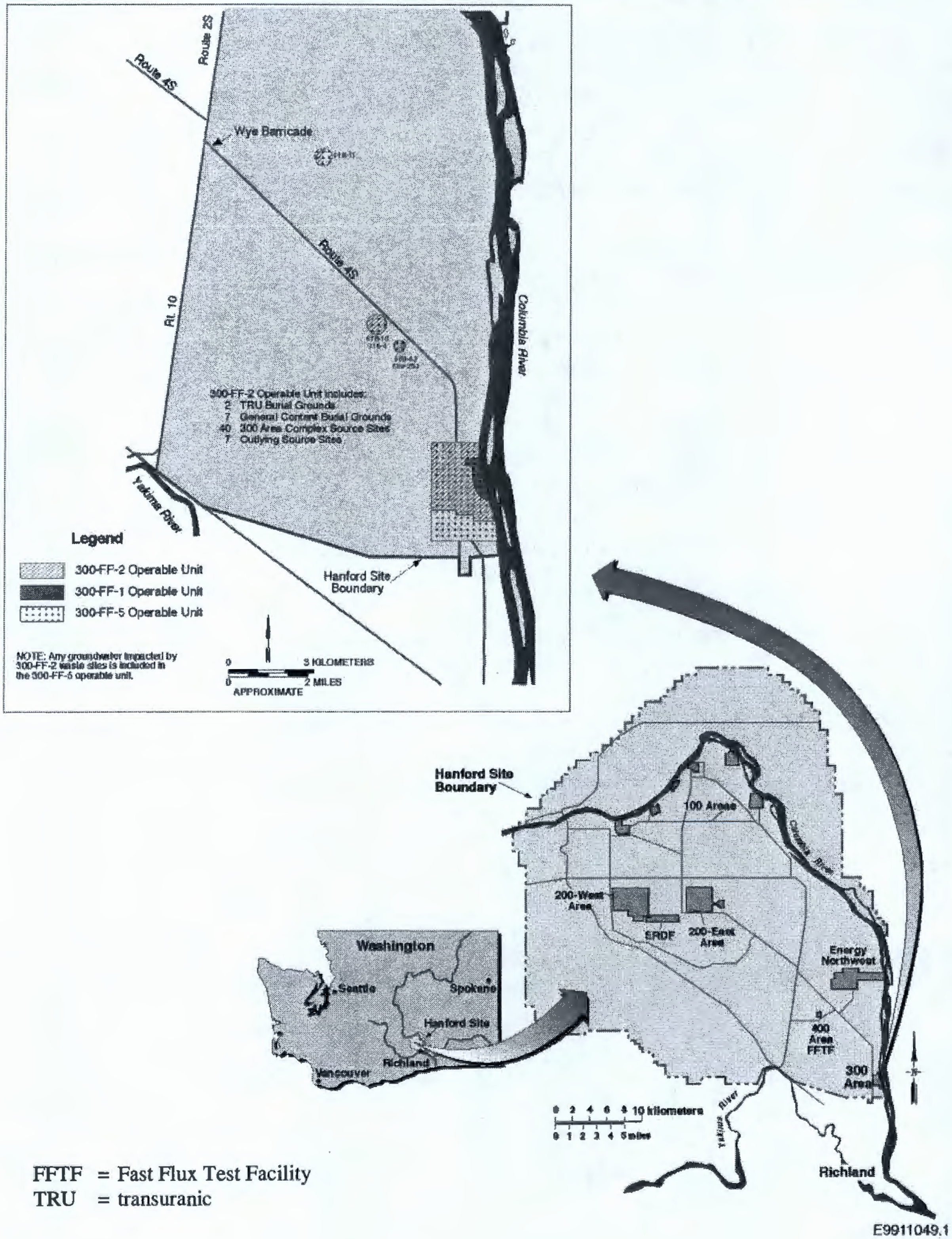
Remedial actions for the 300-FF-1 OU were initiated in 1997 in accordance with the 300-FF-1 ROD (EPA 1996) and the 300-FF-1 RDR/RAWP (DOE-RL 1997) and were completed in 2004. Several 300-FF-2 OU waste sites (300-10, 300-45, and 300-262) were addressed by 300-FF-1 OU remedial actions due to their proximity to other 300-FF-1 OU waste sites.

1.3 REPORT ORGANIZATION

The essential elements of this RDR/RAWP are present in Sections 1.0 through 4.0, which comprise the main body of the report. The appendices present more detailed discussions. The contents of each section are briefly described below:

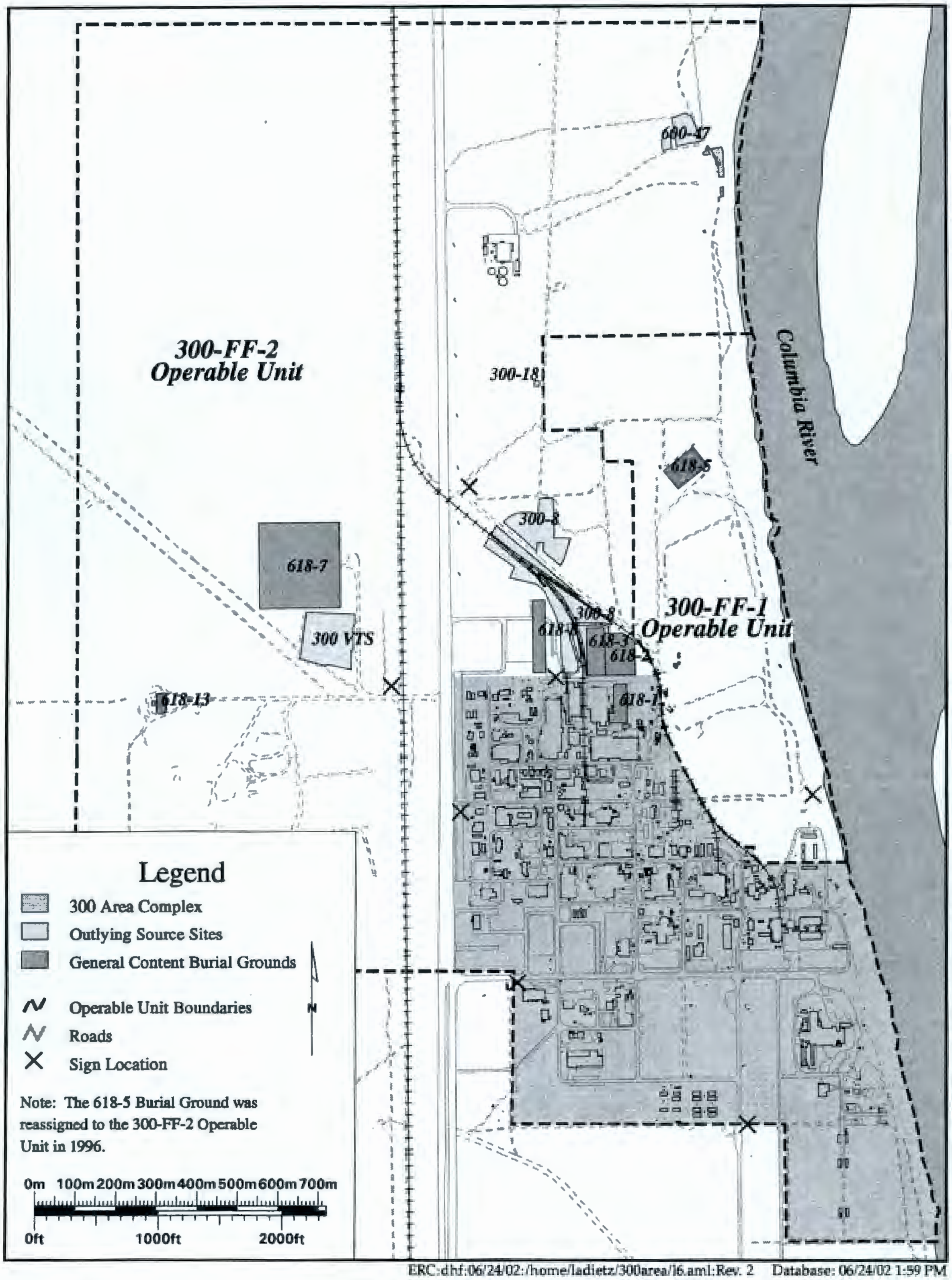
- Section 1.0, "Introduction," presents the purpose, scope, and description of the OUs, as well as an overview of the report's organization.
- Section 2.0, "Basis for Remedial Action," presents the objectives, cleanup levels, verification of waste, and applicable or relevant and appropriate requirements (ARARs).
- Section 3.0, "Remedial Action Approach and Management," presents the project team, cost and schedule, change management approach, planning, remedial action operations, and site closure process.
- Section 4.0, "Waste Management Plan," presents waste storage, transportation, packaging, handling, and labeling as applicable to waste streams for each waste site.
- Section 5.0, "References," contains all reference information used for the main body of the report.
- Appendix A, "Waste Site Information," presents a general description and status of each waste site.
- Appendix B, "Guidance for Cleanup Verification Packages and Remaining Sites Verification Packages," presents a detailed description of the cleanup verification process to aid readers in understanding the details of the remaining sites verification package (RSVP) and cleanup verification package (CVP) process.
- Appendix C, "Revegetation Plan for the 300 Area," presents the revegetation plan for the 300 Area.
- Appendix D, "Remedial Action Goals," presents the development of the contaminant-specific numerical cleanup values.

Figure 1-1. Map of the Hanford Site and the 300 Area Operable Units.



FFTF = Fast Flux Test Facility
TRU = transuranic

Figure 1-2. 300 Area Complex and Adjacent Waste Sites.



VTS = vitrification test site

Table 1-1. Components of the Selected Remedy in the 300-FF-2 Record of Decision. (3 Pages)

Component	How/Where Addressed
Remove/Treat/Disposal Component [a]	
1) Submit an RDR/RAWP and SAP prior to remediation (Section XII, page 51)	In this and subsequent RDR/RAWP and SAP revisions
2) Remove facilities or structures overlying waste sites (Section XII, page 51)	Via engineering evaluation/cost analysis documents and action memorandum
3) Remove and stockpile soils below cleanup levels (Section XII, page 52)	Section 3.0 of this document
4) Excavate and remove contaminated materials (Section XII, page 52)	Section 3.0 of this document
5) Treat wastes as necessary (Section XII, page 52)	Sections 3.0 and 4.0 of this document
6) Dispose of transuranic-contaminated materials (Section XII, page 52)	To be addressed in the RDR/RAWP for the 618-10 and 618-11 Burial Grounds
7) Follow an observational approach during remediation (Section XII, page 53)	Sections 2.0 and 3.0 of this document
8) Use field screening and confirmation sampling techniques (Section XII, page 53)	Sections 2.0, 3.0, and Appendix B of this document
9) Confirm the extent of remediation (Section XII, page 53)	Sections 2.0, 3.0, and Appendix B of this document
10) Confirm achievement of RAOs and, depending on the specific site, demonstrate compliance with the 300 Area industrial or unrestricted land-use exposure scenarios (Section XII, pages 55 and 63)	Sections 2.0, 3.0, and Appendix B of this document
11) Complete CVPs and obtain approvals (Section XII, page 55)	Appendix B of this document
12) Backfill and regrade the waste site (Section XII, page 55)[b]	Section 3.0 of this document
13) Evaluate and apply infiltration controls as necessary (Section XII, page 55)	Section 3.0 of this document
14) Implement the remedy compliant with all ARARs (Section XII, page 56)	Section 2.0 of this document
Additional Requirements for Remove/Treat/Disposal of Waste Sites Within the 300 Area Industrial Complex	
1) Provide dust suppression and water infiltration control measures as needed after facility D4 (Section XII, page 56)	Section 1.0 of this document
2) Provide enhanced access controls and signs as needed after facility D4 (Section XII, page 56)	Section 3.0 of this document
3) Initiate soil cleanup in a timely manner after completion of facility D4 or provide written justification to EPA for approval (Section XII, page 56)	In a future revision to Section 3.0 of this document
4) Provide provisions for identifying new waste sites and provide sampling protocols for these sites (Section XII, page 56)	Section 3.0 of this document

Table 1-1. Components of the Selected Remedy in the 300-FF-2 Record of Decision. (3 Pages)

Component	How/Where Addressed
Institutional Controls Component	
Required Prior to and During Remediation	
1) Control access (Section XII, page 57)	EPA 2001
2) Prohibit well drilling and groundwater use in waste site areas (Section XII, page 57)	EPA 2001
3) Control intrusive work in waste site areas (Section XII, page 57)	EPA 2001
4) Post and maintain warning signs along the Columbia River (Section XII, page 57)	EPA 2001 and Section 3.0 of this document
5) Post and maintain warning signs along access roads (Section XII, page 57)	EPA 2001 and Section 3.0 of this document
6) Report trespass incidents (Section XII, page 57)	EPA 2001
Required Post-Remediation	
1) For sites within the core industrial area and the 618-11 site, restrict use to industrial use only (Section XII, page 57)	EPA 2001
2) Maintain a surveillance program (Section XII, page 57)	EPA 2001
3) Restrict access to former waste site locations when necessary (Section XII, page 58)	EPA 2001
4) Prevent use of groundwater as a drinking water source (Section XII, page 58)	EPA 2001
5) Limit access to and use of water from seeps and springs (Section XII, page 58)	EPA 2001
6) Maintain infiltration controls (Section XII, page 58)	EPA 2001
7) For sites within the core industrial area, prevent irrigation for agriculture or landscaping on former waste site locations (Section XII, page 58)	EPA 2001
8) Control the removal of soil or debris from former waste site locations for other uses (Section XII, page 58)	EPA 2001
9) Limit the removal of soil or debris from former waste site locations where contaminated soils and/or debris remain at depth (i.e., below 4.6 m [15 ft]) above direct contact/direct exposure cleanup levels (Section XII, page 58)	EPA 2001
10) Establish and maintain a records system or database that tracks locations and estimated quantities of residual contamination left in place at waste sites that would preclude unlimited use or unrestricted exposure (Section XII, page 58)	EPA 2001
11) Report the location of residual contamination in deed notices and other informational devices (Section XII, page 58)	EPA 2001
12) Ensure measures are in place to continue land-use restrictions or other institutional controls (e.g., proprietary controls such as property easements or covenants) prior to any transfer or lease of the property	EPA 2001

Table 1-1. Components of the Selected Remedy in the 300-FF-2 Record of Decision. (3 Pages)

Component	How/Where Addressed
Environmental Monitoring Component	
1) Update groundwater monitoring program needs as needed (Section XII, page 59)	*Operation and Maintenance Plan for the 300-FF-5 Operable Unit* (DOE-RL 2001)
2) Continue post-remediation ecological monitoring to support the final 300-FF-2 ROD (Section XII, page 59)	DOE-RL (2001) for shoreline monitoring and a future 300 Area SAP for post-remediation waste site monitoring
3) Evaluate monitoring data regularly (Section XII, page 59)	DOE-RL (2001) for shoreline monitoring and a future 300 Area SAP for post-remediation waste site monitoring
Five-Year Review Component	
1) Review and evaluate data regularly at former waste site locations where contaminants exist above levels for unrestricted use and unlimited exposure (Section XII, page 59)	Conducted every 5 years at the direction of the lead regulator
Plug-In Approach Component	
1) Evaluate newly discovered or candidate sites (Section XII, page 59)	Section 3.0 of this document

[a] Section and page number references correspond to the *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington* (EPA 2001).

[b] Waste sites cleaned up under an industrial land-use scenario within the 300 Area core "industrial core zone and contiguous areas" will be backfilled and regraded in a manner that will provide positive drainage away from areas where residual subsurface contamination could result in adverse groundwater impacts. The grading, to the extent practicable, will maximize the amount of large flat areas and minimize rolling contours or depressions where water may accumulate.

D4 = deactivation, decontamination, decommissioning, and demolition
EPA = U.S. Environmental Protection Agency
RAO = remedial action objective
RDR/RAWP = remedial design report/remedial action work plan
ROD = record of decision
SAP = sampling and analysis plan

2.0 BASIS FOR REMEDIAL ACTION

2.1 REMEDIAL ACTION OBJECTIVES (INDUSTRIAL AND UNRESTRICTED LAND USE)

The remedial action objectives (RAOs) set forth in the 300-FF-2 ROD (EPA 2001) are narrative statements that define the extent to which the waste sites require cleanup to protect human health and the environment. The 300-FF-2 ESD (EPA 2004) does not generally change the RAOs identified in the ROD, although risk levels for individual chemical contaminants are modified to reflect the unrestricted land-use scenario. The ESD changes the land-use scenario for specific sites under which the 300-FF-2 ROD RAOs need to be met. The following RAOs are taken from the 300-FF-2 ROD (EPA 2001).

- **RAO 1:** Prevent or reduce risk to human health, ecological receptors, and natural resources associated with exposure to wastes or soil contaminated above ARARs or risk-based criteria. For radionuclides, this RAO means prevention or reduction of risks from exposure to waste or contaminated soil that exceed the CERCLA cumulative excess cancer risk range of 10^{-4} to 10^{-6}. For chemicals, this RAO means prevention or reduction of risk from direct contact with waste or contaminated soil that exceed the *Washington Administrative Code* (WAC) 173-340-740[1] cumulative excess cancer risk goal of 10^{-5} and/or a hazard index of 1. For sites subject to the unrestricted land-use scenario, cleanup levels for individual chemical constituents are based on a 10^{-6} excess cancer risk.

  This RAO will be met by (1) removal of contaminated media above contaminant-specific remedial action goals (RAGs)/cleanup levels identified in the 300-FF-2 ROD (EPA 2001) or 300-FF-2 ESD (EPA 2004) and this RDR/RAWP, as applicable; (2) demonstration that residual contamination meets the cumulative risk and hazard index standards described in the above RAO for a period of 1,000 years; and (3) demonstration that CVP sample results pass the WAC 173-340-740(7)(e) three-part test for chemical contaminants of concern.[2] The process for achieving these RAGs/cleanup levels is discussed in the subsections that follow.

  The Tri-Parties have chosen an operational guideline of 15 mrem/yr above background over a period of 1,000 years after final remediation for a maximally exposed individual to address this RAO. Meeting this guideline will also be protective of ecological receptors, based on criteria specifying that dose rates shall not exceed 0.1 rad/day for terrestrial organisms and 1.0 rad/day for aquatic organisms and terrestrial plants. Levels may have to be adjusted further to be protective of terrestrial plants and animals, depending on the location of the individual waste site and the nature of the surrounding habitat. These decisions will be made on a site-specific basis and documented in the Administrative Record, as appropriate.

---

[1] The 300-FF-2 ROD was signed in April 2001, and the version of WAC 173-340-740 (1996) in effect at that time applies.

[2] The WAC 173-340-740(7)(e) three-part test consists of the following criteria: (1) the statistical value must be less than the cleanup level, (2) no single detection can exceed two times the cleanup criteria, and (3) the percentage of samples exceeding the cleanup criteria must be less than 10%.

- **RAO 2:** Prevent migration of contaminants through the soil column to groundwater and the Columbia River such that concentrations reaching groundwater and the river do not exceed maximum contaminant levels/nonzero maximum contaminant level goals under the Federal *Safe Drinking Water Act of 1974* (40 *Code of Federal Regulations* [CFR] 141) and/or State of Washington drinking water standards (WAC 246-290), ambient water quality criteria for protection of freshwater aquatic organisms under the Federal *Clean Water Act of 1977* (40 CFR 131) and/or State of Washington surface water quality standards (WAC 173-201A), and the WAC 173-340 groundwater cleanup standards [WAC 173-340-720(3)].

  This RAO will be met by removal of contaminated media above contaminant-specific RAGs/cleanup levels identified in the 300-FF-2 ROD (EPA 2001) or 300-FF-2 ESD (EPA 2004) and RDR/RAWP, as applicable, and demonstration that residual contamination will not exceed the groundwater and river water quality standards described in the above RAO for a period of 1,000 years.[1] The process for achieving these cleanup levels is discussed in the subsections that follow.

- **RAO 3:** Prevent or reduce occupational health risks to workers performing remedial action.

  This RAO will be achieved by compliance with established procedures and plans for subsurface excavation and waste management during remedial actions on the Hanford Site. Hazard analyses are conducted for remedial activities in accordance with the work control process. Hazard analysis data and proposed activities are examined, and controls for hazards that may pose a threat to workers, the public, or the environment are developed. SH-1, *Safety and Health*, ensures that the appropriate level of safety documentation is implemented for all surveillance and work activities. A site-specific health and safety plan (SSHASP) will be prepared.

- **RAO 4:** Minimize the general disruption of cultural resources and wildlife habitat, and prevent adverse impacts to cultural resources and threatened or endangered species.

  This RAO will be achieved through the implementation of resource review activities prior to remediation of a waste site. A cultural resource mitigation plan will be established prior to remediation at 300-FF-2 sites. Known cultural resources and traditional-use areas will be avoided whenever possible. If cultural resources are encountered during excavation, the State Historic Preservation Office and Native American Tribes will be consulted about minimizing impacts and taking appropriate actions for resource documentation or recovery.

[1] Generally this will be demonstrated using the "100 times groundwater cleanup level" and/or the "100 times the dilution-attenuation factor (DAF), times the surface water quality" soil value for chemical constituents, and site-specific RESidual RADioactivity (RESRAD) modeling for radiological constituents. These rules are conservative screening guidelines that may be supplemented with site-specific leach tests and additional RESRAD modeling, where appropriate. The "100 times groundwater" soil value assumes that a soil concentration 100 times acceptable groundwater concentrations will be protective of groundwater quality. The "100 times DAF" assumes that a soil concentration 100 times acceptable surface water quality standards, times a DAF of 2 will be protective of surface water quality. See Appendix B for more details. The use of the "100 times rule" is based on the WAC 173-340-740(3)(a)(ii)(A) regulation (1996 version) in effect at the time of ROD signature.

Remedial action activities will be performed in accordance with the *Mitigation Action Plan for the 300 Area of the Hanford Site* (DOE-RL 2002a), which discusses measures required to prevent or mitigate impacts to cultural and ecological resources within the remediation area. Ecological surveys will be performed prior to remediation activities to identify the species and habitat present and special precautions that should be taken to minimize adverse impacts. In addition, borrow sites will be located in areas where they will only impact low-quality habitat such as cheatgrass. The use of backfill will be implemented in accordance with DOE-RL (2002a). Appendix C of this document presents a revegetation plan for the 300 Area.

- **RAO 5:** Ensure that appropriate institutional controls and monitoring requirements are in place to protect future users at a remediated site.

  Institutional controls and monitoring requirements will be achieved through implementation of the requirements identified in the 300-FF-2 ROD (EPA 2001) and the *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions* (DOE-RL 2002b). The monitoring requirements of this RAO will also be met by compliance with the activities defined in the *Operation and Maintenance Plan for the 300-FF-5 Operable Unit* (DOE-RL 2001).

2.2 CLEANUP LEVELS

To achieve RAOs, numerical cleanup levels for industrial and unrestricted land-use were calculated and promulgated by the 300-FF-2 ROD (EPA 2001) and 300-FF-2 ESD (EPA 2004), respectively. These values were calculated based on best-available site characterization information and the generic conceptual site model for solid waste sites (shown in Figure 2-1). For calculation of direct exposure cleanup levels for radionuclides, it is assumed that the vadose zone consists of a contaminated zone remaining after completion of remedial action with an uncontaminated zone between the contaminated zone and the groundwater. For calculation of cleanup levels for radionuclides protective of groundwater and the river, the generic conceptual site model (shown in Figure 2-2) assumes that the entire vadose zone contains uniform residual contamination.

For nonradionuclides, the "100 times" rule from the 1996 revision of WAC 173-340 is used to determine cleanup levels protective of groundwater so the thickness of the vadose zone does not enter into the determination of cleanup levels for nonradionuclides.

For cleanup verification that residual concentrations of nonradionuclides are protective of groundwater and the river, first compare the soil concentrations to the cleanup levels. If the cleanup levels protective of groundwater are not exceeded, no further action is necessary. Where cleanup levels protective of groundwater are exceeded, RESidual RADioactivity (RESRAD) fate and transport modeling as described in Appendix B is used to determine if the contaminants are predicted to reach groundwater within 1,000 years at concentrations above groundwater cleanup levels. If not, residual soil contamination is protective of groundwater. If so, additional remedial actions must be considered.

2.2.1 Cleanup Levels for Industrial Land Use (300-FF-2 ROD)

The ROD cleanup levels for an industrial land-use scenario are included in Table 2-1 for chemical constituents and in Table 2-2 for radiological constituents. The methodology used to arrive at these values for the direct exposure and groundwater and river protection pathways is included in Appendix D of this document and Appendix F of the 300-FF-2 FFS (DOE-RL 2000a). Cleanup levels for additional constituents required for investigation of remaining 300 Area waste sites were calculated based upon the methodology described in Appendix D and in DOE-RL (2000a).

For radionuclides, the 300 Area industrial land-use scenario assumes that the exposure pathways for residual contamination will be (1) direct exposure to radiation, (2) ingestion of soil containing residual contamination, and (3) inhalation of particles in the air from residual contamination. It is assumed that drinking water is not obtained from groundwater sources and food products are not grown on the site. Although groundwater is not considered a potential exposure pathway in the qualitative risk assessment that supports the basis for remedial action, groundwater is considered to be a potential future drinking water source that must be restored to drinking water standards in a reasonable time frame, as established in the 300-FF-5 ROD (EPA 1996). The assumptions used for the 300 Area industrial land-use scenario are described in Appendix D of this document and Appendix F of the 300-FF-2 FFS (DOE-RL 2000a). Major assumptions include the following:

- **Direct Exposure Route.** The industrial land-use scenario assumes an adult worker is located in the area of residual contamination for approximately 1,500 hr/yr inside a building and 500 hr/yr outdoors for a period of 30 years (these correspond to a typical work year for an adult worker). When the worker is outdoors, it is assumed that clean fill does not provide shielding from residual contamination. Furthermore, it is assumed that indoor exposure to external radiation is 70% of the outdoor levels (based on the shielding provided by the building from direct exposure to radiation from residual contaminants in the soil).

- **Soil Ingestion Route.** The scenario assumes that a worker ingests 25 g of contaminated soil each year.

- **Inhalation Route.** The scenario assumes that the air contamination inside a building is 40% of the outside air particle concentration (which is assumed to be 0.0002 g/m^3 from residual soil contamination).

The key modeling parameters that affect the direct exposure cleanup levels for radionuclides are (1) the depth of cover/clean fill over residual contamination (none is assumed for the 300 Area), and (2) the time spent on the former waste site location, both indoors and outdoors (approximately 1,500 hr/yr inside a building and 500 hr/yr outdoors). Other parameters affect the modeling results but are not as significant as these two items.

Cleanup levels for chemicals in the 300 Area industrial land-use scenario are based on WAC 173-340-745, which assumes that the exposure pathway for residual contamination will be from ingestion of contaminated soil. Soil cleanup levels are calculated using the equations provided by WAC 173-340-745(4), Method C (Ecology 1996) for carcinogens and noncarcinogens. For both carcinogens and noncarcinogens, the calculations assume that a person weighing 70 kg (154 lb) ingests soil at a rate of 50 mg/day (18.25 g/yr), with a contact frequency of 40% and a gastrointestinal absorption rate of 100%. For carcinogens, the calculation is based on achieving a lifetime cancer risk goal of 1 in 100,000 (1×10^{-5}) for an exposure duration of 20 years and a lifetime of 75 years. For noncarcinogens, the calculation is based on achieving a hazard quotient of 1.

The 300-FF-2 ROD (EPA 2001) also requires that the soil cleanup level used not cause contamination of groundwater above drinking water standards or WAC 173-340-720(3), Method B cleanup levels (even though groundwater ingestion is not an applicable exposure pathway in the industrial land-use scenario). The key modeling parameters that affect the analysis of groundwater protection are (1) the hydraulic parameters of the aquifer and contaminant characteristics (e.g., distribution coefficient [K_d] values and leach rates), (2) the evapotranspiration rate (i.e., evaporation and plant uptake of precipitation), and (3) the amount of water applied for irrigation purposes. The key assumptions in the 300 Area industrial land-use scenario that affect the groundwater protection determination are (1) vegetation not requiring irrigation will be grown on the waste site after the cleanup is complete, or the waste site will be resurfaced to reduce water infiltration (thus allowing for a higher, 0.91, evapotranspiration coefficient to be used); and (2) no water will be applied to former waste site locations for irrigation purposes. These assumptions can only be modified if it can be demonstrated that there will be no negative impact on groundwater quality from residual contamination at former waste site locations (which requires EPA approval in advance).

Finally, it is assumed that (1) no sensitive human subpopulations (e.g., children) are permitted to come into contact with residual soil or debris contamination from waste sites (i.e., the cleanup levels are based on exposures to adults); (2) the period of analysis for evaluation of site risks and groundwater protection is 1,000 years; and (3) direct exposure of onsite workers to residual contamination to a depth of 4.6 m (15 ft) may occur (this represents a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of site development activities).

One thousand years was used as a reasonable endpoint for modeling calculations performed to support development of the 300-FF-2 OU preliminary remediation goals. The *Risk Assessment Guidance for Superfund (RAGS)* (EPA 1989) notes that consideration of multigenerational effects is useful when assessing risk posed by long-lived radionuclides. A 1,000-year time period is considered to be a reasonable endpoint for modeling, based on the following considerations:

- A 1,000-year time frame has been recognized by several regulatory programs as being long enough to identify health impacts for residual contaminants. Although some long-lived radioactive materials may remain on these sites as part of the cleanup and disposal process, the peak dose occurs in less than 1,000 years for most.

- When predicting thousands of years into the future, uncertainties become very large because of major potential changes in the geohydrologic regime at the site over long periods of time. The consequences of exposure to residual radioactivity at levels approaching background are small, and considering the large uncertainties, long-term modeling is considered to be of little value.

- Time frames greater than 1,000 years are considered to be more appropriate for evaluating long-term performance of disposal facilities, as opposed to residual contaminants at sites that have undergone a cleanup action.

Based on this information, it was concluded that 1,000 years is a reasonable time period for evaluation of residual risk for the 300-FF-2 OU waste sites.

2.2.2 Cleanup Levels for Unrestricted Land-Use Scenario (300-FF-2 ESD)

The cleanup levels for an unrestricted land-use scenario are included in Table 2-1 for chemical constituents and in Table 2-2 for radiological constituents. The methodology used to arrive at these values described in Appendix D of this document is similar to that in Appendix F of the 300-FF-2 FFS (DOE-RL 2000a) and is identical to the methodology used in developing the 100 Area unrestricted land-use cleanup levels included in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005). However, the radionuclide cleanup levels are developed using area-specific generic input parameters that result in some radionuclides showing somewhat different cleanup levels. Cleanup levels for additional constituents required for investigation of remaining 300 Area waste sites were calculated based upon the methodology described in DOE-RL (2005).

The 300 Area unrestricted land-use scenario is identical to the 100 Area unrestricted or rural-residential land-use scenario, except for site-specific hydrological parameters. For the purpose of using the RESRAD dose model, unrestricted future use in the 300 Area is represented by an individual resident in a rural-residential setting. This resident is assumed to consume and irrigate crops raised in a backyard garden; consume animal products (e.g., meat and milk) from locally raised livestock or meat from game animals (including fish); and live in a residence on the waste site. The exposure pathways considered in estimating dose from radionuclides in soil are inhalation; soil ingestion; ingestion of crops, meat, fish, drinking water, and milk; and external gamma exposure. This individual is conservatively assumed to spend 80% of his/her lifetime onsite. It is assumed that drinking water and irrigation water is obtained from groundwater impacted by the waste site. Groundwater is considered to be a potential future drinking water source that must be restored to drinking water standards in a reasonable time frame as established in the 300-FF-5 ROD (EPA 1996). The assumptions used for the 300 Area unrestricted land-use scenario are described in Appendix D of this document.

Cleanup levels for chemicals or nonradionuclides in the 300 Area unrestricted land-use scenario are based on the 1996 amendment of WAC 173-340-740(3), which assumes that the exposure pathway for residual contamination will be from ingestion, inhalation, and consumption of contaminated groundwater. Soil cleanup levels are calculated using the equations provided by WAC 173-340-740(3) for carcinogens and noncarcinogens. For both carcinogens and noncarcinogens, the calculations assume that a resident with an average body weight 16 kg (35 lb) over the period of exposure ingests soil at a rate of 200 mg/day (73 g/yr), with a frequency of contact of 100% and a gastrointestinal absorption rate of 100%. For carcinogens, the calculation is based on achieving a lifetime cancer risk goal of 1 in 1,000,000 (1×10^{-6}) for an exposure duration of 6 years and a lifetime of 75 years. For noncarcinogens, the calculation is based on achieving a hazard quotient of 1.

The 300-FF-2 ROD (EPA 2001) also requires that the soil cleanup level used not cause contamination of groundwater above drinking water standards or WAC 173-340-720(3), Method B cleanup levels. The key modeling parameters that affect the analysis of groundwater protection are (1) the hydraulic parameters of the aquifer and contaminant characteristics (e.g., K_d values and leach rates), (2) the evapotranspiration rate (i.e., evaporation and plant uptake of precipitation), and (3) the amount of water applied for irrigation purposes. Irrigation water is assumed to be applied at agronomic rates (76 cm/yr [30 in./yr]), surface vegetation is assumed to exist resulting in a evapotranspiration coefficient of 0.91, and the unrestricted land-use exposure pathways are assumed to include drinking water ingestion.

On the same basis as described under the industrial land-use scenario, it is assumed that the period of analysis for evaluation of site risks and groundwater protection is 1,000 years, and direct exposure of onsite residents to residual contamination to a depth of 4.6 m (15 ft) may occur (this represents a reasonable estimate of the soil depth that could be excavated and distributed at the soil surface as a result of site development activities).

2.2.3 Ecological Risk Evaluations

Per Tri-Party Agreement Change Number TPA-CN-179 (DOE-RL 2007a), when evaluating data for the closeout of waste sites, DOE will compare the radionuclide and nonradionuclide data against DOE's RESRAD-BIOTA, EPA's ecological soil screening values at www.epa.gov/ecotox/ecossl, and the WAC 173-340 table 749-3 ecological screening values at http://www.ecy.wa.gov/programs/tcp/policies/terrestrial/table_749-3.htm.

- Ecological protectiveness will be presumed when ecological screening values are not exceeded.
- When ecological screening levels are exceeded and concentrations are less than background, ecological protectiveness will be presumed.
- Ecology, EPA, and DOE guidance allow the use of additional lines of evidence to determine ecological protectiveness when screening and background levels are exceeded. After consideration of additional lines of evidence, there is a Scientific/Management Decision Point.

The potential significance of any exceedances will be evaluated and discussed between the U.S. Department of Energy, Richland Operations Office (DOE-RL) and the lead regulatory agency. The conclusion of the ecological risk evaluation (including, where appropriate, deferral to completion of the risk assessment associated with development of the final RODs) will be documented in the relevant CVP or RSVP. Ecological risk conclusions are interim until the final RODs for the 100 and 300 Areas are issued and placed in the Administrative Record.

2.3 APPLICATION OF CLEANUP LEVELS

2.3.1 Cleanup Levels Based on Vadose Zone Depth

Waste sites may have different cleanup levels for individual constituents, depending on whether contamination is present above or below 4.6 m (15 ft) (see the 300-FF-2 FFS, Appendix F [DOE-RL 2000a]). For vadose zone soils or debris in the top 4.6 m (15 ft), cleanup will be achieved when (1) contaminant concentrations are demonstrated to be at or below direct contact cleanup levels within the CERCLA risk range of 10^{-4} to 10^{-6} (operationally equivalent to a dose of 15 mrem/yr), and (2) contaminant concentrations meet cleanup levels that provide protection of groundwater and the Columbia River. For vadose zone soils or debris below 4.6 m (15 ft), direct exposure/direct contact do not apply; however, cleanup levels protective of groundwater and the Columbia River must be met.

There may be some limited circumstances where contaminated soil, debris, or engineered structures above cleanup standards may be left in place below a depth of 4.6 m (15 ft). Factors such as nature and form of contaminated material, implementability, cost, volume, and impacts to ecological and cultural resources may be used to evaluate the extent of excavation at depths greater than 4.6 m (15 ft). It is anticipated that these exceptions will only be necessary under very limited circumstances. Appropriate remedy selection change documentation (e.g., ESD or ROD amendment, based on the nature of the exception) and public involvement will be required. Regardless of these factors, protection of groundwater and the Columbia River must be achieved for any contamination left below 4.6 m (15 ft) (i.e., alternative remedial measures must be evaluated).

2.3.2 Multiple Contaminant Concentrations

Cumulative effects associated with the presence of multiple radionuclide or chemical contaminants at waste sites may require a reduction in the cleanup levels for individual constituents to meet applicable RAGs in the direct exposure, groundwater, and river protection pathways. This modification of cleanup levels, if necessary, would take place during the verification of site cleanup following remediation. This includes the following standards to be met for cumulative effects of multiple contaminants:

- Cumulative risk of all radionuclides must be within the CERCLA risk range of 10^{-4} to 10^{-6} (operationally equivalent to a dose of 15 mrem/yr).
- Summation of the predicted groundwater dose from all beta- and photon-emitting radionuclides must be less than 4 mrem/yr.
- Total excess cancer risk from all chemical constituents must not exceed 1 in 100,000 (1×10^{-5}).

- Total of all toxicity hazard quotients for chemical or radiological constituents must be a hazard index of less than 1.

2.4 VERIFICATION OF WASTE SITE CLEANUP

Appendix B outlines the process by which CVPs are prepared and reviewed. The purpose of the CVP is to document that the relevant waste site has been remediated in accordance with the applicable ROD, and that the RAOs under the applicable land-use scenario have been achieved. Site-specific data evaluations are presented in the CVP to demonstrate that the waste site, following remediation, does not pose an unacceptable risk to human health and the environment.

Site-specific factors such as the concentration of the contaminant at depth, the type of waste site (solid or liquid), and contaminant K_ds are used to verify that remaining concentrations of contaminants are protective of groundwater and the Columbia River (see Appendix B). Development of a site-specific contaminant distribution model may be necessary to more accurately describe actual site conditions and show that contaminant concentrations decrease with soil depth. Use of analogous sites and process knowledge, or a test pit or borehole, will be needed to establish the distribution of contaminants with respect to soil depth. A site-specific contaminant distribution model, using actual field data, will more accurately predict potential impacts of vadose zone soil contaminants on groundwater and the river. The model information will be used to determine if the remaining residual concentrations of contaminants in the unsaturated vadose zone are protective of groundwater and the river, or if further excavation of remaining contamination in the unsaturated vadose zone is required. Results will be documented in the CVP.

2.5 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The "National Oil and Hazardous Substances Contingency Plan" (NCP) (40 CFR 300) and 300-FF-2 ROD (EPA 2001) require that the remedial actions described in this document comply with the ARARs established in the ROD. The purpose of this section is to discuss how each of the ARARs identified in the ROD will be met during remedial action. Note that the 300-FF-2 ESD (EPA 2004) does not change the general ARARs from the ROD.

All activities associated with the remedial action for the source area sites covered under the ROD are anticipated to occur onsite, as that term is defined under the NCP. As a result, the remedial actions described in this document need only meet the substantive requirements of the ARARs established in the 300-FF-2 ROD (EPA 2001).

The ARARs for this RDR/RAWP are those that were in effect at the time the 300-FF-2 ROD (EPA 2001) was signed. The chemical-, action-, and location-specific ARARs that were in effect for the 300-FF-1 ROD (EPA 1996) were also in effect at the time the 300-FF-2 ROD was signed, and thus are presented in this section. Section 2.5.2 includes only the criteria, advisories, or guidance to be considered that were in effect at the time the 300-FF-2 ROD was signed.
If any requirement that would be applicable or relevant and appropriate for the selected remedial

action is promulgated subsequent to the ROD being signed, the EPA will review the requirement and determine whether the selected remedial action is still protective in light of the new requirement. This determination will be documented in the Administrative Record. Additional background information on these ARARs can be found in Appendix C of the 300-FF-2 FFS (DOE-RL 2000a).

2.5.1 ARARs

"Model Toxics Control Act – Cleanup Regulation" (WAC 173-340 [as amended in 1996]). Certain risk-based cleanup levels are considered ARARs for establishing chemical cleanup levels in soil. The remedial action will comply with these requirements through the removal of contaminants to levels prescribed in the 300-FF-2 ROD (EPA 2001) or 300-FF-2 ESD (EPA 2004), as modified through the process described in this RDR/RAWP, and through routine monitoring during remedial activities.

Safe Drinking Water Act of 1974. Maximum contaminant levels for public drinking water supplies are considered relevant and appropriate for protecting groundwater. The remedial action will comply with these requirements through the removal of contaminants to levels prescribed in the 300-FF-2 ROD (EPA 2001), as modified through the process described in this RDR/RAWP, that could cause exceedances of groundwater or river protection standards, based on drinking water standards.

***Clean Water Act of 1977* for "Protection of Aquatic Life," 40 CFR 131.** These requirements are considered relevant and appropriate for establishing soil cleanup levels that are protective of the Columbia River. The remedial action will comply with these requirements through the removal of contaminants to levels prescribed in the 300-FF-2 ROD (EPA 2001), as modified through the process described in this RDR/RAWP, and through routine monitoring during remedial activities.

"Water Quality Standards for Surface Waters of the State of Washington" (WAC 173-201A). These requirements are considered relevant and appropriate for establishing soil cleanup levels that are protective of the Columbia River. The remedial action will comply with these requirements through the removal of contaminants to levels prescribed in the 300-FF-2 ROD (EPA 2001), as modified through the process described in this RDR/RAWP, and continued monitoring.

***Clean Air Act of 1977,* "National Primary and Secondary Ambient Air Quality Standards" (40 CFR 50) and "General Standards for Maximum Emissions" (WAC 173-400-040).** Authority to implement the national air quality standards has been delegated to the state of Washington and is implemented in WAC 173-400. WAC 173-400-040 establishes general standards for emissions. The ARAR portion of WAC 173-400-040 is (1), (3), and (8). Compliance with these sections will be achieved by the use of fixatives and water sprays to control fugitive emissions of contaminated dust and particulates.

"Controls for New Sources of Toxic Air Pollutants" (WAC 173-460). These requirements are considered applicable should a treatment technology that involves air emissions be necessary during the implementation of the remedial action. No treatment requirements have been identified at this time that would be required to meet the substantive applicable requirements of WAC 173-460. Treatment of some waste encountered during the removal action may be required to meet ERDF waste acceptance criteria. In most cases, the type of treatment anticipated would consist of solidification/stabilization techniques or macroencapsulation such as with grout, and WAC 173-460 would not be considered an ARAR. The remedial action will comply with these requirements, if applicable through the removal/treatment of contaminants under controlled methods prescribed in this RDR/RAWP.

***Clean Air Act of 1977*, "National Emissions Standards for Hazardous Air Pollutants" (40 CFR 61) and "Radiation Protection – Air Emissions" (WAC 246-247).** This documentation specifies that airborne emissions from all combined operations at the Hanford Site may not exceed 10 mrem/yr (40 CFR 61.92) effective dose equivalent to any member of the public or hypothetical offsite maximally exposed individual. The radionuclide emission standard applies to fugitive, diffuse, and point-source air emissions of radionuclides generated during excavation or treatment of contaminated soil. Compliance with the standard is determined on a Hanford Site-wide basis and is documented in the annual radionuclide air emissions report for the Hanford Site. WAC 246-247-075(1), (3) and (8) require monitoring for point sources, nonpoint sources, and fugitive emissions of radioactive material. WAC 246-247-040(3) also requires the application of best available radionuclide control technology to control radioactive air emissions. Standard construction techniques such as using water spray to control fugitive emissions of contaminated dust and particulates will be used.

Asbestos-containing material may be encountered during excavation of waste sites that require remediation. The no visible emission standard and the packaging, labeling, and transportation requirements of 40 CFR 61.150 will be met. Additionally, removal of asbestos on pipelines or other structures that are excavated as part of the remedial actions will be handled consistent with applicable portions of the procedures for asbestos emission control described in 40 CFR 61.145(c).

"State of Washington Dangerous Waste Regulations" (WAC 173-303). These requirements are considered applicable for the identification, treatment, storage, and land disposal of dangerous wastes. Actions will comply with these requirements through adherence to site waste management procedures, as prescribed in this RDR/RAWP, removal of contaminants, continued groundwater monitoring, and adherence to receiving facility waste acceptance criteria.

***Resource Conservation and Recovery Act of 1976* (RCRA) Subtitle C, 40 CFR 261, 40 CFR 264, and 40 CFR 268**. These requirements are considered applicable for the identification, treatment, storage, and land disposal of hazardous wastes. The remedial action will comply with these requirements through adherence to site waste management procedures as prescribed in this RDR/RAWP, removal of contaminants, continued groundwater monitoring, and adherence to waste management procedures and receiving facility waste acceptance criteria.

U.S. Department of Transportation (DOT) Requirements for the Transportation of Hazardous Materials (49 CFR 100 to 179). These requirements will be applicable for any wastes that are transported on public highways. The remedial action will comply with these requirements through adherence to site waste management procedures, as prescribed in this RDR/RAWP.

"Minimum Standards for Construction and Maintenance of Wells" (WAC 173-160 and WAC 173-162). These are applicable regulations for the location, design, construction, and abandonment of water supply and resource protection wells. The remedial action will meet these requirements through compliance with established site well construction and maintenance procedures.

***Toxic Substances Control Act of 1976,* implemented via 40 CFR 761.** This statute and regulation are applicable to the management and disposal of remediation waste containing regulated concentrations of polychlorinated biphenyls (PCBs), including specific requirements for PCB remediation waste. The remedial action will comply with these requirements through adherence to waste management procedures and receiving facility waste acceptance criteria, as prescribed in this RDR/RAWP.

***Archeological and Historical Preservation Act of 1974,* 16 U.S.C. 469; 36 CFR 65.** These requirements are applicable in order to recover and preserve artifacts in areas where an action may cause irreparable harm, loss, or destruction of significant artifacts. The remedial action will comply with these requirements through an assessment and mitigation of archeological and historic sites within the 300 Area prior to remedial action, as prescribed in this RDR/RAWP.

***Archaeological Resources Protection Act of 1979*, 43 CFR 7.** This statute is applicable in order to secure, for the present and future benefit of the American people, the protection of archaeological resources and sites that are on public lands. The remedial action will comply with these requirements through an assessment and mitigation of archeological and historic sites within the 300 Area prior to remedial action, as prescribed in this RDR/RAWP.

***Native American Graves Protection and Repatriation Act of 1990*.** This statute is applicable to any sites should Native American remains be found, and provides requirements for Federal agency responsibilities with regard to these discoveries. The remedial action will comply with these requirements through an assessment and mitigation of Native American remains within the 300 Area prior to remedial action, as prescribed in this RDR/RAWP.

***National Historic Preservation Act of 1966,* 36 CFR 800.** These requirements are applicable to actions in order to ensure that Federal agencies consider the impacts of their actions on properties that are on or are eligible for the National Register of Historic Places. The remedial action will comply with these requirements through an assessment and mitigation of impacts to properties listed on or eligible for inclusion on the National Register of Historic Places.

***Endangered Species Act of 1973,* 50 CFR 200, 50 CFR 402.** These requirements are applicable in order to conserve critical habitat upon which endangered or threatened species depend. Consultation with the U.S. Department of the Interior is required, or in the case of anadromous fish species, consultation with the National Marine Fisheries Service, as applicable. The remedial action will comply with these requirements through an assessment and mitigation of endangered species or their habitat within the 300 Area prior to remedial action, as prescribed in this RDR/RAWP.

***Migratory Bird Treaty Act of 1918*, 50 CFR 10-24.** These requirements are applicable to the protection of migratory bird species, including upland species and waterfowl, associated with the 300 Area. The remedial action will comply with these requirements by following guidance prescribed in the *Mitigation Action Plan for the 300 Area of the Hanford Site* (DOE-RL 2002a), and through the performance of site-specific ecological resource reviews prior to remedial action, as prescribed in this RDR/RAWP.

2.5.2 Other Criteria, Advisories, or Guidance to be Considered for this Remedial Action

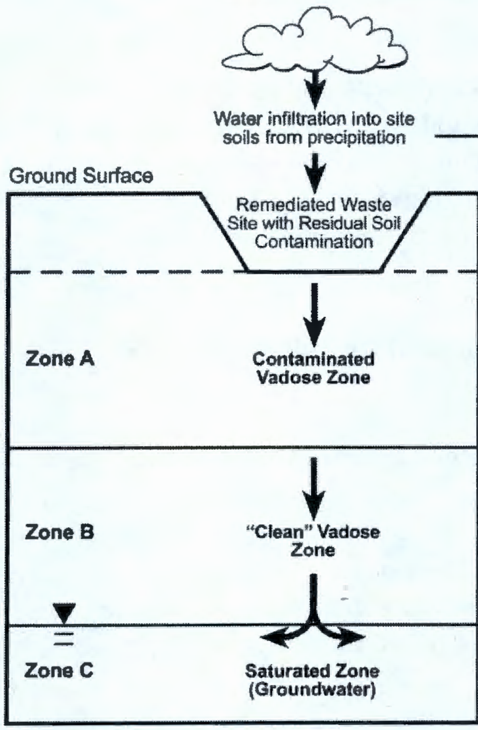
***Environmental Restoration Disposal Facility Waste Acceptance Criteria* (WCH 2008).** The ERDF waste acceptance criteria delineate primary requirements, including regulatory requirements, specific isotopic constituents and contamination levels, the dangerous/hazardous constituents and concentrations, and the physical/chemical waste characteristics that are acceptable for disposal of wastes at the ERDF. The remedial action will comply with these requirements through adherence to waste management procedures and receiving facility waste acceptance criteria, as prescribed in this RDR/RAWP.

"EPA Radiation Protection Guidance for Exposure to the General Public" (59 *Federal Register* [FR] 66414). EPA protection guidance recommends (nonmedical) radiation doses to the public from all sources and pathways to not exceed 100 mrem/yr above background. It also recommends that lower dose limits be applied to individual sources and pathways. One such individual source is residual environmental radiation contamination after the cleanup of a site. Lower dose limits and individual pathways are referred to as secondary limits. The remedial action will comply with these requirements through removal of contaminants to levels prescribed in this ROD and through routine monitoring during remedial activities, as prescribed in this RDR/RAWP.

***The Future For Hanford: Uses and Cleanup, The Final Report of the Hanford Future Site Uses Working Group* (Drummond 1992).** The remedial action considers this guidance through the establishment of RAOs for industrial land use.

Record of Decision: Hanford Comprehensive Land Use Plan Environmental Impact Statement (64 FR 61615). The remedial action considers this guidance through the establishment of RAOs for industrial land use.

Figure 2-1. Generic Conceptual Site Model for Direct Exposure.



Major Assumptions in Generic Conceptual Site Model for Direct Exposure[a]

Zone		Soil Concentration	Kd Value	Fate and Transport Mechanisms
	Remediated Waste Site with Residual Soil Contamination	–	–	The model begins at the bottom of the remediated waste site.
Zone A	**Contaminated Vadose Zone**	95% UCL	Contaminant Specific (same for all zones)	Some contaminants are leached, or desorbed, from soil by infiltration water.
Zone B	**"Clean" Vadose Zone**	"Clean"	Same as above	Some contaminants in infiltration waters are adsorbed (or precipitated) by clean soil. Some continue to groundwater in dissolved form.
Zone C	**Saturated Zone (Groundwater)**	N/A	Same as above	Dissolved contaminants in infiltration water mix with groundwater.

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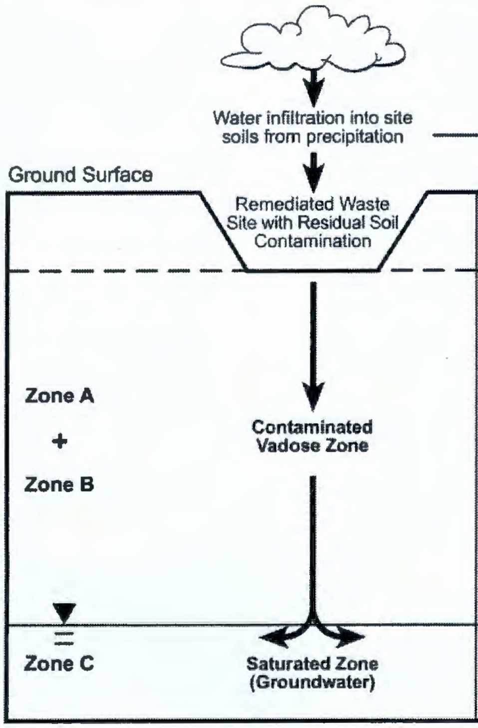
a In the generic site model for direct exposure, a conservative assumption is made that the upper 4.6 m (15 ft) of the vadose zone (Zone A) is contaminated and the lower 5 m (16.4 ft) (Zone B) is uncontaminated. Subsequently, for cleanup verification, a tiered approach is applied in which the generic conceptual site model is modified with site-specific information as appropriate.

Kd = Distribution coefficient
N/A = Not applicable
UCL = Upper confidence limit

Figure 2-2. Generic Conceptual Site Model for Groundwater and River Protection.



Major Assumptions in Generic Conceptual Site Model for Groundwater and River Protection[a]

Soil Concentration	Kd Value	Fate and Transport Mechanisms
–	–	The model begins at the bottom of the remediated waste site.
95% UCL	Contaminant Specific	The entire vadose zone (Zone A + Zone B) contains uniform residual contamination. As the infiltration water moves downward through the contaminated zone, contaminants are leached or desorbed from the soil and carried with the water.
N/A	Same as Above	Infiltration water with contaminants move into the saturated zone and mixes with groundwater.

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[a] In the generic site model for groundwater and river protection, the conservative assumption is made that the remediation excavation is backfilled with 4.6 m (15 ft) of uncontaminated soil and the entire remaining 5 m (16.4 ft) thick vadose zone (Zone A + Zone B) is contaminated. Subsequently, for cleanup verification, a tiered approach is applied in which the generic conceptual site model is modified with site-specific information as appropriate.

Kd = Distribution coefficient
N/A = Not applicable
UCL = Upper confidence limit

Figure 2-3. Observational Approach Path to Waste Site Closeout.

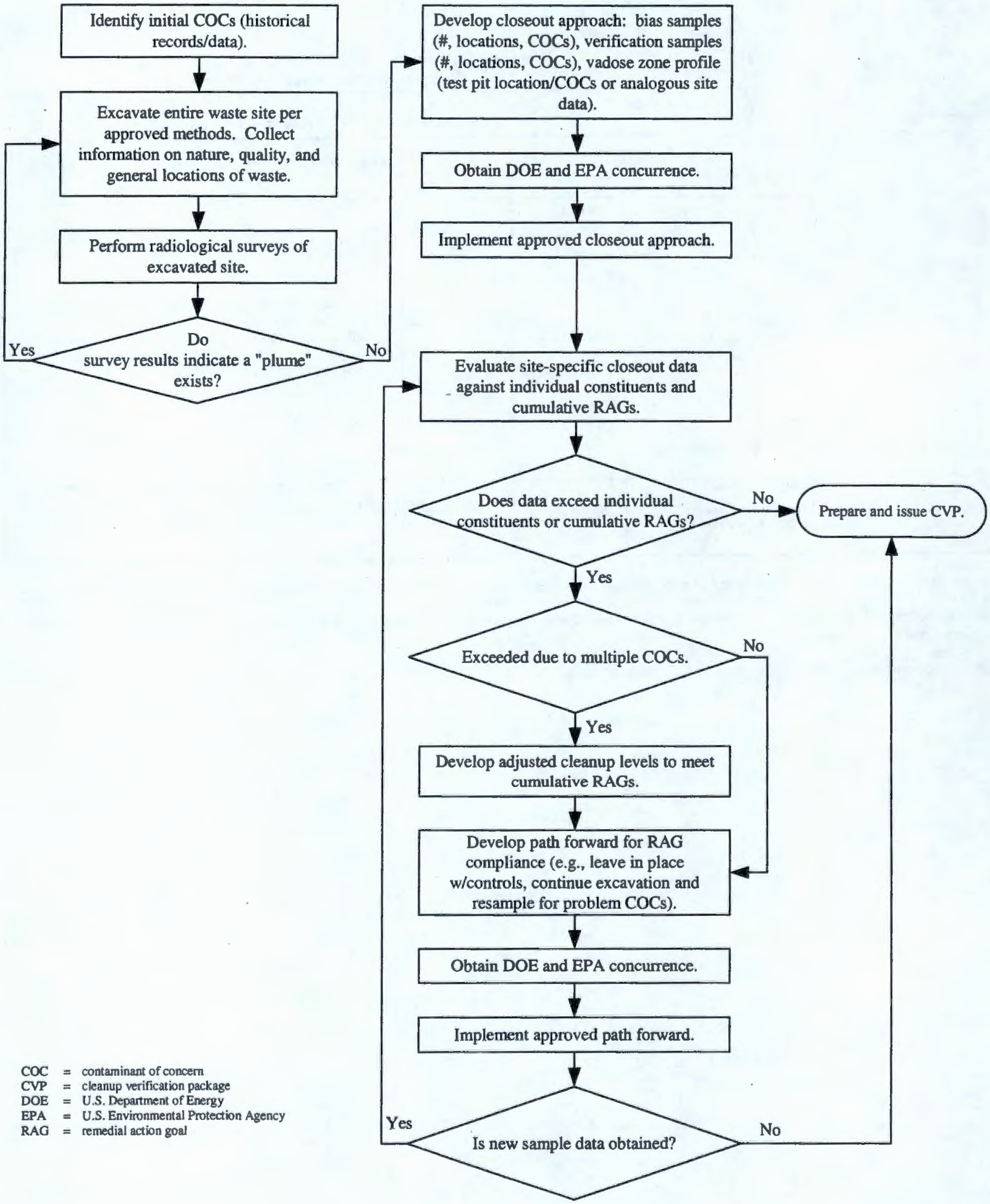


Table 2-1. Summary of 300 Area Industrial and Unrestricted (Residential) Nonradionuclide Cleanup Levels. (4 Pages)

Contaminant	K_d Value (mL/g)	Back-ground (mg/kg)	Soil Cleanup Levels (mg/kg) [a]			
			Industrial Direct Exposure	Residential Direct Exposure	Residential Protective of Ground-water	Residential Protective of the River
Metals						
Antimony	45	5 [b]	1,400	32	5 [c]	5 [c]
Arsenic	3	6.5	58	20 [d]	20 [d]	20 [d]
Barium	25	132	4,900 [e]	1,600 [e]	200	400
Beryllium	790	1.51	104 [e]	10.4 [e]	1.51 [c]	1.51 [c]
Boron	3	NA	700,000	16,000	320	NA
Cadmium	30	0.81 [b]	139 [e]	13.9 [e]	0.81 [c]	0.81 [c]
Chromium, total	200	18.5	5.25E+06	120,000	18.5 [c]	18.5 [c]
Chromium VI	0	NA	21 [e]	2.1 [e]	4.8	2
Cobalt	50	15.7	1,050	24	15.7 [c]	NA
Copper	22	22.0	130,000	2,960	59.2	22.0 [c]
Lead	30	10.2	1,000	353	10.2 [c]	10.2 [c]
Lithium	50	33.5	7,000	160	33.5 [c]	NA
Manganese	50	512	165,000	3,760	512 [c]	512 [c]
Mercury	30	0.33	1,050	24	0.33 [c]	0.33 [c]
Methyl mercury	NA	NA	350	8	0.16	NA
Molybdenum	20	NA	17,500	400	8	NA
Nickel	65	19.1	70,000	1,600	19.1 [c]	27.4
Selenium	5	0.78 [b]	17,500	400	5	1
Silver	90	0.73	17,500	400	8	0.73 [c]
Strontium	25	NA	2.10E+06	48,000	960	NA
Tin	130	NA	2.10E+06	48,000	960	NA
Uranium	8.9 [d]	3.21	505	81	53	106
Vanadium	1,000	85.1	24,500	560	85.1 [c]	NA
Zinc	30	67.8	1.05E+06	24,000	480	67.8 [c]
Inorganics and TPH						
Chloride	0	100	NA	NA	25,000	NA
Cyanide	0	NA	70,000	1,600	20	1.04
Fluoride	150	2.81	210,000	4,800	96	400
Nitrate (as Nitrogen)	0	11.8	5.60E+06	8,000	1,000	2,000
Nitrite (as Nitrogen)	0	NA	350,000	8,000	100	200
Sulfate	0	237	NA	NA	25,000	NA
Sulfide	0	NA	NA	NA	NA	NA
TPH	50	NA	200	200	200	200
VOAs						
Acetone [f]	0.0006	NA	3.15E+06	72,000	720	NA
Carbon tetrachloride [f]	0.152	NA	1,010	7.69	0.0337	0.05
Methylene chloride [f]	0.01	NA	17,500	133	0.5	0.94
Toluene [f]	0.14	NA	28,000	6,400	64	1,360
Xylene [f]	0.233	NA	700,000	16,000	160	NA

Table 2-1. Summary of 300 Area Industrial and Unrestricted (Residential) Nonradionuclide Cleanup Levels. (4 Pages)

Contaminant	K_d Value (mL/g)	Back-ground (mg/kg)	Soil Cleanup Levels (mg/kg) [a]			
			Industrial Direct Exposure	Residential Direct Exposure	Residential Protective of Ground-water	Residential Protective of the River
Semivolatiles						
Acenaphthene	4.9	NA	210,000	4,800	96	129
Acenaphthylene [g]	6.12	NA	210,000	4,800	96	129
Anthracene	23.5	NA	1.05E+06	24,000	240	1,920
Benzo(a)anthracene	360	NA	180	1.37	0.015 [h]	0.015 [h]
Benzo(a)pyrene	5,500	NA	18	0.137	0.015 [h]	0.015 [h]
Benzo(b)fluoranthene	1,230	NA	180	1.37	0. 015 [h]	0. 015 [h]
Benzo(k)fluoranthene	1,230	NA	180	1.37	0. 015 [h]	0. 015 [h]
Benzo(g,h,i)perylene [g]	2,680	NA	105,000	2,400	48	192
Bis(2-chloro-1-methylethyl) ether	0.0392	NA	1,880	14.3	0.33 [h]	7.50
Bis(2-chloroethoxy)methane [g]	0.00277	NA	119	0.909	0.33 [h]	0.33 [h]
Bis(2-chloroethyl) ether	0.0760	NA	119	0.909	0.33 [h]	0.33 [h]
Bis(2-ethylhexyl)phthalate	110	NA	9,380	71.4	0.6	0.36
Bromophenylphenyl ether; 4-	4.16	NA	NA	NA	NA	NA
Butylbenzylphthalate	13.8	NA	700,000	16,000	320	250
Carbazole	200	NA	6,560	50	0.438	NA
Chloro-3-methylphenol; 4- [g]	NA	NA	175,000	4,000	80	NA
Chloroanilene; 4-	0.0725	NA	14,000	320	6.4	NA
Chloronaphthalene; 2-	2.98	NA	280,000	6,400	64	206
Chlorophenol;2-	0.388	NA	17,500	400	4	19.34
Chlorophenylphenyl ether; 4-	NA	NA	NA	NA	NA	NA
Chrysene	200	NA	1,800	13.7	0.12	0.1 [h]
Dibenz(a,h)anthracene	1,790	NA	180	1.37	0.03 [h]	0.03 [h]
Dibenzofuran	11.3	NA	7,000	160	3.20	NA
Dichlorobenzene; 1,2-	0.379	NA	315,000	7,200	60.0	540
Dichlorobenzene; 1,3-	0.434	NA	105,000	2,400	24.0	80
Dichlorobenzene; 1,4-	0.616	NA	5,470	41.7	0.33 [h]	0.972
Dichlorobenzidine; 3,3-	0.724	NA	292	2.22	0.33 [h]	0.33 [h]
Dichlorophenol; 2,4-	0.147	NA	10,500	240	4.80	18.6
Diethylphthalate	0.0820	NA	2.80E+06	64,000	1,280	4,600
Dimethylphthalate	0.0371	NA	3.50E+06	80,000	1,600	14,400
Dimethylphenol; 2,4-	0.209	NA	70,000	1,600	32.0	110.6
Di-n-butylphthalate	1.57	NA	350,000	8,000	160	540
Di-n-octylphthalate	83,200	NA	70,000	1,600	32	NA
Dinitro-2-methylphenol; 4,6-	0.6015	NA	350	8.00	0.33 [h]	NA
Dinitrophenol; 2,4-	0.00001	NA	7,000	160	3.20	14
Dinitrotoluene; 2,4-	0.0955	NA	7,000	160	3.20	0.33 [h]
Dinitrotoluene; 2,6-	0.0692	NA	3,500	80.0	1.60	136
Ethylene glycol	0.001	NA	7.00E+06	160,000	320	NA
Fluoranthene	49.1	NA	140,000	3,200	64	18.0
Fluorene	7.71	NA	140,000	3,200	64	260

Table 2-1. Summary of 300 Area Industrial and Unrestricted (Residential) Nonradionuclide Cleanup Levels. (4 Pages)

Contaminant	K_d Value (mL/g)	Back-ground (mg/kg)	Soil Cleanup Levels (mg/kg) [a]			
			Industrial Direct Exposure	Residential Direct Exposure	Residential Protective of Ground-water	Residential Protective of the River
Hexachlorobenzene	80	NA	82	0.625	0.33 [h]	0.33 [h]
Hexachlorobutadiene	53.7	NA	700	12.8	0.33 [h]	0.33 [h]
Hexachlorocyclopentadiene	200	NA	21,000	480	5	48
Hexachloroethane	1.78	NA	3,500	71.4	0.313	0.38
Hydrazine	0.0143	NA	43.8	0.333	0.33 [h]	NA
Indeno(1,2,3-cd) pyrene	3,470	NA	180	1.37	0.33 [h]	0.33 [h]
Isophorone	0.0468	NA	138,000	1,050	9.21	1.68
Methylnaphthalene; 2-	2.98	NA	14,000	320	3.2	NA
Methylphenol; 2- (cresol;o-)	0.434	NA	175,000	4,000	80.0	NA
Methylphenol; 4- (cresol;p-)	0.434	NA	17,500	400	8.00	NA
Naphthalene	1.19	NA	70,000	1,600	16.0	988
Nitroaniline; 2-	0.0527	NA	105,000	240	2.4	NA
Nitroaniline; 3-	0.0516	NA	1,050	24	0.33 [h]	NA
Nitroaniline; 4-	0.0516	NA	6,250	47.6	0.33 [h]	NA
Nitrobenzene	0.191	NA	7,000	160	1.60	3.4
Nitrophenol; 2-	0.309	NA	NA	NA	NA	NA
Nitrophenol; 4-	0.309	NA	28,000	640	12.8	1,254
Nitroso-di-n-propylamine;N-	0.0240	NA	18.8	0.33 [h]	0.33 [h]	0.33 [h]
Nitrosodiphenylamine;N-	1.29	NA	26,800	204	1.79	1.946
Pentachlorophenol	0.592	NA	1,090	8.33	0.33 [h]	0.33 [h]
Phenanthrene [g]	23.5	NA	1.05E+06	24,000	240	1,920
Phenol	0.0288	NA	1.05E+06	24,000	480	4,200
Pyrene	68	NA	105,000	2,400	48	192
Tributyl phosphate	1.89	NA	24,300	185	3.3 [h]	NA
Trichlorobenzene; 1,2,4-	1.66	NA	35,000	800	7	45.4
Trichlorophenol; 2,4,5-	1.60	NA	350,000	8,000	160	NA
Trichlorophenol; 2,4,6-	0.381	NA	11,900	90.9	0.795	0.42
Pesticides and PCBs						
Aldrin	48.7	NA	7.72	0.0588	0.002 [h]	0.002 [h]
BHC, alpha	1.76	NA	20.8	0.159	0.002 [h]	0.002 [h]
BHC, beta	2.14	NA	72.9	0.556	0.00486	0.00554
BHC, delta	3.38	NA	NA	NA	NA	NA
BHC, gamma (Lindane)	1.35	NA	101	0.769	0.00673	0.0038 [h]
Chlordane (alpha, gamma)	51	NA	375	2.86	0.025	0.01652 [h]
Dalapon	0.00274	NA	105,000	2,400	20	NA
Db; 2,4-	0.1	NA	28,000	640	12.8	NA
DDD, 4,4'-	45.8	NA	547	4.17	0.0365	0.0033 [h]
DDE, 4,4'-	86.4	NA	386	2.94	0.0257	0.0033 [h]
DDT, 4,4'-	678	NA	386	2.94	0.0257	0.0033 [h]
Dicambra	0.0288	NA	105,000	2,400	48	NA
Dichlorophenoxyacetic acid; 2,4-	0.0294	NA	35,000	640	7	NA

Table 2-1. Summary of 300 Area Industrial and Unrestricted (Residential) Nonradionuclide Cleanup Levels. (4 Pages)

Contaminant	K_d Value (mL/g)	Background (mg/kg)	Soil Cleanup Levels (mg/kg) [a]			
			Industrial Direct Exposure	Residential Direct Exposure	Residential Protective of Groundwater	Residential Protective of the River
Dichloroprop [g]	0.0294	NA	35,000	800	7	NA
Dieldrin	25.6	NA	8.2	0.0625	0.003 [h]	0.003 [h]
Dinoseb (DNBP)	3.54	NA	3,500	80	0.7	NA
Endosulfan (I, II, sulfate)	2.04	NA	21,000	480	9.6	0.0112
Endrin (and ketone, aldehyde)	10.8	NA	1,050	24	0.2	0.039
Heptachlor	9.53	NA	29.2	0.222	0.002 [h]	0.002 [h]
Heptachlor epoxide	83.2	NA	14.4	0.11	0.002 [h]	0.002 [h]
Methoxychlor	80	NA	17,500	400	4	1.67
Polychlorinated biphenyls	309	NA	65.6	0.5	0.017 [h]	0.017 [h]
PCB Aroclor-1016	107	NA	65.6	0.5	0.017 [h]	0.017 [h]
PCB Aroclor-1221	10.3	NA	65.6	0.5	0.017 [h]	0.017 [h]
PCB Aroclor-1232	10.3	NA	65.6	0.5	0.017 [h]	0.017 [h]
PCB Aroclor-1242	44.8	NA	65.6	0.5	0.017 [h]	0.017 [h]
PCB Aroclor-1248	43.9	NA	65.6	0.5	0.017 [h]	0.017 [h]
PCB Aroclor-1254	75.6	NA	65.6	0.5	0.017 [h]	0.017 [h]
PCB Aroclor-1260	822	NA	65.6	0.5	0.017 [h]	0.017 [h]
Silvex (tp;2,4,5-)	0.08	NA	28,000	640	5	NA
Toxaphene	95.8	NA	119	0.909	0.2 [h]	0.2 [h]
Trichlorophenoxyacetic acid;2,4,5-	0.049	NA	35,000	800	16	NA

[a] Cleanup levels are established in *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington* (EPA 2001) or calculated as described in Appendix D, Table D-4, per Ecology (1996) (WAC 173-340-720, 173-340-730, and 173-340-740) unless otherwise noted. Deep zone cleanup levels are the lower of soil values protective of groundwater and the river. Industrial and Unrestricted deep zone cleanup levels are identical because groundwater and river cleanup levels are based on MTCA Method B criteria. When deep zone cleanup levels are exceeded, site-specific RESRAD modeling will be performed to determine if constituent analyses are protective without irrigation for industrial land use and with irrigation for unrestricted land use.

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

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

[d] The K_d for uranium of 8.9 mL/g is from EPA (2004) and applies to all 300-FF-2 Operable Unit sites. The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement Project Managers.

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

[f] Common laboratory contaminant unlikely to be found in soil. If detected in soil, all analyses of blanks, duplicates, and splits should be checked and the original soil sample reanalyzed.

[g] Toxicity data for this chemical are not available. Cleanup levels are based on surrogate chemicals:
Contaminant: acenaphthylene; surrogate: acenaphthene
Contaminant: benzo(g,h,i)perylene; surrogate: pyrene
Contaminant: bis(2-chloroethoxyl)methane; surrogate: bis(2-chloroethyl)ether
Contaminant: chloro-3-methylphenol; 4-; surrogate: methylphenol; 3-
Contaminant: dichloroprop (pesticide); surrogate: Dichlorophenoxyacetic acid; 2,4-; (2,4-D)
Contaminant: phenathrene; surrogate: anthracene.

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

Ecology = Washington State Department of Ecology

K_d = Distribution coefficient discussed in *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005), Appendix E. When unavailable from DOE-RL (2005), K_d values are taken from the Ecology CLARC Database at < http://www.ecy.wa.gov > or from the Risk Assessment Information System database maintained by the Oak Ridge National Laboratory at < http://risk.lsd.ornl.gov >.

NA = not available
PCB = polychlorinated biphenyl
RDL = required detection limit
TPH = total petroleum hydrocarbons
VOA = volatile organic analyte
WAC = *Washington Administrative Code*

Table 2-2. Summary of 300 Area Industrial and Unrestricted Radionuclide Lookup Values.

Contaminant	K_d Value (mL/g)	Back-ground (pCi/g)	Soil Lookup Value (pCi/g) [a]			
			Industrial Direct Exposure	Unrestricted Direct Exposure	Industrial Groundwater/ River Protection	Unrestricted Groundwater/ River Protection
Americium-241	200	NA	210	32.1	NA	NA
Carbon-14	200	NA	82	8.7	NA	NA
Cesium-137	50	1.1	25	6.2	NA	NA
Cobalt-60	50	0.008	5.2	1.4	NA	NA
Europium-152	200	NA	12	3.3	NA	NA
Europium-154	200	0.033	11	3.0	NA	NA
Europium-155	200	0.054	518	125	NA	NA
Nickel-63	30	NA	3.37E+06	4,026	NA	385
Plutonium-238	200	0.004	155	38.8	NA	NA
Plutonium-239/240	200	0.025	245	35.1	NA	NA
Plutonium-241	200	NA	12,900	854	NA	NA
Strontium-90	25	0.18	2,500	4.5	NA	70.2
Technetium-99	0	NA	410,000	34.7	239	33.2
Thorium-228	200	NA	10.8	2.3	NA	NA
Thorium-230	200	NA	23.2	3.0	NA	NA
Thorium-232	200	1.3	4.8	1.0	NA	NA
Tritium (H-3) [b]	0	NA	1,980	711	5,360	746
Uranium-233/234	8.9 [c]	1.1	167	27.2	127.4	17.9
Uranium-235	8.9 [c]	0.11	16	2.7	13.2	1.8
Uranium-238	8.9 [c]	1.1	167	26.2	127.4	17.3
Total uranium	8.9 [c]	2.27	350	56.1	267.0	37.0

[a] Lookup values established in *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington* (EPA 2001) or calculated using RESRAD 6.4 with input parameters from Tables B-7a and B-7b of this document.

[b] Tritium samples will be taken six inches below the excavation surface. If tritium is detected, a path forward will be developed with the lead regulatory agency for appropriate cleanup verification sampling per Tri-Party Agreement Change Number TPA-CN-177.

[c] Value is from *Explanation of Significant Difference for the 300-FF-2 Operable Unit Record of Decision, Hanford Site, Benton County, Washington* (300-FF-2 ESD) (EPA 2004). Details of unrestricted land use uranium lookup values are from *300 Area Unrestricted Land Use Lookup Values*, 0300X-CA-V0042, Rev. 0 (BHI 2003).

K_d = Distribution coefficient discussed in *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005), Appendix E. When unavailable from DOE-RL (2005), K_d values are taken from the Washington State Department of Ecology CLARC Database at < http://www.ecy.wa.gov > or from the Risk Assessment Information System database maintained by the Oak Ridge National Laboratory at < http://risk.lsd.ornl.gov >. The K_d for uranium is 8.9 mL/g from EPA (2004).

NA = not available

3.0 REMEDIAL ACTION APPROACH AND MANAGEMENT

Initiation of full-scale remedial action to accomplish the goals set forth in the 300-FF-2 ROD (EPA 2001) requires a supporting infrastructure and completion of numerous interdependent tasks. The project team, cost and schedule, change management approach, planning, remedial action operations, and site closure process are described in the following subsections. Key tasks associated with this process are shown in Figure 3-1.

3.1 PROJECT TEAM

The term "project team," in the strictest sense, means all individuals working to accomplish a particular project. According to this definition, there are numerous members of the project team. For the purpose of this discussion, the project team will be limited to the regulatory agencies, DOE, and the River Corridor Closure (RCC) Project.

3.1.1 Regulatory Agencies

The regulatory agencies for the CERCLA remediation activities in the 300 Area of the Hanford Site are EPA and Ecology. The lead regulatory agency for this area is the EPA, with support from Ecology, where integration with RCRA treatment, storage, and disposal units is required. The lead regulatory agency is responsible for overseeing the activities to ensure that all applicable regulatory requirements are met.

3.1.2 U.S. Department of Energy, Richland Operations Office

The DOE-RL is the government agency responsible for the remedial actions throughout the 300 Area and the remaining Hanford Site. The DOE-RL has assigned project managers to each major area and task involved with remediation activities. The DOE-RL project managers are responsible for the management of their assigned activities including scope, schedule, budget, quality, personnel, communication, risk/safety, contracts, and regulatory interface.

3.1.3 River Corridor Closure Contractor

The RCC Project team is currently responsible for implementation of remedial actions in the 300 Area. The RCC Project team is made up of Washington Closure Hanford (WCH) and Eberline Services Hanford, Inc. Under the direction of the Director of the Field Remediation Closure Project, project managers are assigned, consistent with the project management assignments of DOE-RL, to promote a single point-of-contact management philosophy. Each WCH project manager must develop, maintain, and oversee individual project teams. The project team will include all required disciplines to accomplish the remedial actions in a safe, efficient, and compliant manner.

3.2 COST AND SCHEDULE

Cost estimates for remediation of 300-FF-2 OU waste sites were prepared as part of the 300-FF-2 FFS (DOE-RL 2000a) and subsequently carried forward into the proposed plan (DOE-RL 2000c) and 300-FF-2 ROD (EPA 2001). The estimates were prepared with an accuracy of -30% to +50% to support evaluation of remedial alternatives and selection of a remedy. Cost estimates are updated based on design work. In accordance with CERCLA requirements, an ESD will be pursued by the Tri-Parties if remediation costs change significantly from those identified in the ROD.

Project schedules are developed in accordance with the RCC Project's procedures at several different levels consistent with the project work breakdown structure (WBS). The WBS-based schedules promote complete and consistent compliance with DOE Order 413.3, *Program and Project Management for the Acquisition of Capital Assets,* and cost and schedule control systems criteria. Large-scale (multi-year) projects encompassing multiple smaller projects (e.g., each waste site remediation can be considered a single project, while the entire project is to remediate all waste sites) are generally planned and scheduled using a phased approach. Near-term (less than 1 year) work is usually planned and scheduled at a detail activity level using logic ties to establish and maintain a true critical-path schedule. Logic-driven, critical-path schedules, commonly referred to as the critical-path method, are used to manage and control the daily progress of the work and provide early warning of problem areas. Forecast planning and scheduling (1 to 2 years) can be performed at the task-package level, and long-range planning and scheduling (greater than 2 years) is performed at the work package or cost account levels.

3.2.1 Remediation Scheduling

Post-ROD planning and scheduling for remediation projects follows a distinct pattern consistent with the work package level of the WBS. Planning elements at this level include, but are not limited to or bound by, remedial design, procurement, remedial actions, and site closures.

3.2.1.1 Remedial Design. Remedial design includes all design work, project plans, project procedures, remediation cost estimating, drawings, and specifications required to procure a remediation subcontractor to perform the remediation. Project plans will define the data-gathering requirements to ensure worker health and safety and to eventually prove the waste sites meet remediation goals and standards. Project procedures will define the "how to" of obtaining data and controlling the site activities. Planning documentation is discussed further in Section 3.4. Scope of work, design drawings, and specifications will provide the necessary technical tools to procure a subcontractor.

3.2.1.2 Procurement. Procurement includes soliciting qualified subcontractors, preparing requests for proposals (RFPs), awarding the subcontract, coordinating submittals, negotiating change orders, and receiving and controlling subcontractor request for payments. The RFP documents are prepared as part of the remedial design. Procurement must assemble the RFP and contract documents.

3.2.1.3 Remedial Actions. Remedial action includes implementing the remedial design and project plans. The implementation will include, but will not be limited to, subcontractor oversight, excavation, material handling, analytical system operations, worker health and safety, radiological controls, data gathering, and overall daily conduct of operations. Subcontractor oversight occurs through administration of subcontract documents. Project specifications and procedures define the "how to" of excavation, material handling, analytical system operation, data gathering, and overall daily conduct of operations. Worker health and safety and radiological control requirements are included in site health and safety plans and permits.

3.2.1.4 Site Verification and Closeout. Site verification and closeout includes, but is not limited to, data collection (including samples and photographs), data evaluation, data interpretation, preparation of documentation, Tri-Party approval that the RAOs have been met, and updating the WCH End States and Final Closure Project files and the Hanford Site Waste Information Data System (WIDS).

The remedial action schedules for cleanup of the Hanford Site are driven by a set of milestones that have been established as part of the Tri-Party Agreement (Ecology et al. 1989), a number of which have been renegotiated. Schedule commitments associated with cleanup of the 300-FF-2 OUs are summarized in Table 3-1 and are shown in Figure 3-2.

3.3 REMEDIAL ACTION CHANGE MANAGEMENT

Types of changes in the 300 Area remedial actions that affect compliance with the requirements in the 300-FF-2 ROD (EPA 2001) will be classified as nonsignificant, significant, or fundamental. The WCH project manager is responsible for tracking all changes and obtaining appropriate reviews by WCH staff. The project manager will discuss the proposed change with DOE-RL, and DOE-RL will then discuss the type of change that is necessary with the EPA. As the lead regulatory agency, the EPA is responsible to determine the significance of the change.

3.4 REMEDIAL ACTION PLANNING

Post-ROD planning and scheduling for remediation projects follows a distinct pattern consistent with the work package level of the WBS. Planning elements at this level include development of the remedial design and solicitation of a remedial action subcontractor. Additional planning documentation includes field procedures, SAP, health and safety plan, mitigation action plan (MAP), air monitoring plan, technical performance specifications, safety analysis/hazard classification, and procurement documents. Some of the tiered planning documentation (e.g., remedial designs, air monitoring plans, site-specific investigations, or others) may require approval by the lead regulatory agency, if requested. When reviews are required, DOE shall provide the documentation to the lead regulatory agency for review and approval. Summary briefings and discussions may be held at unit manager's meetings or other forums, as agreed. Issues will be identified and resolved in a timely manner to prevent or minimize impacts to schedules, including those for procurement. A specific process for remedial design and air monitoring plan reviews and approvals is included in the applicable planning subsections below.

3.4.1 Remedial Action Designs

Remedial design includes all design work, project plans, project procedures, remediation cost estimating, drawings, and specifications required to procure a remedial action subcontractor to perform the work. Project plans will define the data-gathering requirements to ensure worker health and safety, and to eventually prove that the waste sites meet remediation goals and standards. Project procedures will define the "how to" of obtaining data and controlling the site activities. Scope of work, design drawings, and specifications will provide the necessary tools to procure a subcontractor. DOE shall provide the remedial designs to the lead regulatory agency for review and approval, if requested. Summary briefings and discussions may be held at Unit Manager's meetings or other forums, as agreed. Issues will be identified and resolved in a timely manner to prevent or minimize impacts to schedules for issuing RFPs.

The following process will be followed to implement the requirement above, and may be modified at the 300 Area unit manager's meeting:

- The DOE shall provide the draft remedial design package and design schedule to the lead regulatory agency at the unit manager's meetings, or deliver to the local field office.
- The lead regulatory agency shall provide notice to DOE in a timely manner, if approval is warranted, usually within 3 to 5 days.
- The lead regulatory agency review period is generally 2 weeks. If additional review time is necessary, the review period can be increased up to 4 weeks. If more than 4 weeks is required due to the complexity of the project, DOE and the lead regulatory agency shall agree to the review period, as necessary. To minimize impacts to the schedule, additional review time should be communicated early in the process.
- Review comments and issues shall be identified and resolved in a timely manner. Review comments and issues, including responses or resolutions, shall be documented in the unit manager's meetings, letters, or other forums, as agreed.
- The DOE shall provide a copy of the final remedial design package, with comments incorporated, to the lead regulatory agency at the unit manager's meetings, deliver to the local field office, or transmit.
- An approval letter should be provided to DOE by the lead regulatory agency within a reasonable time frame. The approval letter should reference the specific design, and indicate that approval by the lead regulatory agency is warranted.

3.4.2 Field Procedures

Field procedures provide guidance to site workers during field work execution. The procedures define the scope, operations, progression of field work, personnel control requirements, radiological posting requirements, and analytical system guidance. The procedures also provide contingency plans should unexpected conditions arise. The site superintendent must execute field operations in compliance with these field procedures.

3.4.3 Sampling and Analysis Plan

The *300 Area Remedial Action Sampling and Analysis Plan* (300 Area SAP) (DOE-RL 2009) will provide direction for sampling efforts to support excavation guidance, waste characterization, worker health and safety, and site closure. The SAP includes quality assurance project plans that define the strategy to control the quality and reliability of the analytical data and establish associated protocols for data management. The field analytical team must perform all sampling and analysis efforts in strict compliance with the SAP. The SAP will be prepared by project staff and provided to the DOE and regulatory agencies for review and approval.

The 300 Area SAP also defines the decision-making process for the candidate sites and newly discovered sites. The decision-making process for the candidate sites and newly discovered sites is performed on a site-specific basis. Because of the diversity of characteristics among the candidate sites, an agreement was made with the EPA to provide the details of the sample design for each site in a site-specific WI. Sampling and analysis results could indicate that some of the candidate sites and newly discovered sites may not require remediation.

3.4.4 Health and Safety Plan

The *River Corridor Closure Hazard Identification & Mitigation Document* (WCH 2009) identifies typical hazards that are found at the sites. It encompasses the SSHASPs and provides direction for health and safety measures specific to the site and remedial action scope. All project personnel, including the remedial action subcontractor, will be trained on the SSHASP.

3.4.5 Mitigation Action Plan

A MAP was prepared for the 300 Area in 2002 (DOE-RL 2002a). The document was developed to fulfill the requirement for a "natural resource mitigation plan," as specified in the 300-FF-1 ROD (EPA 1996). Consistent with the selected remedy in the ROD, the MAP was developed with input from affected stakeholders. The MAP states the methods for mitigation and restoration, as well as the species inhabiting the 300 Area.

The MAP presents a framework for limiting disturbances to natural and cultural resources during remedial action projects, and identifies opportunities for site restoration and revegetation, as appropriate. The MAP is intended to be used as a guidance document where mitigation and restoration are required.

Key objectives of the 300 Area MAP (DOE-RL 2002a) are to avoid, minimize, rectify, reduce/eliminate, or compensate for impacts to natural resources incurred as the result of remedial action and construction. Prior to remedial action or the construction of support areas, cultural and ecological resource reviews are conducted to determine if the proposed activities in these areas will impact natural or cultural resources. The first line of action is to avoid or minimize impacts by siting activities in areas with the least potential for impact. When impacts to natural or cultural resources are unavoidable, the project is given recommendations to minimize impacts. Additional mitigation may be required if criterion for a threshold area of disturbance or habitat quality is met. Habitat quality thresholds are described in the biological resource management plan (DOE-RL 2000b).

Not all biological resources are considered mitigable resources at the Hanford Site. For projects that do not exceed the thresholds for rectification or compensation as defined by (DOE-RL 200b), mitigation actions are discussed in the project planning documents or site-specific ecological resource reviews. Avoidance and minimization mitigation for low-quality invasive plant species on highly disturbed sites or nonvegetated areas is employed only as necessary to reduce impacts to site-specific resources such as nesting birds. The duration of activities and foreseeable land use are also accounted for in mitigation planning.

Where site revegetation is appropriate for compensatory mitigation purposes (i.e., active revegetation as compensation for the destruction of high-quality habitat for the construction of layback and staging areas) or for site stabilization, the 300 Area MAP outlines methods of site preparation to facilitate successful revegetation by native species (DOE-RL 2002a). Waste sites will be revegetated with native species that will survive without irrigation. The purpose of this sustainable revegetation is to provide dust control and prevent infiltration. Subsequent land development design, although outside the scope of this RDR/RAWP, will include engineered runoff controls for parking lots and roof runoff to prevent residual contaminants from migrating to groundwater. Graveled areas will generally not be appropriate for areas that are over residual subsurface contamination but may be used on a case-by-case basis if the gravel cover offers continued protection of groundwater.

3.4.6 Air Monitoring Plan

The substantive requirements applicable to radioactive air emissions resulting from remediation activities are to quantify potential emissions, monitor the emissions, and identify and employ best available radionuclide control technology. Exemption from these requirements may be requested if the potential-to-emit for the activity or emission unit would result in a total effective dose equivalent of less than 0.1 mrem/yr. Implementation of these elements fulfills the ARARs identified in the 300-FF-2 ROD (EPA 2001). The use of best available radionuclide control technology includes, but is not limited to, dust suppression (e.g., water, water sprays, fixatives) and the use of other standard engineering controls (e.g., high-efficiency particulate air filter vacuum cleaners). An air monitoring plan for the remedial action activity will be developed to incorporate the above requirements and will be provided to the lead regulatory agency for review and approval, if requested. Summary briefings and discussions may be held at unit manager meetings or other forums, as agreed. Issues will be identified and resolved in a timely manner to prevent or minimize impacts to schedules.

To implement review and approval, the following general process shall be used. This process is intended as a guide and may be amended or altered by mutual agreement.

- The DOE shall provide the draft air monitoring plan and schedule to the lead regulatory agency at the unit manager's meetings, deliver to the local field office, or other forums, as agreed.
- The lead regulatory agency shall provide notice to DOE in a timely manner, if approval is warranted, usually within 3 to 5 working days.
- The lead regulatory agency review period is generally 2 weeks. If additional review time is necessary, the review period can be increased up to 4 weeks. If more than 4 weeks is required due to the complexity of the project, DOE and the lead regulatory agency shall agree to the review period, as necessary. To minimize impacts to the schedule, additional review time should be communicated early in the process.
- Review comments and issues shall be identified and resolved in a timely manner. Review comments and issues, including responses or resolutions, shall be documented in the unit manager's meetings, letters, or other forums, as agreed.
- The DOE shall provide a copy of the final air monitoring plan, with comments incorporated, to the lead regulatory agency at the unit manager's meetings, deliver to the local field office, or transmit.
- DOE shall transmit the final air monitoring plan to the lead regulatory agency for approval.
- The lead regulatory agency should provide an approval letter to DOE within a reasonable time frame. The approval letter should reference the specific air monitoring plan and indicate that approval by the lead regulatory is warranted.

3.4.7 Technical Performance Specifications

Technical performance specifications are prepared to support solicitation of a remedial action subcontractor. Remediation of these sites requires soil removal, segregation, storage, transportation, disposal, and backfilling. Technical performance specifications have been prepared for the following areas:

- Earthwork and excavated material handling
- Survey and decontamination station
- Waste profile station
- Basic electrical materials and methods
- Lighting.

Each technical specification establishes quality and workmanship requirements and defines how quality is measured. Following contract award, a detailed design for facility layout and excavation will be completed by the remedial action subcontractor. Future remedial design tasks will be defined based on the scheduled remedial actions.

3.4.8 Safety Analysis/Emergency Preparedness

Hazards associated with the proposed remedial actions addressed in this document are examined based on anticipated inventories of radioactive and/or hazardous materials and appropriate controls identified, and the final hazard categorization is documented in a final report. Hazard categorization documentation, as well as analysis of radioisotopes and hazardous material for emergency response planning for the 300-FF-2 OU waste sites, will be prepared before initiating excavation operations.

3.5 REMEDIAL ACTION OPERATIONS

The components of the selected remedy are identified in Section 1.2.1. During all aspects of the remedial action, dust control will be maintained on the haul roads, at the excavation site, and in the staging areas. Use of water for dust control at the excavation site will be minimized. Soil fixatives (e.g., soil cement) will be applied to open excavation sites during periods of extended inactivity and/or when potential concerns arise about health issues or the spread of contamination. For the purpose of this discussion, the removal, treatment, disposal, and backfill components of the remedial action operations are divided into mobilization, excavation, material handling and transportation, soil characterization and analysis, and decontamination. The remaining components (institutional controls, groundwater/ecological monitoring, and implementation of the plug-in process) are discussed in separate sections.

3.5.1 Mobilization and Site Preparation

Mobilization and site preparation include the following activities that are necessary to prepare the site for excavation:

- Establishing site utility services as required.

- Constructing roads, field support facilities, container survey stations, and decontamination stations. Hanford Site roadways are constructed of existing site materials, except the surface course, which is imported. Field support facilities provide a changing area, lunchroom, and construction offices at individual sites. The changing area includes lockers, benches, and storage for both clean and contaminated personal protection equipment.

- Stripping the existing vegetation and debris. Stripping removes surface and near-surface materials (including vegetation and roots, cobbles, and boulders) that will be stockpiled and used later as a top dressing and planting medium for revegetation.

- Removing overburden material. Clean overburden will be segregated and stockpiled onsite for later use as backfill material.

- Removing slabs and foundations of demolished buildings.

3.5.2 Excavation of Burial Grounds, Dump Sites, and Test Sites

Following completion of pre-excavation activities, excavation involves removing clean and contaminated soil, debris, and anomalous waste present within the site boundaries. For all burial grounds and dump sites, materials will be excavated with standard construction equipment using one or more of the following techniques to sort and disposition waste:

- **0.3-m (1-ft) Horizontal Lifts.** The exposed surface of each lift will be visually observed, radiologically screened, sorted as necessary to remove anomalous material and large debris, and then excavated using heavy equipment and stockpiled. Material will also be observed as it is being stockpiled for any additional sorting that is appropriate.

- **0.3-m (1-ft) Diagonal (Sloping) Lifts.** The exposed surface of each lift will be visually observed as it is raked down the face of an excavation slope using heavy equipment. Material will be radiologically surveyed at the bottom of the slope, sorted as necessary, and stockpiled. Material will also be observed as it is being stockpiled for any additional sorting that is appropriate.

- **Bulk Excavate and Spread.** Material will be bulk excavated using heavy equipment, and then spread onto the ground in approximately 0.3-m (1-ft) layers. The shallow layer of material will then be radiologically screened and sorted.

- **0.2-m (0.5-ft) Loader Lifts.** The surface of each lift will be visually observed, radiologically screened, sorted as necessary, and then excavated using the front-end loader. This technique is best suited for areas with little visible debris.

In excavation areas where there are large quantities of observed lead-containing materials (e.g., lead bricks, lead slag) intermixed with the soil, a variation of these excavation/sorting methods may be used. Observation, sorting, and radiological surveys for removal of the large materials and non-lead anomalous materials will be performed using one or more of the above-described methods. The remaining materials may then be identified as meeting the RCRA definition of "soil" per 40 CFR 268.2 and considered hazardous/dangerous due to lead contamination. In such cases, the soil will be sampled in accordance with the 300 Area SAP (DOE-RL 2009) and transported to the ERDF or other approved facility for treatment (stabilization) and subsequent disposal.

Sluicing (use of water) is not an acceptable excavation method. Excavation operations in areas where there is known drummed waste will be performed using horizontal lifts as described above. In all other cases, selection of the excavation/sorting method will be made by the remedial action subcontractor, and the method may be changed to another approved method based on the type of material being excavated. Alternate excavation/sorting methods (e.g., vacuum systems, metal detectors) may be proposed by the project on a case-by-case basis and implemented with concurrence from the DOE and EPA project representatives. During the excavation process, care will be taken to prevent the breakage or puncture of unopened or sealed cans, jars, and containers.

Material from waste sites that are not burial grounds (e.g., acid neutralization pit) or the periphery of burial grounds (e.g., plumes) where anomalous material is not encountered does not require mechanical sorting. This material may be directly loaded into containers after enough information is gathered to characterize the waste. Material that has been excavated using one of the approved sorting techniques will be directed in one of the following ways.

- Material that is above cleanup levels and within the ERDF waste acceptance criteria (WCH 2008) will be loaded into plastic-lined roll-off containers on project haul trucks at the excavation site. Asbestos-containing material will be double-bagged or put into roll-off containers that are double lined. The loaded containers will be covered (i.e., by folding and securing the liner over the load) and surveyed prior to being transported to a container transfer facility (CTF) using the project haul trucks. If contamination is found on a container exterior, the container will be decontaminated using standard equipment and techniques. In the unlikely event that a container cannot be decontaminated using standard methods, advanced techniques will be implemented as necessary. Released containers will be off loaded and staged in the CTF until applicable shipping papers are completed. When the shipping papers have been completed, ERDF transport vehicles will enter the CTF, pick up the full containers, and haul them to the ERDF.

- Anomalous waste (e.g., drums, intact containers, elemental lead, unknown materials) and/or above-cleanup-level material that is not within ERDF waste acceptance criteria (WCH 2008) will be set aside within the area of contamination (AOC) or within designated staging piles for further characterization and final disposition. Land disposal-restricted (LDR) wastes stored outside of the AOC shall only be returned to the AOC, and removed from the container with lead regulator approval. As needed, appropriate inerting materials may be added to drums that contain waste with pyrophoric properties. Waste that is subsequently identified for ERDF disposal or staging will be directed as described previously, with the exception that drummed waste will be transported on flatbed trailers. Excavated material that must be sent to facilities other than ERDF for treatment and/or disposal will be stockpiled or drummed and staged within the AOC or within designated staging pile areas until loaded for offsite shipment. Identification of an appropriate treatment and/or disposal facility, and arrangements for loading and transporting excavated material to facilities other than ERDF will be made on a case-by-case basis by the project in coordination with the RCC Project waste management representatives. Prior to shipment, an offsite acceptability determination in accordance with 40 CFR 300.440 must be obtained from the EPA for receipt, storage, treatment, and disposal of CERCLA waste at the identified treatment/disposal facility.

- Material that is free of anomalous waste and below cleanup levels may be stockpiled onsite for use as backfill material. In certain situations, soil may be placed over material excavated within a waste site or discovered within a staging pile as a temporary measure. Such action may be undertaken to minimize an imminent threat to the worker (e.g., a high-dose item is uncovered, and a temporary soil cover is appropriate to control worker exposure). Temporary covering with soil may also be undertaken to prevent windborne dispersal of excavated material or highly contaminated soil and to maintain segregation from other waste site materials. These temporary measures may be undertaken while plans are developed for safe re-excavation and removal of waste site materials. In these instances lead regulator notification will be made.

- Excavated material that has been packaged may be returned to an excavation area or staging pile area in situations where the dose rates, contamination levels, free liquids, or other abnormalities have subsequently been determined to exceed normal transport requirements. In these situations, when repackaging is necessary, the previously excavated material will be reloaded into the transportation container. Notification to the lead regulatory agency is generally not required for these actions. The exception is LDR waste, which shall be managed in accordance with the second bullet above).

- An approved LDR treatment method for radioactively contaminated cadmium-, silver-, and mercury-containing batteries allows for macroencapsulation prior to disposal. However, lead-acid batteries are not covered by this standard and require initial treatment (draining corrosive liquids, treating separately prior to disposal) (DOE-RL et al. 2005b).

Excavated material will be surveyed and characterized for appropriate disposition prior to undertaking disposal of materials. When excavation of a waste site is complete, exposed dig faces will be evaluated to verify that remedial action goals have been met. When RAGs have been met and backfill concurrence is obtained from the lead regulatory agency, site backfill will be authorized. (Note: Unless specified otherwise, the term "backfill" as used in this document refers to filling in the excavation once post-waste site remediation sampling has demonstrated that RAGs have been met). Clean backfill material is obtained from clean material storage areas, approved/clean rubble, and local borrow sites. Excavations are backfilled so the sites conform to local topography.

3.5.3 Material Handling and Transportation

All contaminated materials (including excavated soils, debris, disposable protective clothing, air filters, and trash) require proper packaging, handling, and transportation in accordance with the waste management plan prescribed in Section 4.0. Contaminated bulk materials will be hauled in the standard ERDF open-top, hinged-gate roll-off boxes that are designed for a maximum capacity of approximately 18.1 metric tons (20 tons) and 22.7 metric tons (25 tons). The bulk containers will be transported on roll-on/roll-off trailers with hydraulic dumping capabilities that are towed by conventional tractor units. Drummed waste will be hauled on flatbed tractor-trailer units. The trailers and tractors will be suitable for operating on sloped excavation access ramps and other off-road ramps, and meet applicable DOT requirements. The wheel wells of the tractor will be constructed to prevent soil from being thrown onto the trailer and its containers during transport.

Weighed containers will be transported from the 300 Area to the ERDF over existing Hanford Site roadways. Each shipment of soil/debris transported to the ERDF will be referenced to a waste profile that is intended to bound the material found at the site. The waste profile is in effect until the characteristics of the excavation site have changed significantly. Empty containers returning from the ERDF will be removed from the ERDF tractor trailers in the CTF and rolled on to project haul trucks for refilling. The CTF helps to maintain a continuous flow of materials through the transportation system by allowing excavation to continue for a limited time if the trucks running to the ERDF are not operating, or it allows ERDF trucks to continue to run for a limited time if the excavators are not operating.

The containers are inspected for the presence of water prior to placing a liner or waste into the container. When water is found in a container with an estimated volume of 151 L (40 gal) or less (less than a depth of 1.27 cm (0.5 in.) in the bottom of the container), the water will typically be used as an aid for dust suppression in the adjacent radiological excavation, staging pile, or radiological debris piles in a manner that is consistent with regulator-approved work plans. When water is found in the container with an estimated volume greater than 151 L (40 gal), lead regulatory agency approval will be sought to use the water as an aid for dust suppression in the adjacent radiological excavation, staging pile, or radiological debris pile, or direction from the agency to process the water through other means.

Transportation and handling for offsite treatment and/or disposal of contaminated material will be coordinated on a case-by-case basis. All offsite shipments will be conducted using equipment and methods that are compliant with applicable DOT regulations.

3.5.4 Soil and Debris Characterization

Soil and debris characterization will be based on the observational approach and performed in accordance with the 300 Area SAP (DOE-RL 2009). This approach relies on available historical information and limited field investigations combined with a "characterize-and-remediate-in-one-step" methodology. The latter methodology consists of site excavation and monitoring at sites where remedial action and cleanup goals have been selected. Remediation will continue until a combination of field screening results, sampling results, and/or observed absence of waste debris indicates that cleanup goals have been achieved.

3.5.5 Decontamination

Decontamination to support excavation activities will generally be performed using dry methods (e.g., wiping and high-efficiency particulate air-filtered vacuum cleaners) to the extent possible. When the use of wet methods (e.g., pressure washers and steam cleaners) is required to achieve decontamination objectives and the associated water or cleaning solutions are not collected, work will be conducted by trained site workers in accordance with the following best management practices (BMP):

General Best Management Practice (BMP). This applies to all equipment cleaning/ decontamination activities within a waste site.

- Decontamination activities will be performed within active excavation areas of the AOC.
- The amount of water used to clean equipment will be minimized.
- Only raw or potable water will be used.
- Soaps, detergents, or other cleaning agents that would regulate as a hazardous waste will not be added to wash water.
- Pressure washing will normally use cold water (hot water may be used to avoid icing).
- Steam cleaning will be used only after other methods prove to be ineffective.
- Decontamination practices will be documented in the daily log.
- Personnel responsible for equipment decontamination will be trained to this BMP.

Ongoing Remediation site BMP. This applies to equipment being washed and/or decontaminated within sites that have ongoing remediation.

- Equipment washing/decontamination will be located in areas with ongoing waste removal.
- Spent wash water and associated contamination will be kept within active areas of the AOC.
- Pre- and post-washing/decontamination contaminant surveys are not required.
- The project may opt to collect wash water for reuse in the excavation or to be sent for treatment.

Completed Remediation Site BMP. This applies to equipment being washed and/or decontaminated within sites that have achieved preliminary remediation goals.

- At the "completion" of excavation activities at a site, the project may opt to transport the equipment to a nearby site that is being remediated (by excavation) to perform equipment washing/decontamination (as described above).
- Equipment washing/decontamination to be performed at the site will be physically located within the remediated site.
- A pre- and post-survey will be performed on the washing/decontamination area to assess and remediate (if required) areas affected by the activity.

- When the washing/decontamination is set up in an area of a site that has apparently attained the preliminary remediation goals, sampling of the area will be performed in accordance with the SAP (DOE-RL 2009) or site-specific WIs, as applicable.

- The project may also opt to perform other methods of equipment washing and/or decontamination for a completed site (e.g., wrap the equipment for transfer to a decontamination pad, provide for a temporary facility at the site to collect wash water, fix the contamination to the equipment).

See also Section 4.2.4.2.

3.5.6 Implementation and Maintenance of Institutional Controls

Institutional controls are designed to prevent exposure to contamination by limiting land or resource uses. Cleanup to industrial levels in the 300 Area is based on the mandate of restricted land and groundwater use, until such time that contaminant concentrations are conducive to unlimited use. These institutional controls are required during remedial action and after cleanup is complete, or until the site meets the requirements for unrestricted land use as defined in Section 2.0.

A plan for implementing current and post-remedial action institutional controls as specified in the 300-FF-2 ROD (EPA 2001) is presented in the *Sitewide Institutional Controls Plan for Hanford CERCLA Response Action Sites* (DOE-RL 2002b). The institutional controls defined in the plan will be enforced during and after cleanup, as appropriate. The 300-FF-2 ROD (EPA 2001) describes the institutional controls, which are grouped into five main types: warning notices, entry restrictions, land-use management, groundwater-use management, and waste site information management. As described in Table 1-1 and shown in Figures 1-2 and 1-3, implementation of the specific ROD requirements to post and maintain warning signs along the Columbia River and access roads are elaborated below.

- Along the Columbia River, a sign set has been placed at or above the high water line (at approximately the same line as the current no trespassing signs). The sign set consists of one each in English and Spanish. The signs are located so that the distance for viewing from the river is approximately 152 m (500 ft). The English sign reads as follows:

WARNING: HAZARDOUS AREA
DO NOT ENTER
Area May Contain Hazardous Soil and Water
For Information Call: 509-376-7501

The Spanish sign reads as follows:

ADVERTENCIA: AREA DE PELIGRO
NO ENTRE
Esta area puede contener tierra y fuentes de agua que son peligrosas.
Para Informacion Llame al (509) 376-7501

- One large sign is located at the entrance to the active remediation area, north of the 300 Area (just past the railroad tracks). The sign reads as follows:

WARNING: HAZARDOUS AREA
Area May Contain Hazardous Soil
Only Authorized Personnel Allowed
For Information Call: 509-376-7501

- Additional smaller signs are located at key access roads into the 300 Area (e.g., George Washington Way extension, Cypress Street) and at roads leading to the 618-7 and 618-13 Burial Grounds, the 618-10 Burial Ground area, and the 618-11 Burial Ground. The signs are in English only and have been placed at a height adequate to be seen from a distance. The signs to specific waste sites read as follows:

WARNING: HAZARDOUS AREA
Area May Contain Hazardous Soil
Only Authorized Personnel Allowed
For Information Call: 509-376-7501

- The four signs placed at the key access roads into the 300 Area read as follows:

WARNING: HAZARDOUS AREA
Area May Contain Hazardous Soil
Observe All Signs and Hazard Postings
Only Authorized Personnel Allowed
For Information Call: 509-376-7501

3.5.7 Implementation and Maintenance of Groundwater and Ecological Monitoring Activities

Information regarding the implementation and maintenance of groundwater and shoreline ecological monitoring activities required by the 300-FF-2 ROD (EPA 2001) is included in the *Operation and Maintenance Plan for the 300-FF-5 Operable Unit* (DOE-RL 2001).

A terrestrial ecological monitoring program will be developed and included in a subsequent version of this RDR/RAWP to support the post-remediation ecological monitoring requirements specified in the 300-FF-2 ROD. This ecological monitoring program will use as a guideline and consider the outcome and recommendations of the 100-B/C pilot project risk assessment, which is currently under way to evaluate post-remediation risk to ecological receptors in the 100-B/C Area.

3.5.8 Implementation of "Plug-In" or "Analogous Site" Approach

Newly discovered sites within the boundaries of the 300-FF-2 OU that are identified after the 300-FF-2 ROD (EPA 2001) is signed and that fit the site profile and require remedial action based on the cleanup levels required to meet the RAOs in the ROD will be remediated by using the "plug-in" approach to the selected remedy of remove, treat, and dispose. The Tri-Parties will notify the public regarding the decision to plug in newly discovered waste sites through the periodic publication of ESDs to the 300-FF-2 ROD (EPA 2001) and/or fact sheets. Minor additions (as determined by the regulatory agency) to the 300-FF-2 waste site list will be managed through memoranda issued by the EPA to the OU file maintained in the Administrative Record. In addition, 24 candidate sites consistent with the 300-FF-2 site profile were identified (Appendix A of the ROD), but additional site characterization data are required to evaluate the basis for action. This site characterization effort is required by the 300-FF-2 ROD (EPA 2001) and will be presented in separate site-specific WIs as discussed in the 300 Area SAP (DOE-RL 2009). However, if historical data provide a basis for taking action, characterization may not be required. If further site characterization indicates that remedial action is needed, the waste sites will be plugged in to the RTD remedy.

Based on experience to date in the 100 Areas, focused sampling is often appropriate for confirmatory sampling at candidate sites, whereas statistical sampling is most often used at radioactive liquid effluent sites and candidate sites that require remedial action. The site-specific WIs (sampling designs) are reviewed and approved by the EPA. Based on the EPA review, each WI may be modified before final agency approval.

3.6 SITE VERIFICATION AND CLOSEOUT

Site verification and closeout includes sample collection, demonstration of attainment of RAOs, cleanup documentation, site closure, and site release, as summarized in the following subsections.

3.6.1 Verification Sample Collection

Verification samples of the residual soil from the excavated site, any clean soil stockpiles intended for use as backfill material, and residual soil from staging areas (if applicable) will be collected in accordance with the 300 Area SAP (DOE-RL 2009). Results from the verification samples will be used to demonstrate attainment of the RAOs. Details regarding verification sampling and analysis for candidate sites can be found in the 300 Area SAP (DOE-RL 2009) and site-specific WIs for verification sampling.

3.6.2 Attainment of Remedial Action Objectives

The general approach for verifying attainment of RAOs identified in the 300-FF-2 ROD (EPA 2001) and summarized in Section 2.0 involves the following steps:

- Calculating summary statistics using the verification data set
- Evaluating summary statistics against the appropriate RAGs
- Modeling exposure and risk to future site inhabitants (human and ecological)
- Modeling future impacts to groundwater and the Columbia River.

A detailed description of the process for verifying attainment of the RAOs is provided in Appendix B of this document.

3.6.3 CERCLA Cleanup Documentation

Subsequent to determining that the RAOs have been attained, CVPs or RSVPs will be prepared. The CVP or RSVP will document the remedial action process, verification sampling results, and attainment of the RAOs under the appropriate land use at a site; report the results of evaluations against ecological soil screening values as discussed in Section 2.2.3; and will support the eventual removal of the OU from the NPL. In some cases, EPA may request DOE to evaluate compliance with unrestricted use cleanup levels in order to eliminate unnecessary institutional controls for the site. The CVP/RSVP will be prepared for groups of sites or individual sites, as needed, in accordance with the guidance provided in Appendix B. The CVPs/RSVPs will also be used to support other CERCLA closeout documentation (e.g., remedial action reports, construction completion reports, NPL deletion packages).

Candidate sites that are evaluated and dispositioned as "no action sites" or, following confirmation sampling, confirmed not to exceed the RAOs for any constituents, will be reclassified as "no action" per the waste site reclassification guideline TPA-MP-14, "Maintenance of the Waste Information Data System" (DOE-RL 2007b). Regulator approval will be documented on a waste site reclassification form, which is accompanied by an EPA-reviewed site-specific informal report. Supporting documentation (e.g., calculations, memorandum to file explaining field investigation effort) will be held in records retention for retrieval. The WIDS database will serve as formal notification to the public that the site is no longer a candidate for remedial action and satisfies RAOs established in the 300-FF-2 ROD (EPA 2001).

3.6.4 Backfill and Regrade

Once attainment of the RAOs under the appropriate land use has been verified, the site will be recontoured and/or backfilled as prescribed by the ROD. A general recontour/backfill design will be developed based on the final excavated site and surrounding area topography, as well as the amount of stockpiled overburden/below cleanup level material that has been released for use as backfill material. As needed, additional backfill material may be transported to the excavated site from approved Hanford Site borrow areas. Recontouring and backfilling operations will be performed using standard construction equipment.

Waste sites within the 300 Area "industrial core zone and contiguous areas" will be backfilled and regraded in a manner that will support future industrial reuse of the site. The slope of the regrade topography will provide positive drainage away from areas where residual subsurface contamination could result in adverse groundwater impacts. The grading, to the extent practicable, will maximize the amount of large flat areas and minimize rolling contours or depressions where water may accumulate. Outlying sites should be backfilled and revegetated in a manner that matches the local area contours.

3.6.5 Site Release

The DOE will continue to manage the land in the 300 Area of the Hanford Site as long as necessary to support remedial actions and other missions. The release of land areas for industrial or unrestricted uses will depend on the following: (1) release of the individual waste sites, and (2) the completion of other work in the OU, such as decontamination and decommissioning of facilities, as well as final cleanup verification under CERCLA.

Where deed notices or other institutional controls are used in accordance with this RDR/RAWP and the 300-FF-2 ROD (EPA 2001), the DOE will not allow activities that would interfere with the remedial action prior to EPA and Ecology approval. In addition, DOE will take necessary measures, such as filing deed notices in appropriate county offices and enforcing such land-use limitations through contractual mechanisms, to ensure the continuation of these restrictions prior to any transfer or lease of the property to any private party in accordance with the statutory requirements of Section 120(h) of CERCLA and the regulatory requirements of 40 CFR 373. A copy of any restriction notification will be given to prospective purchaser/transferee before any transfer or lease by DOE. The DOE will provide EPA and Ecology with written verification that these restrictions are in place. In addition, unless and until cleanup levels that would support unlimited use and unrestricted exposure are attained, a reevaluation of the remedial action will occur as part of the CERCLA 5-year review for the 300-FF-2 OU. For more information on requirements applicable to potential land transfers, sales, or leases, see the 300-FF-2 ROD (EPA 2001).

Figure 3-1. Remedial Action Process Overview.

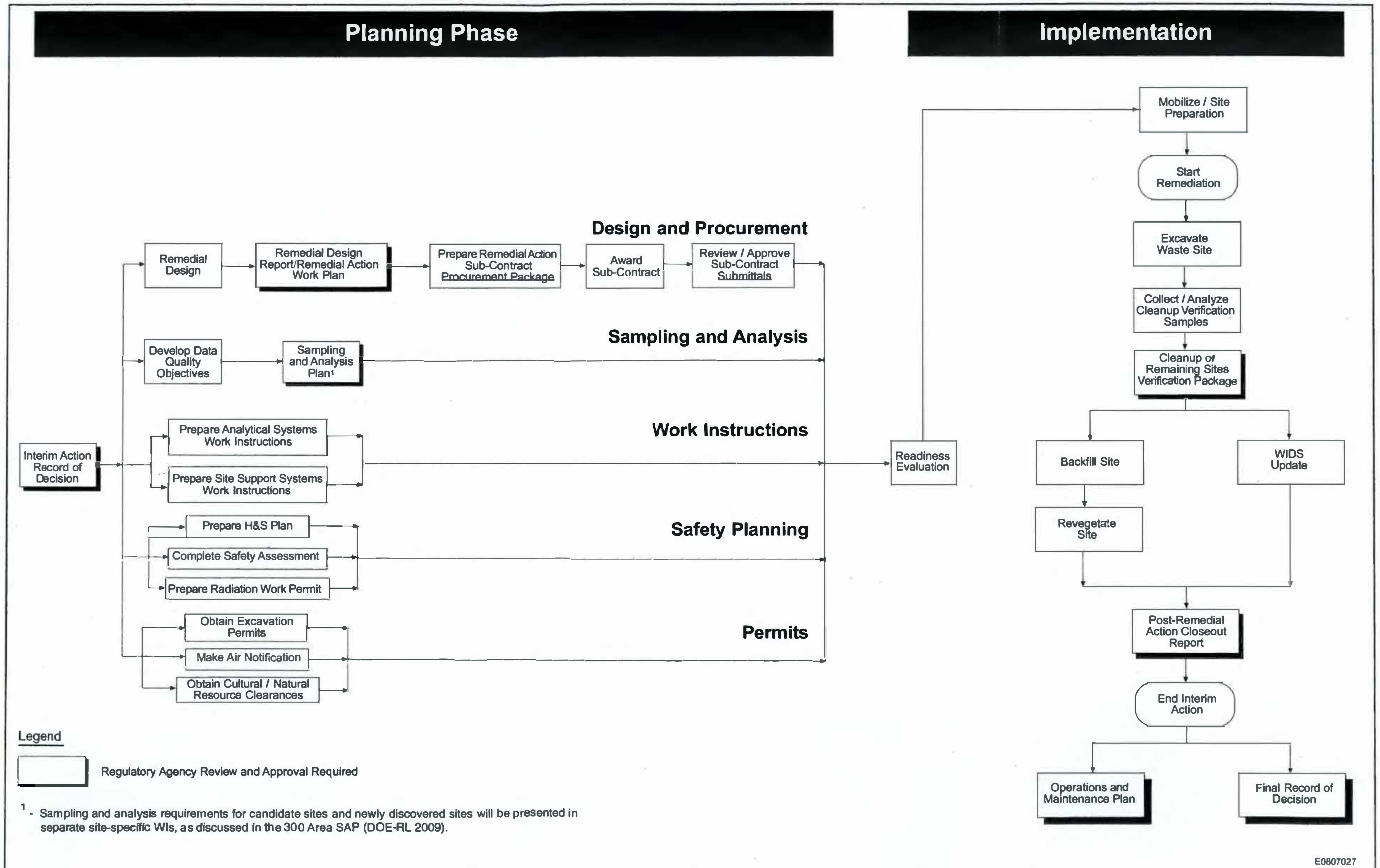
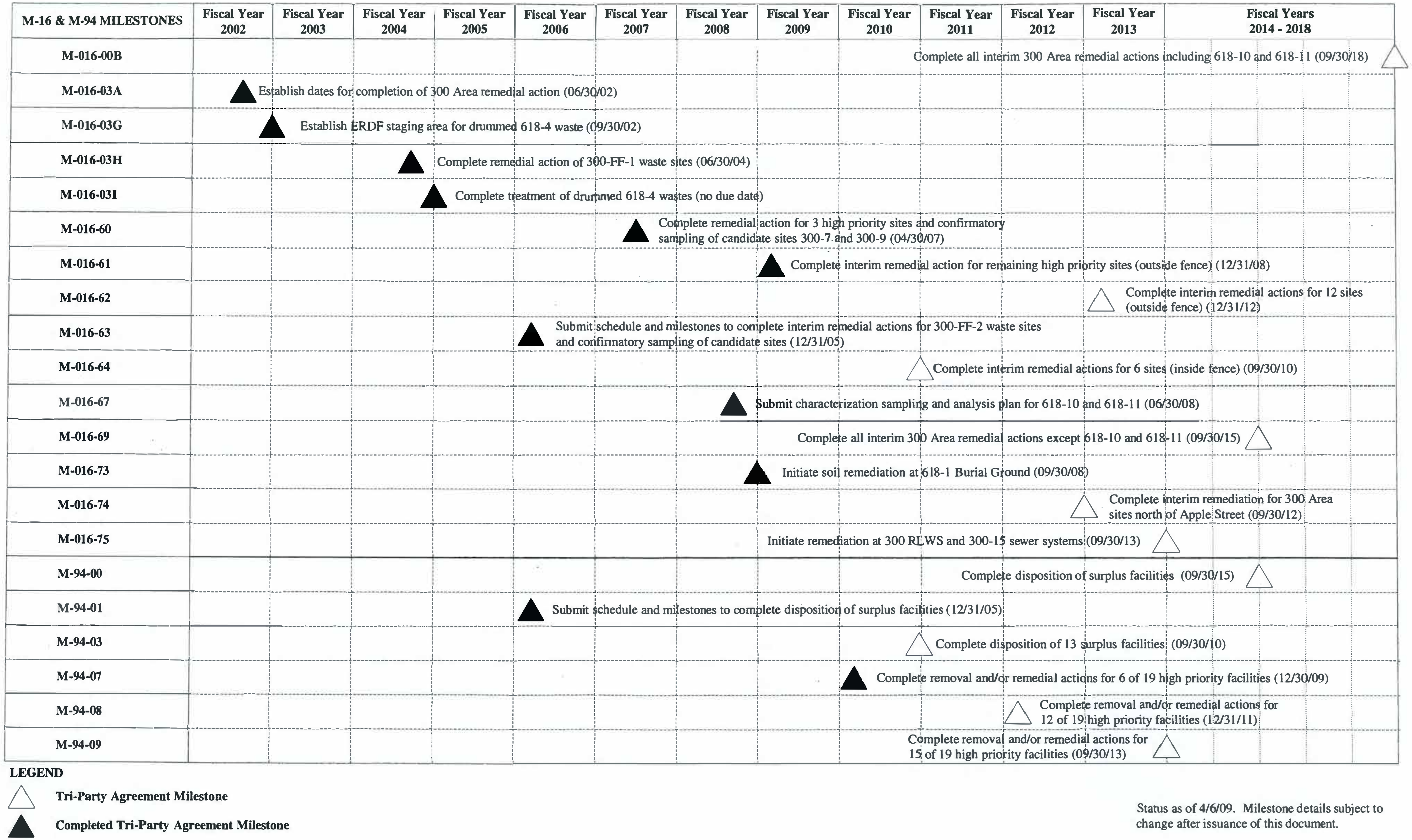


Figure 3-2. Tri-Party Agreement Milestones for 300 Area CERCLA Cleanup.



Status as of 4/6/09. Milestone details subject to change after issuance of this document.

Table 3-1. Summary of Relevant Tri-Party Agreement Milestones. (4 Pages)

Milestone	Description	Due Date/ Complete Date
	General 300 Area Milestones	
M-16-00	Complete remedial actions for all nontank farm OUs.	September 30, 2018
M-16-00B	Complete all interim 300 Area remedial actions including the 618-10 and 618-11 Burial Grounds. Completion of all interim remedial actions is defined as completion of interim ROD requirements in accordance with an approved RD/RA work plan, and obtain EPA approval of appropriate project closeout documents. The disposition of impeding surplus facilities will be performed in accordance with Milestone M-094-00.	September 30, 2018
M-16-03A	Establish dates for completion of 300 Area remedial action.	June 30, 2002 Completed April 30, 2002
M-16-03G	Establish Environmental Restoration Disposal Facility staging area for drummed 618-4 waste.	September 30, 2002 Completed April 10, 2002
M-16-03H	Complete remediation of waste sites in the 300-FF-1 OU to include excavation, verification, and regrading, including the 618-4 Burial Ground, in accordance with an approved RDR/RAWP.	June 30, 2004 Completed February 19, 2004
M-16-03I	Complete treatment of drummed waste from the 618-4 Burial Ground in accordance with an approved RDR/RAWP.	No date assigned Completed August 4, 2004
	Outside the Fence Milestones	
M-016-60	Complete interim remedial actions for at least three of the following high environmental priority 300-FF-2 waste sites (316-4, 618-2, 618-3, 618-5, and 618-7), and complete confirmatory sampling of 300-FF-2 candidate sites 300-7 and 300-9.	April 30, 2007 Completed December 28, 2006
M-016-61	Complete interim remedial actions for the remaining high environmental priority 300-FF-2 waste sites (618-2, 618-3, 618-5, and 618-7).	December 31, 2008 Completed December 29, 2008
M-016-62	Complete interim remedial actions for the following 300-FF-2 waste sites (300-8, 300-18, 300 VTS, 316-4, 600-47, 600-259, 618-2, 618-3, 618-5, 618-7, 618-8, and 618-13).	December 31, 2012

Table 3-1. Summary of Relevant Tri-Party Agreement Milestones. (4 Pages)

Milestone	Description	Due Date/ Complete Date
	Inside the Fence Milestones	
M-016-63	Submit a schedule and Tri-Party Agreement milestones to complete interim remedial actions for the 300-FF-2 waste sites and confirmatory sampling of the 300-FF-2 candidate sites. The milestone deliverable shall include at least (1) a schedule for submittals of any documents requiring EPA and/or Ecology approval (e.g., RDR/RAWPs, etc.), (2) a schedule that defines dates for initiating and completing interim remedial actions at waste sites and impeding facilities, (3) a Tri-Party Agreement change package that includes milestones for groups of waste sites and impeding facilities that will ensure completion of M-016-00B. It is expected that schedules will be aligned with the associated schedules required by M-094-01.	December 31, 2005 Completed December 29, 2005
M-016-64	Complete interim remedial actions for the following 300-FF-2 waste sites: 300-259, 303-M SA, 303-M UOF, UPR-300-46, UPR-300-17, and 618-1.	September 30, 2010
M-016-65[a]	Submit schedule and milestones for remedial action and confirmatory sampling.	August 30, 2005 Cancelled September 5, 2003
M-016-73	Initiate substantial and continuous soil remediation at the 618-1 Burial Ground.	September 30, 2008 Completed September 17, 2008
M-016-74	Complete interim remediation (to include excavation, loadout, closeout sampling, backfill, and revegetation) for all 300 Area "Inside the Fence" waste sites north of Apple Street, except that for the 300 RLWS, 300-15, 300-4, 300-268, and 300-123 waste sites, remediation need only be completed through excavation and loadout.	September 30, 2012
M-016-75	Initiate substantial and continuous soil remediation on the 309 Facility Dedicated Radioactive Liquid Waste Sewer (300 RLWS) and the 300 Area Process Sewer (300-15) systems.	September 30, 2013

Table 3-1. Summary of Relevant Tri-Party Agreement Milestones. (4 Pages)

Milestone	Description	Due Date/ Complete Date
	618-10 and 618-11 Burial Ground Milestones	
M-016-66 [b]	Complete preliminary design and documented safety analysis for remedial actions at the 618-10 and 618-11 Burial Grounds. The preliminary design shall include, at a minimum, a design basis report, site layout, drawings and preliminary technical specification. Preliminary design activities will use WIPP remote-handled transuranic waste acceptance criteria, an evaluation of remote-handled transuranic technology development efforts, and an evaluation of lessons learned from other ongoing DOE complex transuranic excavation efforts. The documented safety analysis shall include, at a minimum, any approvals required to support additional site characterization within the 618-10 and 618-11 Burial Grounds for design purposes and any treatability investigations.	September 30, 2004 Completed September 30, 2004
M-016-67	Submit a characterization SAP to EPA for approval as a primary document for the 618-10 and 618-11 Burial Grounds. The SAP shall identify the sampling schedule and the date of submission of the summary report to EPA.	June 30, 2008 Completed June 20, 2008
M-016-69	Complete all interim 300 Area remedial actions to include confirmatory sampling of all candidate sites listed in the 300-FF-2 ROD (except for 618-10 and 618-11 Burial Grounds).	September 30, 2015
	Facility-Related Milestones	
M-94-00	Complete disposition of 300 Area surplus facilities. Completion of facility disposition is defined as the completion of deactivation, decontamination, decommissioning, and demolition and obtain EPA and/or Ecology approval of the appropriate project closeout documents. The cleanup of 300-FF-2 waste sites associated with 300 Area surplus facilities will be performed in accordance with Tri-Party Agreement major milestone M-16-00B.	September 30, 2015
M-94-01	Submit a schedule and Tri-Party Agreement milestones to complete disposition of surplus facilities in the 300 Area. Milestone deliverable shall include at least the following: (1) a schedule for submittals of EE/CAs, removal action memoranda, removal action work plans, closure/post-closure plans, and other documents that require EPA and/or Ecology approval; (2) a schedule that defines initiation and completion dates for disposition of groups of surplus facilities and associated waste sites; and (3) a Tri-Party Agreement change package that includes milestones for groups of surplus facilities and associated waste sites that will ensure completion of M-94-00. These schedules shall be included (and updated as appropriate) in 300 Area removal action work plans submitted for EPA and/or Ecology approval and will be aligned with the associated schedules required by M-16-63.	December 31, 2005 Completed December 29, 2005
M-94-02 [b]	Submit amendment for 324 Building closure plan.	July 30, 2002

Table 3-1. Summary of Relevant Tri-Party Agreement Milestones. (4 Pages)

Milestone	Description	Due Date/ Complete Date
M-94-03	Complete disposition of the following surplus facilities: 303M, 332, 333, 334, 334A, 3221, 3222, 3223, 3324, 3225, 324, 324B, and 327.	September 30, 2010
M-94-04[c]	Submit a schedule and Tri-Party Agreement milestones to complete disposition of the surplus facilities in the 300 Area and identify the 300 Area facilities and associated waste sites that will remain past the M-094-00 completion date (September 30, 2018).	August 30, 2005 Deleted September 5, 2003
M-94-07	Complete the selected removal and/or remedial actions that are selected for 6 of the following 19 high-priority facilities: 305B, 306E, 306W, 307 Retention Basins, 308, 309, 321, 323, 324, 324B, 325, 326, 327, 329, 333, 340, 3706, 307 Trench, and 3720; to include the 306E, 306W, 3720, and 305B Facilities.	September 30, 2009 Completed March 23, 2009
M-94-08	Complete the selected removal and/or remedial actions that are selected for 12 of the following 19 high-priority facilities: 305B, 306E, 306W, 307 Retention Basins, 308, 309, 321, 323, 324, 324B, 325, 326, 327, 329, 333, 340, 3706, 307 Trench, and 3720.	September 30, 2011
M-94-09	Complete the selected removal and/or remedial actions that are selected for 15 of the following 19 high-priority facilities: 305B, 306E, 306W, 307 Retention Basins, 308, 309, 321, 323, 324, 324B, 325, 326, 327, 329, 333, 340, 3706, 307 Trench, and 3720; to include the 323 Facility and the 307 Trench.	September 30, 2013

[a] Milestone cancelled via change request M-16-03-03, dated September 5, 2003.
[b] Other Hanford Site contractor scope.
[c] Milestone deleted via change request M-94-03-01, dated September 5, 2003.

DOE = U.S. Department of Energy
Ecology = Washington State Department of Ecology
EE/CA = engineering evaluation/cost analysis
EPA = U.S. Environmental Protection Agency
OU = operable unit
RDR/RAWP = remedial design report/remedial action work plan
ROD = Record of Decision
SAP = sampling and analysis plan
VTS = vitrification test site
WIPP = Waste Isolation Pilot Plant

4.0 WASTE MANAGEMENT PLAN

Waste management activities will be performed in accordance with the applicable ARARs identified in the 300-FF-2 ROD (EPA 2001) and RCC Project internal procedures. The requirements specified by the ARARs and other applicable guidance will address waste storage, transportation, packaging, handling, and labeling as they specifically apply to waste streams from each waste site. This process is illustrated in Figure 4-1.

4.1 WASTE DESIGNATION METHODS

Wastes will be designated for waste disposition based on historical data, process knowledge, engineering calculations, sampling and analysis, or combinations thereof. Each of these methods and their applications is described as follows:

- Historical data (e.g., analytical results) may be used to designate waste forms that have previously been characterized (e.g., the *618-4 Burial Ground Excavation Report* [BHI 1998]). In addition, previous and current 300 Area remediation projects have designated significant quantities of buried solid waste. The waste forms in this category are readily identified and are known for their hazardous material content.

- Process knowledge will be used to designate waste for which process knowledge provides sufficient information. Waste forms such as asbestos-containing floor tiles and pipe lagging do not require sampling and analysis because these will be designated as asbestos-containing materials based on visual observation. Elemental lead debris, paint debris, and lead acid batteries are other examples where designation will be based on process knowledge.

- Engineering calculations may be performed to estimate the weight or volume of a hazardous waste in a certain matrix (e.g., calculating lead-based paint content on pump housings).

- Sampling and analysis will be used for designation of wastes when the above-mentioned methods are not appropriate or available. Sampling and analysis is required for liquids and most of the anomalous waste forms. Where sampling is needed, historical data, process knowledge, and/or engineering calculations may be used to reduce the suite of analyses required. All sampling activities supporting waste designation will be performed in accordance with the 300 Area SAP (DOE-RL 2009).

Specific types of waste that are initially designated based on sampling results may be designated using one of the other methods (e.g., historical data) as the waste is repeatedly unearthed during the excavation. All excavation operations will be observed by waste management personnel assigned to assist with the designation process.

When asbestos in nonfriable form (e.g., asbestos in the pipe matrix, asbestos impregnated in tar paper wrapped water pipes) is encountered in the shallow zone, as in pipelines, and no other

CERCLA hazardous waste is associated with the pipelines other than asbestos in non-friable form, remediation of such pipelines is not required (DOE-RL et al. 2005c).

4.2 WASTE STREAM-SPECIFIC MANAGEMENT

Various waste streams will be encountered during the course of remedial actions. Each waste stream will require specific processing and disposal. Similar types of waste will be managed uniformly. Management of waste streams that are projected to be encountered during the course of remedial actions are summarized in the following subsections.

4.2.1 Miscellaneous Solid Wastes

Miscellaneous solid waste that has contacted potentially contaminated materials will be segregated from other materials and will generally be transported to the ERDF for disposal. Miscellaneous solid waste that has not contacted contaminated media and that has been radiologically released may be disposed offsite at a permitted disposal facility, disposed in an onsite limited purpose or inert landfill, or recycled, as appropriate. Examples of miscellaneous solid waste include (but are not limited to) filter paper, wipes, personal protective equipment, cloth, plastic, equipment, tools, pumps, wire, metal and plastic piping, and materials from cleanup of unplanned releases.

4.2.2 Low-Level Radioactive Waste

Low-level radioactive waste, including soil, concrete, debris, and structures, will be removed during excavation. Plastic, paper, and other compactible waste will also be generated as part of the remediation activities. Debris that has contacted contaminated media may be disposed at the ERDF if the waste acceptance criteria can be met. If the waste acceptance criteria cannot be met, the waste will be shipped to an appropriate offsite facility, depending on the waste designation. Offsite facilities that receive contaminated waste must be deemed acceptable by the EPA in accordance with 40 CFR 300.440.

4.2.3 Hazardous and/or Mixed Waste (Both Radioactive and Hazardous)

Hazardous and/or mixed waste that meets the land disposal-restricted treatment standards and the most current ERDF waste acceptance criteria may be disposed in the ERDF. Wastes that do not meet the acceptance criteria may be staged until they can be treated to meet the criteria and will be handled on a case-by-case basis. Depending on the waste designation, the waste may be shipped to an appropriate offsite facility. Offsite facilities that receive contaminated waste must be deemed acceptable by the EPA in accordance with 40 CFR 300.440.

4.2.4 Liquid

4.2.4.1 Liquids from Unplanned Releases. If a release occurs, the notification of WCH Spill Release Support is required. The reporting requirements will be met as prescribed by DOE O 232.1A, *Occurrence Reporting and Processing Operations*. The WCH point-of-contact will determine the actions required to address the spill and determine if the lead regulatory agency needs to be notified.

Spills (unplanned releases) that occur in clean areas that are being used in support of a CERCLA remediation are appropriate for disposal at the ERDF, when the following conditions exist:

1. The spill occurred from equipment supporting the CERCLA activity.
2. The waste meets the ERDF waste acceptance criteria (WCH 2008).
3. The spill occurred within the CERCLA OU boundary or onsite area.

A "clean area" is defined as an area supporting a CERCLA remediation activity that is not contaminated with the contaminants of concern found in the active remediation areas (DOE-RL et al. 2007).

Liquid that does not meet the ERDF acceptance criteria will be shipped to the Effluent Treatment Facility (ETF) or an appropriate offsite facility. The ETF is an approved noncontiguous onsite facility pursuant to CERCLA Section 104(d)(4) to store and treat liquid waste generated from removal actions, provided the waste acceptance criteria can be met.

4.2.4.2 Decontamination Fluids. Decontamination fluids (i.e., water and/or nonhazardous cleaning solutions) from cleaning equipment and tools used in the OU will be discharged to the ground in accordance with Section 3.5.5. If decontamination fluids are collected and they are above the collection criteria, they will be designated and transported to the ETF or the 310 Treated Effluent Disposal Facility (if the waste acceptance criteria can be met), or other facilities as authorized by the lead regulatory agency. Small volumes of nondangerous decontamination fluids may be stabilized to eliminate free liquids and then disposed to the ERDF if the waste acceptance criteria can be met.

4.2.4.3 Liquid Remaining in Pipes. Liquids that may remain in pipelines to be remediated will be collected to the extent reasonably practicable, designated, and transported to the ETF or other facility as authorized by the lead regulatory agency. If the liquid is water and contains contaminants in levels below those listed in WAC 173-200 or groundwater cleanup standards in WAC 173-340-720, it may be used as dust suppressant. Water above the WAC 173-200 or WAC 173-340-720 limits may be used as dust suppressant following approval by the lead regulatory agency.

Pipeline removal may be a planned remedial action or an activity made necessary by an unplanned discovery. Projects perform historical research to locate buried pipelines and learn as much as possible about their past functions and what liquids they may currently hold. Based upon that research, and observations and data gathered during remedial action, a graded approach will be taken to spill control practices implemented during pipeline removal. The most stringent efforts will be used for pipes containing or expected to contain dangerous waste liquids. Those pipelines will be hot tapped and liquids drained, containerized, and properly disposed.

Mitigative measures required in most cases will lie somewhere between those extremes. Spill control practices (spill kits, absorbents, liners, catch basins, etc.) will be used to minimize the quantities of nondangerous waste liquids that may be released to the soil. Pipelines will not be deliberately breached unless their contents are known or measures are in place to positively contain any liquids that may be discharged. Proposed pipeline remediation will be discussed with the regulators so they understand the approach to be used, spill controls that will be employed, and uncertainties or risks of unknown liquids or inadvertent discharges.

4.2.5 Used Oil and Hydraulic Fluids

Used oil and hydraulic fluids generated during operation of machinery at the waste sites will be radiologically released and sent offsite for recycling or disposal, as appropriate or may be stabilized in accordance with ERDF waste acceptance criteria (WCH 2008) and disposed to ERDF if fluid contacted contaminated media associated with the waste site.

4.2.6 Returned Sample Waste

Screening and analysis of both solids and liquids may be conducted at the waste sites, offsite or onsite laboratories, and/or the Radiological Counting Facility. Samples from these may be returned to the OU. Unused samples and associated laboratory waste from offsite analyses will be managed by the applicable laboratory in accordance with contract specifications. Waste from field screening and onsite laboratories will be managed depending on whether it has been altered. Altered samples will be contained and disposed at the ETF, ERDF, or other appropriate facilities as authorized by the lead regulatory agency, depending on waste designation. Unaltered liquid waste generated during sample screening and analysis may be discharged to the ground near the point of generation, if it is below the collection criteria limits, or disposed at the ETF, ERDF, or other appropriate facilities if it is above the collection criteria. Some liquids may be neutralized and/or stabilized to meet the disposal facility's waste acceptance criteria. Pursuant to 40 CFR 300.440, DOE-RL approval is required before returning unused samples or waste from onsite or offsite laboratories. Approval of this RDR/RAWP constitutes DOE-RL remedial project manager approval for shipment of offsite and onsite laboratory sample waste back to the waste site of origin.

4.3 WASTE HANDLING, PACKAGING, AND LABELING

Materials requiring collection will be placed in containers appropriate for the material and the receiving facility. Although ERDF containers will be used for most wastes, an alternative "truck and pup" style of container may be used for nonradionuclide-contaminated waste.

Waste moved outside of the AOC must meet all substantive requirements of WAC 173-303 and DOT requirements, as appropriate. In addition, polychlorinated biphenyl (PCB) wastes will be managed in accordance with substantive provisions of 40 CFR 761, and asbestos waste will be managed in accordance with 40 CFR 61. Waste will be packaged, marked, and labeled in accordance with ARARs.

4.4 STORAGE

In general, waste unearthed in support of this RDR/RAWP will be disposed at the ERDF or other approved onsite or offsite facility. As necessary, waste will be stored in staging piles within the AOC or at the ERDF as described in the following subsections.

4.4.1 Area of Contamination

Waste that is excavated and held (i.e., not immediately transported to the ERDF) for further analysis, treatment, or any other reason will be typically managed within the AOC. The AOC approach was discussed in the NCP (55 FR 8666) with regards to remedial actions under CERCLA. The guidance states that the AOC can be equated to a RCRA landfill where movement within the area would not be considered land disposal and would not trigger the requirements of Subtitle C, such as 90-day storage or land disposal restrictions. Any movement of soil outside of the AOC but within the CERCLA onsite area will trigger compliance with all ARARs, such as RCRA provisions for management of dangerous waste. The AOC for each waste site will be delineated in the project drawings. These drawings may be provided to the lead regulatory agency upon request.

4.4.2 Staging Piles

As an alternative to storage within the AOC, waste that is not immediately transported to the ERDF or other EPA-approved disposal facility may be stored in staging piles. The staging piles must be operated in accordance with the standards and design criteria prescribed in 40 CFR 264.554, paragraphs (d) through (k). General requirements for the staging piles include the following.

- Staging piles are used only during remedial operations for temporary storage at a facility and must be located within the contiguous property where the wastes to be managed in the staging piles originated.

- The staging pile must be designed so as to prevent or minimize releases of hazardous wastes and hazardous constituents into the environment and minimize or adequately control cross-media transfer. To protect human health and the environment, this can include installation of berms, dust control practices, or using plastic liners/covers, as appropriate. A release of a hazardous substance outside the staging pile confines into the underlying soil or ambient air will be considered a release into the environment, and immediate notification under CERCLA will be pursued in accordance with 40 CFR 302, if the quantity involved exceeds a reportable quantity over a 24-hour period, and/or in accordance with other regulation(s) as applicable. However, if hazardous substances are discovered within the confines of an approved staging pile, it is not considered a release (DOE-RL et al. 2005a).

- The staging pile must not operate for more than 2 years (measured from the first time remediation waste is placed into the pile), except when the EPA grants an operating term extension. A record of the date when remediation waste was first placed in the staging pile must be maintained until final closeout of the site is achieved.

- Ignitable or reactive waste must not be placed in a staging pile unless it has been treated or mixed before being placed in the pile so that the waste no longer meets the definition of ignitable or reactive waste, or the waste is managed in order to protect it from exposure to any material or condition that may cause it to ignite or react.

- Incompatible wastes may not be placed in the same staging pile, unless the requirements in 40 CFR 264.17(b) have been met. The incompatible materials must be separated or they must be protected from each other with a dike, berm, wall, or other device. Remediation waste may not be piled on the same base where incompatible wastes or materials were previously piled, unless the base has been decontaminated sufficiently to comply with 40 CFR 264.17(b).

- Within 180 days after the operating term of the staging pile located in a previously uncontaminated area expires, the staging pile must be closed in accordance with 40 CFR 264.258(a) and 264.111, or 40 CFR 265.258(a) and 265.111. This includes removing all remediation waste, contaminated containment system components, contaminated structures and equipment, and leachate.

Approval of this RDR/RAWP by the EPA constitutes general authorization to operate staging piles during remediation of the 300-FF-2 OU. Specific staging pile locations will be identified on project drawings and approved by the EPA in unit manager's meetings. Field operation of staging piles within the referenced regulatory provisions will be accomplished through the following controls:

- The staging pile area will be surrounded with a minimum of a 15-cm (6-in.) berm to control run-on/runoff prior to use.

- Dust control practices will be deployed consistent with soil piles managed in the AOC, including the use of crusting agents, as necessary, to minimize migration/leaching or contaminants into underlying soil.

- Surveys of the staging pile area will be performed prior to placement to ensure no cross-media transfer or staging of waste on previous contaminated areas.

- Gross sorting of waste will be performed within the AOC to identify and remove drums or other containers from the bulk soil prior to moving the soil to the staging piles. Additional sorting may be required on bulk soil prior to moving the soil to the staging pile area. Any dangerous or unknown waste identified will be packaged and managed appropriately (drums) within the staging pile area and within close proximity to the specific staging pile.

Drums will be properly labeled, managed, and inspected weekly, or as described in RCC Project waste management procedures.

Once characterization and designation of the material is completed, the waste will be loaded into containers for transport to the ERDF or shipped offsite for treatment and/or disposal, as appropriate. To close out the staging pile areas after the waste has been removed, samples of the residual soil will be collected in accordance with the 300 Area SAP (DOE-RL 2009). In cases where staging piles for industrial waste sites are located in an uncontaminated area, the sample results should also be compared against the soil cleanup levels in Tables 2-1 and 2-2. If the sample results meet the unrestricted cleanup levels, by direct comparison to the Table 2-1 and 2-2 cleanup levels no further action or assessment is necessary. If the sample results exceed the unrestricted cleanup levels and are below the industrial cleanup levels, institutional controls will apply to the staging pile area consistent with the actual waste site. This will be accomplished by identifying the staging pile area as a decision unit.

4.4.3 Environmental Restoration Disposal Facility Drummed Waste Staging Area

On a case-by-case basis, a staging area may be available at the ERDF for drummed wastes from the 300 Area remedial action sites that require special handling and/or treatment not currently available, such as thermal treatment of a mixed radioactive/dangerous waste. Drummed waste will be characterized at the site prior to transport to the ERDF staging area. All drummed waste sent to the ERDF staging area will be stored in accordance with requirements prescribed by the ERDF ROD (EPA 2002).

4.5 WASTE TRANSPORTATION

Packaging, marking, and labeling for transportation will be in accordance with DOT 49 CFR requirements, procedures, and the ARARs, as appropriate. With appropriate documentation (e.g., safety analysis report for packaging or risk-based exemption), packaging exceptions to DOT requirements that provide an equivalent degree of safety during transportation may be used for waste shipments. Coordination and preparation of these documents will be approved by the DOE-RL. ERDF roll-off-type containers will be used for most bulk wastes. Tractor-trailer flatbed units will be used for transportation of drummed waste. Containers will be sealed and shipped to the identified disposal facility as quickly as economically feasible. Waste will be transported in accordance with WAC 173-303 and DOT regulations, as appropriate.

4.6 WASTE TREATMENT

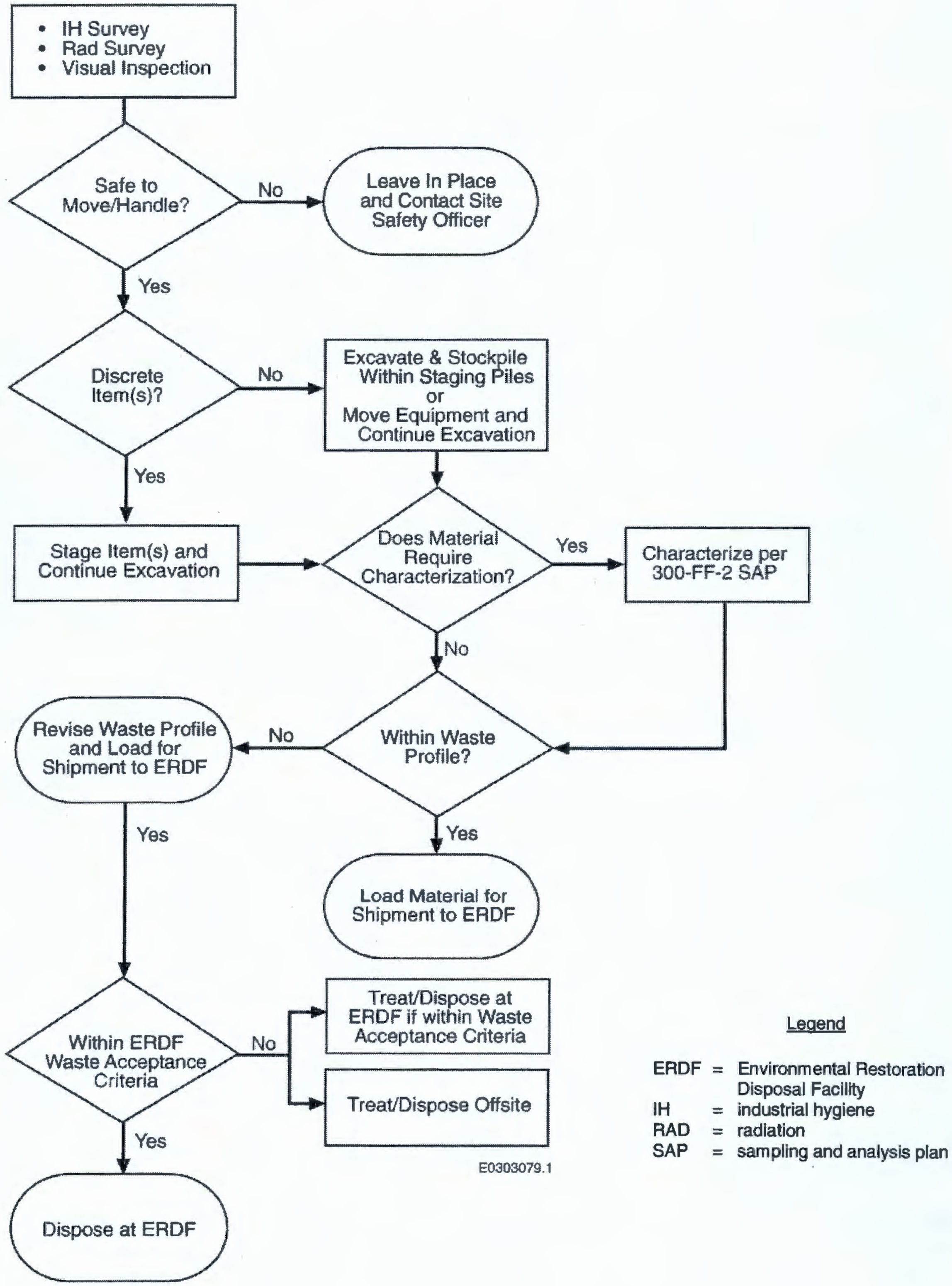
When necessary, treatment is one of the selected remedy elements for the 300 Area waste sites. Treatment may be conducted at the site, at the ERDF (in special cases), or at an EPA-approved offsite facility. If land disposal-restricted wastes are encountered, the requirements of 40 CFR 268 will be applied, unless a treatability variance is approved by the EPA. Offsite treatment must be performed at a facility approved by the EPA in accordance with

40 CFR 300.440. Return of treated waste from offsite treatment facilities for disposal at the ERDF will require additional authorization from the DOE-RL.

Treatment will be required for LDR material unless a treatability variance or ARAR waiver is requested by DOE-RL and approved by the regulatory agencies. If LDR wastes are encountered, the requirements of 40 CFR 268 and WAC 173-303-140 will be applied. Should LDR material be encountered, it will be temporarily stored within the AOC or staging piles and disposed in accordance with applicable regulations. If treatment is required to address LDR wastes, DOE-RL will obtain regulatory agency approval.

An approved LDR treatment method for radioactively contaminated cadmium-, silver-, and mercury-containing batteries allows for macroencapsulation prior to disposal. However, lead-acid batteries are not covered by this standard and require initial treatment (draining corrosive liquids, treating separately prior to disposal) (DOE-RL et al. 2005b).

Figure 4-1. Logic Flow Diagram for Disposition of Buried Waste and Co-Mingled Soil.



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APPENDIX A

WASTE SITE INFORMATION

APPENDIX A

300-FF-2 OPERABLE UNIT WASTE SITE SUMMARY

A summary of the 300-FF-2 operable unit waste sites that have undergone or will be undergoing remedial design and remedial action as listed in the *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington* (EPA 2001) are presented in this appendix as Table A-1. Information related to current site knowledge and status was compiled from the following resources:

- Waste Information Data System (WIDS)
- Stewardship Information System (SIS)
- *300-FF-2 Operable Unit Technical Baseline Report* (BHI 1995)
- *100 and 300 Area Burial Ground Remediation Study* (BHI 1996)
- *Limited Field Investigation Report for the 300-FF-2 Operable Unit* (DOE-RL 1996)
- *Focused Feasibility Study for the 300-FF-2 Operable Unit* (DOE-RL 2000).

Table A-1. Waste Site Information. (8 Pages)

Site Name	Site Information	Site Status
300 RLWS, 300 Area Radioactive Liquid Waste Sewer	Consists of a network of underground, double-encased stainless-steel pipe (encased in reinforced-fiberglass or plastic pipe as secondary containment) draining to the 340 Complex. Replaced the original radioactive liquid sewer (300 RRLWS, Retired Radioactive Liquid Waste Sewer) in 1979.	
300 RRLWS, 300 Area Retired Radioactive Liquid Waste Sewer System	A network of 5-, 8-, 10-, and 15-cm (2-, 3-, 4-, and 6-in.) single-walled stainless steel piping and carbon steel fittings buried between 3 and 6 m (10 and 20 ft) below grade. A separate 8-cm (3-in.) carbon steel transfer line installed in 1960 connected the 309 Building to the 340 Complex. The system was replaced with the double-encased pipe of the 300 Area Radioactive Liquid Waste System (300 RLWS).	
300 VTS, 300 Area Vitrification Test Site	The site was used in the 1980s and 1990s as a field demonstration site for the vitrification (glassification) of soils containing waste simulates.	Site has been remediated and interim closed. See CVP-2005-00009.
300-2, Contaminated Light Water Disposal	The site is a release to soil in 1965 of about 189,250 L (50,000 gal) of secondary cooling water contaminated with fission products.	
300-4, Substation Soil Contamination	The site consists of the contaminated soil inside the southwest corner of the fenced (active) electrical substation.	
300-5, Fire Station Fuel Tanks, Fire Station	The site was two underground fuel tanks, the pump island, ancillary piping, and contaminated soil. The tanks were removed in 1992.	
300-7, Undocumented Solid Waste Burial Ground	The site is a small rise that extends to the north and west from the 300 Area North Parking Lot. Surface debris piles can be seen and subsurface disturbances have been identified with ground penetrating radar. Currently, the site is covered with natural vegetation. Some of the visible surface debris consists of concrete, trash, and cables.	
300-8, Aluminum Recycle Storage Area	The site consisted of six irregularly shaped soil contamination areas. The area was used to stage aluminum scrap from fuel fabrication operations to be sold to salvage contractors.	Site has been remediated and interim closed. See CVP-2005-00007.
300-9, Solid Waste Burial Ground	In 1952, an area of contamination was accidentally uncovered while installing poles for a new power line. This burial ground was supposedly used to dispose of solid uranium waste in 1944.	
300-11, Pumphouse Underground Gasoline Tank	The site was releases to the soil that were discovered following the removal of an underground gasoline tank in September 1992.	
300-15, 300 Area Process Sewer System	The site is an underground process sewer extending throughout the 300 Area for the disposal of process wastes such as steam condensate, cooling water, and nonregulated liquids. The piping consists primarily of 20-cm (8-in.) vitrified clay pipes with acid-proof joints, as well as cast-iron, stainless-steel, carbon steel, and polyvinyl chloride.	
300-16, Solid Waste Near 314 Building	On March 6, 1992, May 4, 1994, and September 22, 1995, radioactive contamination (yellow-cake uranium) was discovered on the bottom ends of several utility poles that had been removed.	

Table A-1. Waste Site Information. (8 Pages)

Site Name	Site Information	Site Status
300-18, SCA #4, Surface Contamination Area #4	The site was identified during routine surveillance activities in 1993 as soil and metal shavings with contamination levels of 3,000 to 4,000 disintegrations per minute and six pieces of contaminated concrete reading 2,000 to 4,000 disintegrations per minute.	Site was remediated and interim closed. See CVP-2005-00004.
300-22, 309 Building B-Cell Cleanout Leak	The site is an unplanned release from a parted hose coupling that contaminated the ground outside the emergency airlock of the 309 Building on September 20, 1962.	
300-24, Soil Contamination at the 314 Metal Extrusion Building	The oxide burner operations caused contamination to spread and be deposited on the south side of the facility near the southwest corner of the building and outside the door to the facility.	
300-28, Contamination Found Along Ginko Street	The site is contaminated asphalt and soil beneath Ginko Street found during excavation activities associated with the installation of a fiber optic telephone system in 1994. Contaminated soils were encountered just below the asphalt paving.	
300-29, 305-B Berm	The site was a U-shaped soil berm that surrounded the east wing of the 305-B Chemical Waste Storage Building.	Site was reclassified to no action. See CCN 134247 and WSRF 2004-100.
300-33, 306W Metal Fabrication Development Building Releases	The site is the contaminated soil around and under the 306W Building. The area around the 306W Building is paved and posted as having underground radioactive contamination.	
300-34, 300 Area Process Sewer Leak	The site was a release to soil that was discovered during excavation to install a new manhole (PS-87). PS-87 is a 0.7-m (2.3-ft)-diameter sewer opening with a round metal cover at grade.	
300-40, Corrosion of Vitrified Clay Process Sewer Pipe	This leg of pipe collected rain water drainage from the 311 Tank Farm and the 303-F floor drains. The piping also collected effluent from the 311 Stillhouse.	
300-43, Unplanned Release Outside 304 Building	The site is uranium-contaminated soil around the 304 Building (formerly the 304 Concretion Facility) in the 300 Area. The site also includes residual contamination remaining in the 304 Storage Area (304 SA).	
300-46, Soil Contamination Surrounding 3706 Building	This site estimates the extent of uranium, transuranic and chemical contamination of the 3706 Building and the surrounding area.	
300-48, Thorium Oxide and Fuel Fab Chemical Wastes Around 3732 Building	This site is the 3732 Building foundation and the surrounding soil contamination. The site appears as a gravel-covered mound.	
300-80, 314 Building Stormwater Runoff, Misc Stream #268	The site is a square concrete structure adjacent to the 314 Building and next to a fenced stairway leading down. The site is covered by a steel plate marked with a sign "Radioactive material, internally contaminated."	
300-109, 333 Building Stormwater Runoff, Misc Stream #455	The *Inventory of Miscellaneous Streams* (DOE-RL 1995) report states the injection well is below grade. A site visit on October 26, 1998, could not visually identify any surface features resembling a drain north of the 333 Building. The site was revisited on November 11, 1998, with a facility representative. A white PVC pipe emerges laterally from the asphalt in the approximate location described in the *Inventory of Miscellaneous Streams* report (DOE-RL 1995).	

Table A-1. Waste Site Information. (8 Pages)

Site Name	Site Information	Site Status
300-110, 333 Building Stormwater Runoff, Misc Stream #456	The site is a 0.41-m (1.4-ft)-diameter drain with a metal grate labeled "Internal Radioactive Contamination" due to its proximity to the 618-1 Burial Ground. The drain has a dirt bottom that is approximately 0.61 m (2 ft) below the surface of the asphalt and an overflow line that drains to the process sewer.	
300-121, 3621D Building Stormwater Runoff, Misc Stream #403, Injection Well #26	The site is a french drain with a concrete base. The drain is covered by a 1.4-m (4.5-ft) metal lid. The lid appears to fit flush with the concrete base and is labeled "Confined Space" and has "FD 26" written on it. The site is surrounded by sandy soil and rocks.	
300-175, 3714 Building Steam Condensate, Misc Stream #434	The site is a 36-cm (14.2-in.)-diameter concrete french drain with a metal cover. The inside is dry and filled with cobbles. There are no steam lines entering the site, and no steam lines are visible inside the drain.	
300-214, 300 Area Retention Process Sewer	The site is an underground carbon steel and polyvinyl chloride pipeline connecting the 300 Area laboratory facilities (308, 324, 325, 326, 327, and 329 Buildings) to the 307 Retention Basins. The Retention Process Sewer (RPS) provides radioactive monitoring and transport of nonhazardous, potentially radioactive process waste.	
300-224, WATS and U-Bearing Piping Trench	The site is a subsurface concrete pipe trench with concrete block and metal plate covers. The pipe trench has several sections that allow piping connections to be made between process operations in the 313 Building, the 303-F Building, the 311 Tank Farm, the 333 Building, the 334-A Building, and the 334 Tank Farm.	
300-251, Unplanned Release Outside 303-K Building	The site consists of uranium contaminated soil around and under the 303-K Building (also known as the 303-K Contaminated Waste Storage). The 303-K Building was removed and clean closed on July 22, 2002.	
300-255, 309 Tank Farm Contaminated Soil	The site is contaminated soil located inside the 309 Building Tank Farm fenced area. The source of the contamination was probably the piping related to tanks 309-TW-1, 309-TW-2, and 309-TW-3.	
300-256, 306E Fabrication and Testing Laboratory Releases	The site is contaminated soil under and around the 306E Building. The area around the 306E Building is paved and posted as having underground radioactive contamination.	
300-257, 309 Process Sewer to River	The site is process sewer piping that was originally connected to the 309 Buildings Rupture Loop Holding Tank. The tank was removed in the late 1970s, but the piping remains.	
300-258, Abandoned Pipe Trench	The site is an abandoned subsurface concrete pipe trench. The top of the pipe trench is level with the ground surface and is covered with metal plates to allow vehicle traffic on the north side of the 306E Building to drive over the pipe trench. Between the 333 Building fence and the 334 Tank Farm, the trench is primarily surrounded by gravel.	
300-259, Contamination Area Surrounding 618-1 Burial Ground	The Contamination Area is located in the northeast corner of the 300 Area, north and east of the 618-1 Burial Ground.	

Table A-1. Waste Site Information. (8 Pages)

Site Name	Site Information	Site Status
300-260, Contaminated Soil West of 313 Building	The site is currently surrounded by light posts and a yellow rope, but no signs of any kind are present. A small amount of equipment and large wooden boxes are stored inside the roped area.	
300-262, Contaminated Soil West of South Process Pond	The contaminated soil was discovered in 1994 during excavation activities to install a utility pipeline.	Site was remediated and closed. See CVP-2003-00002.
300-263, 324 Building Diversion Tank	The site is an inactive catch tank. The tank was set up to hold contaminated process solutions that were too hot to send directly to the crib without additional treatment. After the tank was put on line, it was intended to be used as a diversion tank in the event of a radioactive release from the facility (324 Building). Shortly after the tank was installed, the 340 Complex came on line. At that time, the piping system to the diversion tank in the 324 yard was bypassed and capped. Since that time, the 324 Building has transferred its waste to the 340 Complex.	
300-265, Pipe Trench Between 324 and 325 Buildings	The site is a 5-cm (2-in.) underground encased stainless-steel waste transfer line encased within a 10-cm (4-in.) fiberglass-reinforced epoxy pipe. Inside the pipeline are two other stainless-steel Schedule 40 pipes, one is 3/8 in. and the other is 3/4 in.	
300-268, 3741 Building Foundation	The contamination related to this building were a result of passive dust from machining irradiated uranium, graphite, and other metallic samples from the 305 Test Pile. The contamination, if remaining, would be associated with any remaining concrete foundation.	
300-269, 331-A Virology Laboratory Foundation	The site is a rectangular concrete building foundation. Air conditioner units are installed on the concrete foundation to support the adjacent 331 facility.	
300-270, Unplanned Release at 313 Building	The "unplanned release" is a milky-white flow of water that came out of a pipe located below the loading dock on the east side of the 313 Building. The pipe drains stormwater from the roof of the 313 Building. The release was on to the surface of the ground, in an area of compacted gravel and soil.	
303-M SA, 303-M Storage Area	The storage pad has been painted (including the curbs and area within about 0.9 m [3 ft] outside the curb) to fix all radioactive contamination. The storage pad had been posted with "fixed radioactive contamination" signs on its surface.	
303-M UOF, 303M Uranium Oxide Facility	The facility was used to oxidize pyrophoric uranium metal turnings and chips and zircalloy-2 fines generated during fuel fabrication machining operations in the 333 Building. The metal turnings were received in 114-L (30-gal) drums filled with water for fire prevention. The metal turnings were removed, screened, hand fed into a shredder/chopper, and small bags of metallic fines were placed inside a burner chamber for oxidation.	
313 ESSP, 313 East Site Storage Pad	The site is a large concrete pad with an asphalt ramp that connects the pad to Ginko street. Previously, the site staged radiological waste from 313 Building operations and, during fuel fabrication operations, staged mixed waste from the 313 Centrifuge and uranium waste from the 313 Filter Press. The unit was also used to stage raw materials received by rail cars.	

Table A-1. Waste Site Information. (8 Pages)

Site Name	Site Information	Site Status
316-3, 307 Disposal Trenches	The site consisted of two trenches, each 180 m (600 ft) long, 9.1 m (30 ft) wide at the east end, tapering to 3.0 m (10 ft) wide at the west end. The depth varied from 3.7 m (12 ft) to 8.2 m (27 ft). Each contained a 13-cm (5-in.) vitrified clay pipe that ran the entire length of the unit. The trenches ran in an east and west direction, approximately 6.1 m (20 ft) apart. From 1953 to 1963, effluent below discharge limits was released from the 307 Retention Basins and discharged to these trenches.	
316-4, 321 Cribs, 300 North Cribs, 316-N-1, 616-4)	The site consists of two bottomless tanks buried 3 m (10 ft) below grade and resting on gravel strata. The tanks are 0.6 m (2 ft) apart, with a stainless steel overflow pipe connecting them just below the top of each tank. A total of 895.4 kg (1,974 lb) of uranium was discharged to the cribs as uranium-bearing organic wastes from the 321 Building between 1948 and 1954.	Site partially excavated, tanks removed and backfilled; deep soil contamination remains.
331 LSLDF, Life Sciences Lab Drain Field	The site consists of an abandoned drain field. The unit is fed by one diversion box and four septic tanks. The unit discharged sanitary wastewater, and potentially animal waste, to the soil column. The site was abandoned in place after the waste system was connected to the 300 Area Sanitary Sewer.	Site was reclassified to no action. See CCN 141797 and WSRF 2008-020.
331 LSLT1, Life Sciences Lab Trench No. 1	The site is an abandoned leaching trench that has been backfilled. The site was a rectangular excavation and includes connecting waste transfer lines. The 331 Leaching Trenches disposed of sanitary and animal wastes to the soil column.	
331 LSLT2, Life Sciences Lab Trench No. 2	The site is an abandoned leaching trench that has been backfilled. The site was a rectangular excavation and includes connecting waste transfer lines. The 331 Leaching Trenches disposed of sanitary and animal wastes to the soil column.	
333 ESHWSA, East Side Hazardous Waste Storage Area	The storage area is part of the asphalt paved area near the northeast corner of the 333 Building, within the building fence line. The area provided temporary storage for miscellaneous hazardous wastes in barrels, buckets, cans, and/or drums.	
340 Complex, 340 Radioactive Liquid Waste Handling Facility	The 340 Complex consists of the 340, 340-A, 340-B, and 3707-F Buildings, and two office trailers. Other 340 complex systems include the 307 Retention Basins, two tanks in an underground vault, six aboveground tanks in 340A, underground transfer pipes, load-out and decontamination equipment, and instrumentation.	
600-47, Dumping Area North of 300-FF-1	The site consisted of several areas of debris and irrigation pipes, four underground radioactive material areas, and one small soil contamination area. Debris included concrete, brick, cinder block, glass, stainless steel, plastic, tar roofing paper, wire, pipe, bottles, and screen.	Site has been remediated and interim closed. See CVP-2005-00005.
600-63, 300-N Lysimeter Area	The site is potentially contaminated soil and equipment. In 1978, the Buried Waste Test Facility (BWTF) was established to investigate recharge and radionuclide migration at the Hanford Site. Six drainage lysimeters 7.6 m (25 ft) deep and two weighing lysimeters 1.5 m (5 ft) deep were installed. Trace amounts of cobalt-60 and tritium were placed in lysimeters and migration of the contaminants was monitored.	

Table A-1. Waste Site Information. (8 Pages)

Site Name	Site Information	Site Status
600-259, Inactive Lysimeter Site East End, Special Waste Form Lysimeter	The special waste form lysimeter was constructed in the summer of 1983 and consisted of 10 soil-filled caissons around a central access caisson.	Site has been remediated and interim closed. See CVP-2005-00008.
600-276, GEDF, Cold Test Facility	The site is a large open field with a high mound of soil in the center. The facility became operational in 1982 to test burial ground subsidence control alternatives. The original site consisted of three test areas. Each test area was a cluster of buried simulated waste with a center monitoring caisson.	
618-1, Burial Ground No. 1, 318-1	The site consists of at least two trenches. It received waste from the 321 Building, 3741 contaminated machining operation, and 3706 Laboratory. Reports mention burial of a bronze crucible reading 179 mr/hr. Some buried waste may have been dissolved after a nitric acid tank leak in 1965.	
618-2, Burial Ground No. 2, 318-2	The site consisted of three trenches containing waste from fuel fabrication and laboratory activities. Automobile batteries were found on the surface prior to surface stabilization in 1989. They were left in place and covered with 0.6 m (2 ft) of clean backfill material.	Site has been remediated and interim closed. See CVP-2006-00010.
618-3, Burial Ground No. 3, Dry Waste Burial Ground No. 3	The site consisted of a pit. Inventory included uranium-contaminated construction debris from the 311 Building and construction/demolition debris from remodeling of the 313, 303-J, and 303-K Buildings.	Site has been remediated and interim closed. See CVP-2006-00005.
618-5, Burial Ground No. 5, 318-5	Single burning pit and storage area for aluminum silicate and bronze crucibles surrounded by two fences. Contained uranium-contaminated trash, uranium-contaminated aluminum silicate, and bronze crucibles, with radiation levels up to 200 mr/hr.	Site has been remediated and interim closed. See CVP-2003-00021.
618-7, Solid Waste Burial Ground No. 7, Burial Ground #7, 318-7	Used for disposal of hundreds of drums containing zircaloy chips from the process of machining the ends of zircaloy-clad fuel elements at the 321, 3722, and 3732 Buildings. The chips may be contaminated with beryllium and uranium. They were considered to be pyrophoric and were put into 113.6-L (30–gal) iron drums that were filled with water prior to disposal. Other low-level material contaminated with uranium and thorium was also buried at the site.	Site has been remediated and interim closed. See CVP-2008-00002.
618-8, Burial Ground No. 8, 318-8, Early Solid Waste Burial Ground	It is suspected that the site contained debris from expansion and remodeling of the 313 Building in 1954. A parking lot was constructed over a majority of the site.	Site has been remediated and interim closed. See CVP-2006-00006.
618-13, Burial Ground 318-13, 303 Building Contaminated Soil Burial Site	Originally a single-use site for disposal of uranium–contaminated soil removed from the 303 Building perimeter in 1950. Covered with 0.6 m (2 ft) of clean soil. Reportedly later served as a safety shield for hexone drums stored in buildings west of the mound (prior to burial in the 618-9 Trench). Concrete foundation exists directly west of mound.	
UPR-300-1, 316-1A, 307-340 Waste Line Leak	The site was a release to the soil in the area between the 307 Retention Basins and the 340 Building. The release consisted of process effluent contaminated by transuranic fission products.	
UPR-300-2, Releases at 340 Facility	The site appears to be multiple releases from ongoing decontamination and waste handling activities starting in January 1954.	

Table A-1. Waste Site Information. (8 Pages)

Site Name	Site Information	Site Status
UPR-300-4, Contaminated Soil Beneath 321 Building	The site is the soil beneath and south of the 321 Building. The site represents a number of releases that occurred from 1945 to 1988. This time period covers the development of the REDOX, PUREX processes, and numerous other pilot operations.	
UPR-300-5, Spill at 309 Storage Basin	The site was a release that contaminated the storage basin area, the filter vault, the stack base, the truck stall, and the truck ramp outside the 309 Building. The waste was low-level radioactive water. The primary isotope was cesium-137.	
UPR-300-10, Contamination Under 325 Building	This release occurred in the radioactive waste sewer line that served the 325-B Hot Cells between the west basement wall of room 32 and the north foundation wall of room 202 of the 325 Building. It included waste from dissolution of highly radioactive samples including irradiated reactor fuels.	
UPR-300-11, Underground Radioactive Liquid Line Leak	The site was a release to the soil that involved a 1.22-m (4-ft)-diameter column of gravel-covered soil in the 340 Complex yard, located immediately south of the 340 Vault. The release occurred around and below a leaking flanged-tee that connected the Retired Radioactive Liquid Waste Sewer (RRLWS) to the 340 Vault.	
UPR-300-12, Contaminated Soil Beneath 325 Building	The site was an unplanned release that occurred in the basement floor on the east side of the 325-A Building. The waste migrated through cracks in the floor to the soil beneath the building. The site received radioactive rinse water overflow containing nitrate ions, promethium-147, fission products, and transuranic nuclides.	
UPR-300-17, Metal Shavings Fire	The site was the asphalt area at the southeast corner of Building 333. The waste consisted of oily rags and other waste material, including what was believed to be uranium shavings.	
UPR-300-38, Soil Contamination Beneath 313 Building	The site is the contaminated soil beneath the 313 Building, as well as the concrete foundation. The full extent of contamination will not be determined until the 313 Building foundation has been removed and soil remediation occurs. The contamination resulted from multiple unplanned release events.	
UPR-300-39, Sodium Hydroxide Leak at 311 Tank Farm	About 1954, an unplanned release occurred in the 311 Tank Farm when one of two (37,854-L [10,000-gal]) tanks leaked a 50% sodium hydroxide solution into the soil.	
UPR-300-40, Acid Release at 303-F Pipe Trench	The release was to the soil between the 311 Tank Farm and the 303-F Building. The waste consisted of uranium-bearing acid containing nitric and sulfuric acid with uranium in solution and chromic acids with copper and zinc in solution.	
UPR-300-45, 303-F Building Uranium-Bearing Acid Spill	The release was to the soil beneath the transfer piping adjacent to the 303-F Building. The release was identified as nitric and sulfuric acid with uranium in solution.	
UPR-300-46, Contamination North of 333 Building	The release was a layer of radioactively contaminated soil found during a pipe trench excavation.	
UPR-300-48, 325 Building Basement Topsy Pit	The site is radioactively contaminated soil that occurred as a result of a release through a crack in the process sewer underneath the 325 Building foundation in room 30 under a sewer drain pipe elbow.	

Table A-1. Waste Site Information. (8 Pages)

Site Name	Site Information	Site Status
UPR-600-22, WPPSS Windrow Site, 600-21	The area was contaminated prior to 1972 with particulate fallout from burial activities in the 618-11 Burial Grounds. The contaminated area was covered by scraping the affected ground into windrows, which are a series of small parallel berms, approximately 0.6 m (2 ft), 0.9 m (3 ft) wide and 91 m (100 yd) long. The berms are arranged to form a triangle approximately 137 m (150 yd) by 91 m (100 yd) long. Perimeter berms are approximately 1.2 m (4 ft) tall.	

CCN = correspondence control number
CVP = cleanup verification package
PVC = polyvinyl chloride
WSRF = waste site reclassification form

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CCN 134247, Interoffice Memorandum from L. M. Dittmer to J. W. Darby, *300-29 Remaining Site for Remedial Action*, dated June 13, 2007, Washington Closure Hanford, Richland, Washington.

CVP-2003-00002, *Cleanup Verification Package for the South Process Pond (WIDS Site 316-1), the Retired Filter Backwash Pond (WIDS Site 300 RFBP), 300-262 Contaminated Soil, and Unplanned Release Sites UPR-300-32, UPR-300-33, UPR-300-34, UPR-300-35, UPR-300-36, UPR-300-37, and UPR-300-FF-1,* Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

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Waste Site Reclassification Form, Control Number 2004-100, *300-29,* January 2005, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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APPENDIX B

GUIDANCE FOR CLEANUP VERIFICATION PACKAGES AND REMAINING SITES VERIFICATION PACKAGES

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FIGURES

TABLES

ACRONYMS

CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
CVP	cleanup verification package
DAF	dilution-attenuation factor
DQA	data quality assessment
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
PQL	practical quantitation limit
RAG	remedial action goal
RAO	remedial action objective
RDR/RAWP	remedial design report/remedial action work plan
RESRAD	RESidual RADioactivity (dose model)
ROD	record of decision
RSVP	remaining sites verification package
SAP	sampling and analysis plan
UCL	upper confidence limit
WAC	*Washington Administrative Code*
WSRF	Waste Site Reclassification Form

APPENDIX B

GUIDANCE FOR CLEANUP VERIFICATION PACKAGES AND REMAINING SITES VERIFICATION PACKAGES

B.I INTRODUCTION TO APPENDIX B

B.I-1.0 PREFACE

The purpose of this appendix is to provide guidance to assist both authors and readers of cleanup verification packages (CVPs) and remaining sites verification packages (RSVPs). CVPs are traditionally written to close out radioactive liquid effluent sites. RSVPs are written to close out sites termed "remaining sites." Remediation of future waste sites in the 300 Area is expected to contain fewer concerns about radionuclides and more concerns about nonradionuclides. To streamline the CVPs and make them easier to read and understand, these documents will henceforth use the format of the RSVPs. Authors will use this appendix as guidance for the cleanup verification and remaining sites verification processes and as guidance for preparing CVP and RSVP documents.

B.I-2.0 OBJECTIVE

The overall objective of the CVP/RSVP is to demonstrate that, under the appropriate land-use scenario, the relevant waste site has been remediated in accordance with the applicable Record of Decision (ROD) or *Explanation of Significant Difference for the 300-FF-2 Operable Unit Record of Decision, Hanford Site, Benton County, Washington* (ESD) (EPA 2004). The *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington* (300-FF-2 ROD) (EPA 2001) and the *Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units, Hanford Site, Benton County, Washington* (EPA 1996) provide the U.S. Department of Energy, Richland Operations Office, with the authority and guidelines to conduct remedial actions at waste sites in the 300 Area. The ROD and ESD specify the remedial action objectives (RAOs), as described in Section 2.1.1 of this remedial design report/remedial action work plan (RDR/RAWP), that define the extent to which the waste sites require cleanup to protect human health and the environment.

B.I-3.0 SCOPE

The scope of this guidance is limited to the CVPs and RSVPs for the 300-FF-2 Operable Unit remedial actions covered by this RDR/RAWP. This is a guidance document, not a requirements document. Deviations from the guidance are acceptable; however, they should be documented in the CVP or RSVP along with corresponding rationale.

The following are three potential examples where it may be appropriate to deviate from this guidance:

- A small waste site is sampled or remediated and sampled; analytical results indicate all radionuclides and chemical constituents are below remedial action goals (RAGs). The decision-makers agree to attach the raw analytic data to the TPA-MP-14 waste site reclassification form (DOE-RL 2007) with a location map and a brief description of the action(s) performed. No other effort may be needed for reclassification or cleanup verification of this waste site.

- Site-specific guidance from the decision makers specifically provides an alternate method for a portion of the CVP/RSVP or for an entire CVP/RSVP. This site-specific guidance should be documented in specific meeting minutes, by correspondence, or specifically noted in the alternate CVP/RSVP approved by decision makers.

- Continuing process improvements may require deviation from this guidance in an effort to improve and streamline the CVPs and RSVPs. CVP and RSVP process changes will be incorporated into this appendix during future revisions of this document. Material process changes and decision-maker concurrence with material CVP and RSVP changes are documented either in meeting minutes or by correspondence.

The remainder of this guidance describes many of the steps and details of both a CVP and an RSVP. It is not designed to serve as a textbook, general statistics primer, or RESidual RADioactivity (RESRAD) manual. The guidance describes how many of the CVPs and RSVPs are prepared.

B.II CLEANUP VERIFICATION PACKAGES AND REMAINING SITES VERIFICATION PACKAGES

EXECUTIVE SUMMARY

The executive summary restates (at a high level) the contents of the CVP/RSVP. Included in this summary is a table documenting achievement of RAOs for the given waste site. Table B-1 is an example of such a table. The Executive Summary will also include text comparing sampling results against ecological screening levels meeting the criteria described in Section 2.2.3, "Ecological Risk Evaluations," of this RDR/RAWP. In addition, a Waste Site Reclassification Form (WSRF) is also included for each waste site. In a CVP, the WSRF follows the Executive Summary, but the RSVP is an attachment to the WSRF.

Table B-1. Summary of Attainment of Remedial Action Objectives. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?	Ref.
Direct Exposure – Radionuclides	Attain 15 mrem/yr dose rate above background over 1,000 years.	**Example Language:** *Maximum dose rate calculated by RESRAD is 4.59 mrem/yr.*	Yes	e
Direct Exposure – Nonradionuclides	Attain individual COC RAGs.	**Example Language:** *All individual COC concentrations are below the RAGs.*	*Yes*	*e,f*
Meet Nonradionuclide Risk Requirements	Attain a hazard quotient of <1 for all individual noncarcinogens.	**Example Language:** *The hazard quotients for individual nonradionuclide COCs in the shallow zone and overburden are less than 1.*	*Yes*	*f*
	Attain a cumulative hazard quotient of <1 for noncarcinogens.	**Example Language:** *The cumulative hazard quotient is less than 1 for the shallow zone and overburden.*	*Yes*	*f*
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	**Example Language:** *Excess cancer risk values for individual nonradionuclide COCs are less than* 1×10^{-6}.	*Yes*	*f*
	Attain a total excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	**Example Language:** *Total excess cancer risk is less than* 1×10^{-5}.	*Yes*	*f*
Groundwater/ River Protection – Radionuclides	Attain single COC groundwater and river protection RAGs.	**Example Language:** *Cesium-137, cobalt-60, nickel-63, strontium-90, and tritium are calculated to reach groundwater in the 1,000 years of the RESRAD model run. However, none of these constituents is predicted to migrate to groundwater (and thus the Columbia River) at concentrations exceeding groundwater or river criteria within 1,000 years. Therefore, residual concentrations achieve the remedial action objectives for groundwater and river protection.*	*Yes*	*b*
	Attain National Primary Drinking Water Standards: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs. [a]	**Example Language:** *The organ-specific dose rate is below the 4 mrem/yr dose rate limit.*		*f*
	Meet drinking water standards for alpha emitters: the more stringent of the 15 pCi/L MCL or 1/25th of the derived concentration guide per DOE Order 5400.5. [b]	**Example Language:** *There are no alpha-emitting COCs for this site.*	*NA*	*f*

Table B-1. Summary of Attainment of Remedial Action Objectives. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?	Ref.
	Meet total uranium standard of 21.2 pCi/L.[c]	**Example Language:** *Isotopic uranium concentrations are below background.*	*NA*	*e*
Groundwater/ River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	**Example Language:** *Residual concentrations of lead exceeded soil RAGs for the protection of groundwater and/or the Columbia River. However, it is predicted that lead will not migrate to groundwater (and thus the Columbia River) at concentrations exceeding groundwater or river criteria within 1,000 years.[d] Therefore, residual concentrations achieve the remedial action objectives for groundwater and river protection.*	*Yes*	*e*
Other supporting Information	Sampling plan (Appendix D).			*g*
	Closeout Plan for the 618-2 Burial Ground.			*h*

Example Footnotes:

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

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

[c] Based on the isotopic distribution of uranium in the Hanford Site background, the 30 µg/L MCL (40 CFR 141) 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*, 0100X-CA-V0038 (BHI 2001).

[d] *100 Area Analogous Sites RESRAD Calculations*, 0100X-CA-V0050, Rev. 0, Bechtel Hanford, Inc., Richland, Washington (BHI 2005).

[e] *618-2 Burial Ground Cleanup Verification RESRAD Calculation Brief*, 0300X-CA-V0080, Rev. 0, Washington Closure Hanford, Richland, Washington.

[f] *Cleanup Verification 95% UCL Calculations for 618-2 Shallow Zone/Deep Zone/Overburden and 618-2, 618-3, 618-8 Staging Pile and Decon Pad Footprint*, 0600X-CA-V0060, Rev. 2, Washington Closure Hanford, Richland, Washington.

[g] *618-2 Shallow, Deep Zone, Overburden/Stockpile Area Sampling Plan*, 0300X-CA-V0077, Rev. 0, Washington Closure Hanford, Richland, Washington.

[h] *Closeout Plan for the 618-2 Burial Ground*, CCN 129577, Washington Closure Hanford, Richland, Washington.

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

Example Attachment ES-1

Waste Site Reclassification Form

Date Submitted: 10/07/06 Originator: XXX Phone: XXX	**WASTE SITE RECLASSIFICATION FORM** Operable Unit(s): 300-FF-2 Waste Site Code: 618-2 Type of Reclassification Action: Closed Out ☐ Interim Closed Out ☒ No Action ☐ RCRA Postclosure ☐ Rejected ☐ Consolidated ☐	Control Number: 2006-062

This form documents agreement among parties listed authorizing classification of the subject unit as Closed Out, Interim Closed Out, No Action, RCRA Postclosure, Rejected, or Consolidated. This form also authorizes backfill of the waste management unit, if appropriate, for Closed Out and Interim Closed Out units. Final removal from the NPL of No Action and Closed Out waste management units will occur at a future date.

Description of current waste site condition:

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

Basis for reclassification:

The 618-2 site has been remediated to meet the remedial action objectives specified in the *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 2001). Remedial actions were performed so as to allow industrial land use and to protect groundwater and the Columbia River. The results of verification sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The waste site has a deep zone; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 618-2 Burial Ground* (CVP-2006-00010), Washington Closure Hanford, Richland, Washington.

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.

XXX		
DOE Federal Project Director (printed)	Signature	Date
N/A		
Ecology Project Manager (printed)	Signature	Date
XXX		
EPA Project Manager (printed)	Signature	Date

B.II-1.0 STATEMENT OF PROTECTIVENESS

A paragraph states that the waste site attains RAOs of the relevant ROD and discusses the pertinent future land use for the area. Whether or not institutional controls are necessary is explained.

B.II-2.0 SITE DESCRIPTION AND BACKGROUND

The site history, waste disposal history, site physical dimensions, and location are summarized in this section of the CVP/RSVP and a figure(s) showing the vicinity map and/or site plan are provided.

B.II-3.0 CONFIRMATORY SAMPLING ACTIVITIES

The purpose of this section is to summarize results of site confirmatory sampling activities performed for the site. The type of information to be provided would include dates of site visits, dates of sampling, whether the U.S. Department of Energy, Richland Operations Office or regulatory agencies participated, objectives of the site visit, and any findings or determinations (e.g., nature and extent of contamination, visible description of staining, waste form) of the site visit.

Geophysical Investigations

This section describes geophysical surveys performed at the site including figures showing nature and extent of possible contamination.

Contaminants of Potential Concern for Confirmatory Sampling

The purpose of this section is to summarize and discuss all contaminants of potential concern (COPCs) and provide a description of how they were derived (e.g., based on process knowledge, as listed in this RDR/RAWP, the DQO, or ROD [EPA 2001], based on analogous site information, visible inspection of waste form.)

Confirmatory Sample Design

The purpose of this section is to summarize the site-specific work instruction or other documentation/processes leading to sampling (e.g., phased approach using Visual Sample Plan[1] software and focused sampling, statistical sampling). This section typically includes a figure showing locations of confirmatory samples and a confirmatory sample summary table similar to Table B-2.

[1] Visual Sample Plan is a site map-based user-interface program that may be downloaded at http://dqo.pnl.gov.

Table B-2. Confirmatory Sample Summary.

Sample Location	Sample Media	Sample Number	Coordinate Locations	Depth (m bgs)	Sample Analysis
Example Information					
Septic tank	*Septic tank contents*	*J01XN2*	*N 147917 E 580875*	*3*	*GEA, gross alpha, gross beta, ICP metals, PCB, pesticides, mercury, SVOA, VOA*
		J01XN6			*Hexavalent chromium*
Duplicate septic tank samples	*Septic tank contents*	*J01XN3*	*N 147917 E 580875*	*3*	*GEA, gross alpha, gross beta, ICP metals, PCB, pesticides, mercury, SVOA, VOA*
		J01XN7			*Hexavalent chromium*
Ash located east of septic tank	*Ash*	*J01XN1*	*N 147917 E 580882*	*0.5*	*ICP metals, PCB, pesticides, mercury, SVOA*
		J01XN5			*Hexavalent chromium*
Equipment blank	*Silica sand*	*J01XN4*	*NA*	*NA*	*ICP metals, mercury, SVOA, PCB, pesticides*

Example Footnotes:
Source: Remaining Sites Field Sampling, Logbook.
bgs = below ground surface
GEA = gamma energy analysis
ICP = inductively coupled plasma
NA = not applicable
PCB = polychlorinated biphenyl
SVOA = semivolatile organic analysis
VOA = volatile organic analysis

Confirmatory Sample Results

The purpose of this section is to describe the results of confirmatory sampling activities and compare sampling results to the RAGs. This section also documents the determination of whether remedial action is recommended for the given waste site. Results of confirmatory sampling are provided in an appendix to the RSVP.

B.II-4.0 REMEDIAL ACTION SUMMARY

A description of the excavation and disposal activities is given in this section. The pre- and post-remediation topographic contours are shown in figures. Necessary information includes the dates of waste site excavation, description (and photographs if applicable) of materials excavated, disposal location of waste material, general excavation dimensions and elevations, and amount of material disposed from the site.

Additionally, the CVP/RSVP will discuss significant materials that may have been left at the site (if any) and what significant materials were removed. A summary of field screening activities (if applicable) that guided remedial actions is also included.

B.II-5.0 VERIFICATION SAMPLING ACTIVITIES

Describe and discuss the information used to develop the sampling designs for cleanup verification sampling including reference to appropriate documents and dates of sampling. Discuss the figures showing pre-excavation and post-excavation boundaries and site contours.

Contaminants of Concern and Contaminants of Potential Concern

Waste site contaminants of concern (COCs) and COPCs identified for cleanup verification through process knowledge, previous sampling, and/or agreement with decision makers are listed in this section. During site remediation additional COCs/COPCs may be identified by in-process sampling for the site, and COPCs previously identified may also be excluded. Additional COCs or COPCs may be identified for the site to demonstrate RAG and RAO attainment. Likewise, if during remediation and/or verification sampling a SAP-identified COPC is not detected, the constituent will be excluded from the final site COC list. Excluded COPCs are not included in calculation of waste site risk or hazard quotient. The rationale for the final site COC/COPC list is discussed in this section.

Verification Sample Design

The purpose of this section is to describe the verification sampling design for the given waste site. Sample designs are typically developed using Visual Sample Plan, which is a tool to develop the statistical sampling design for a given waste site. This tool uses the remediation footprint of the site to develop a systematic grid for verification soil sample collection. This section describes the number of samples and locations for the given site and includes a table listing the sample numbers, the associated Hanford Environmental Information System sample number, and the Washington State Plane coordinates of each sample location. These sample locations are also typically presented in a figure showing the remediation footprint of the given waste site.

The division of the site excavation into decision units (e.g., shallow zone and deep zone) is a function of the applicable RAGs. The direct exposure, groundwater protection, and river protection RAGs are applicable to soils within 4.6 m (15 ft) of the ground surface. This soil zone is referred to as the shallow zone. The groundwater protection and river protection RAGs are applicable to soils greater than 4.6 m (15 ft) below the ground surface. This soil zone is referred to as the deep zone. If a site is relatively clean and will meet the direct exposure cleanup criteria throughout the site excavation, it is appropriate to handle the entire site as a shallow zone decision unit. This is advantageous for site closure because a site that does not have a deep zone component will have no requirement for deep zone institutional controls.

A brief explanation regarding the remedial excavation decision units and cleanup verification sampling is included in this section. Discussion regarding the rationale for using a single shallow zone decision unit or dividing the site into separate shallow and deep zone decision units is given. Sampling dates and the number of samples collected per decision unit are discussed in this section. If any focused sampling was conducted, a summary of this activity and rationale is also included.

B.II-6.0 VERIFICATION SAMPLING RESULTS

The verification samples collected are submitted to offsite laboratories for analysis using approved EPA analytical methods. The laboratory-reported analyses from the sampling are used in the statistical calculations (as appropriate) and are included in appendices to the CVP/RSVP.

The primary statistical calculation to support cleanup verification is the 95% upper confidence limit (UCL) on the arithmetic mean of the data. The 95% UCL values for each COC and detected COPC are computed for each decision unit (e.g., for the shallow and deep zones and overburden, as appropriate). If no detection for a given COPC was reported in the data set, no statistical evaluation or calculations are performed for that COPC. For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set.

The statistical values represent the COC concentrations for each decision unit (e.g., shallow zone or deep zone soils). Statistical values are established in the 95% UCL calculation brief for compliance with cleanup standards, where the data are evaluated per *Washington Administrative Code* (WAC) 173-340 guidance. The 95% UCL calculation brief is included in an appendix to the CVP/RSVP.

- **Radionuclides:** The 95% UCL is calculated on the arithmetic mean for each radionuclide COC and detected COPC. The laboratory reported values, including negative values, are used in the UCL calculation. If a UCL is negative, the value is rounded to zero. In instances where the laboratory does not report a value below the minimum detectable activity, half of the minimum detectable activity value is used in the 95% UCL value for all radionuclide nonparametric formulae that is used to calculate the 95% UCL value for all radionuclide verification data sets.

- **Nonradionuclides:** For nonradionuclides, the distribution of large data sets (10 or more data points per component) is examined per the guidelines presented in *Statistical Guidance for Ecology Site Managers* (Ecology 1992) and in *Statistical Guidance for Ecology Site Managers, Supplement S-6* (Ecology 1993). Small data sets (less than 10 data points per component) are evaluated in accordance with Section 5.2.1.4 of the site managers' guidelines (Ecology 1992).

  For nonradionuclide data flagged with "U" (i.e., less than detection), a value equal to half the practical quantitation limit is used in the 95% UCL calculation for COCs and detected COPCs. When a nonradionuclide COC or COPC is detected in fewer than 50% of the samples collected, and for focused sampling, the maximum detected value is used for comparison with the RAGs instead of calculating the 95% UCL value.

Comparisons of quantified COC and COPC results with the RAGs for the waste site are summarized in appropriate tables. Comparison to statistical contaminant concentrations and comparisons to focused sampling results are presented in separate tables. Contaminants that were not detected by laboratory analysis are excluded from these tables. Calculated cleanup levels are not presented in the *Cleanup Levels and Risk Calculations (CLARC) Database* (Ecology 2005) under WAC 173-340-740(3) for aluminum, calcium, iron, magnesium, potassium, silicon, and sodium; therefore, these constituents are not considered site COPCs and are also not included in these tables. Potassium-40, radium-226, radium-228, thorium-228, and thorium-232 may be detected in waste site samples, but are excluded from these tables because these isotopes are not related to the operational history of the Hanford Site. The laboratory-reported data results for all constituents are stored in the Environmental Restoration (ENRE) project-specific database prior to archival in the Hanford Environmental Information System (HEIS) and are included in document appendices.

An example table showing the statistical results as determined in the UCL, site lookup values for shallow zone, groundwater protection, and river protection and a comparison of the statistical value to the lookup values is shown in Table B-3.

Table B-3. Comparison of Maximum or Statistical Contaminant Concentrations to Unrestricted Action Levels.[a] (3 Pages)

COC/COPC	Maximum or Statistical Result (pCi/g)	Generic Site Lookup Values (pCi/g)			Does the Statistical Result Exceed Lookup Values?	Does the Statistical Result Pass RESRAD Modeling?
		Shallow Zone Lookup Value[b]	Groundwater Protection Lookup Value	River Protection Lookup Value		
Example Results:						
Cesium-137	*0.036*	*6.2*	*NA*	*NA*	*No*	*--*
Strontium-90	*0.49*	*4.5*	*NA*	*70.2*	*No*	*--*
COC/COPC	**Maximum or Statistical Result (mg/kg)**	**Remedial Action Goals (mg/kg)**			**Does the Statistical Result Exceed RAGs?**	**Does the Statistical Result Pass RESRAD Modeling?**
		Direct Exposure	**Soil Cleanup Level for Groundwater Protection**	**Soil Cleanup Level for River Protection**		
Example Results:						
Arsenic	*3.5 (<BG)*	*20[c]*	*20[c]*	*20[c]*	*No*	*--*
Barium	*106 (<BG)*	*1,600*	*200*	*400*	*No*	*--*
Beryllium	*0.35 (<BG)*	*10.4[f]*	*1.51[e]*	*1.51[e]*	*No*	*--*
Boron[g]	*5.3*	*16,000[d]*	*320*	*--[h]*	*No*	*--*
Chromium (total)	*9.0 (<BG)*	*120,000*	*18.5[e]*	*18.5[e]*	*No*	*--*
Chromium (hexavalent)	*0.6*	*2.1[f]*	*4.8*	*2*	*No*	*--*

Table B-3. Comparison of Maximum or Statistical Contaminant Concentrations to Unrestricted Action Levels.[a] (3 Pages)

COC/COPC	Maximum or Statistical Result (mg/kg)	Remedial Action Goals (mg/kg)			Does the Statistical Result Exceed RAGs?	Does the Statistical Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Example Results (cont):						
Copper	*13.0 (<BG)*	*2,960[d]*	*59.2*	*22[e]*	*No*	--
Lead	*10.4*	*353[j]*	*10.2[e]*	*10.2[e]*	*Yes*	*Yes[j]*
Manganese	*318 (<BG)*	*3,760[d]*	*512[e]*	*512[e]*	*No*	--
Mercury	*0.03 (<BG)*	*24[d]*	*0.33[e]*	*0.33[e]*	*No*	--
Nickel	*10.0 (<BG)*	*1,600[d]*	*19.1[e]*	*27.4*	*No*	--
Vanadium	*38.6 (<BG)*	*560[d]*	*85.1[e]*	--[h]	*No*	--
Zinc	*47.8 (<BG)*	*24,000[d]*	*480*	*67.8[e]*	*No*	--
Anthracene	*0.065*	*24,000*	*240*	*1,920*	*No*	--
Benzo(a)anthracene	*0.005*	*1.37[k]*	*0.015[l]*	*0.015[l]*	*No*	--
Benzo(a)pyrene	*0.005*	*0.33*	*0.015[l]*	*0.015[l]*	*No*	--
Benzo(b)fluoranthene	*0.004*	*1.37[k]*	*0.015[l]*	*0.015[l]*	*No*	--
Benzo(g,h,i)perylene[m]	*0.140*	*2,400*	*48*	*192*	*No*	--
Benzo(k)fluoranthene	*0.0076*	*13.7[k]*	*0.015[l]*	*0.015[l]*	*No*	--
Chrysene	*0.06*	*137[k]*	*.12*	*0.1[l]*	*No*	--
Dibenzo(a,h) anthracene	*0.024*	*1.37[l]*	*0.03[l]*	*0.03[l]*	*No*	--
Fluoranthene	*0.15*	*3,200[d]*	*64*	*18*	*No*	--
Fluorene	*0.030*	*3,200[d]*	*64*	*260*	*No*	--
Indeno(1,2,3-cd) pyrene	*0.04*	*1.37[k]*	*0.33[l]*	*0.33[l]*	*No*	--

Table B-3. Comparison of Maximum or Statistical Contaminant Concentrations to Unrestricted Action Levels.[a] (3 Pages)

COC/COPC	Statistical Result (mg/kg)	Remedial Action Goals (mg/kg)			Does the Statistical Result Exceed RAGs?	Does the Statistical Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Example Results (cont):						
Phenanthrene[m]	*0.09*	*24,000[d]*	*240*	*1,920*	*No*	--
Pyrene	*0.14*	*2,400[d]*	*48*	*192*	*No*	--

Example Footnotes:

[a] RAG and lookup values obtained from the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (DOE-RL 2009), as available. When no values available in DOE-RL (2009), appropriate values were determined per WAC 173-340-720, WAC 173-340-730, and WAC 173-340-740 and the most recent available carcinogenicity/toxicity data, unless otherwise noted.
[b] Activity corresponding to a single-radionuclide 15 mrem/yr exposure as calculated using a generic RESRAD model (DOE-RL 2008).
[c] The cleanup value of 20 mg/kg has been agreed to by Tri-Party project managers. The basis for 20 mg/kg is provided in DOE-RL (2008).
[d] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), Method B, 1996.
[e] Where cleanup levels are less than background, cleanup levels default to background (WAC 173-340-700[4][d]) (1996).
[f] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3]) (1996).
[g] No Hanford Site-specific or Washington State background value available.
[h] No cleanup level is available from the Ecology Cleanup Levels and Risk Calculations tables, and no toxicity values are available to calculate cleanup levels (Ecology 2005).
[i] A WAC 173-340-740(3) (1996) value for lead is not available. This value is based on the *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children* (EPA 1994).
[j] Based on the *100 Area Analogous Sites RESRAD Calculations* (BHI 2005), lead is not expected to migrate more than 3 m (10 ft) vertically in 1,000 years. The vadose zone underlying the remediation footprint is approximately 13 m (43 ft) thick.
[k] Carcinogenic cleanup level calculated per WAC 173-340-740(3), Method B, 1996.
[l] Where cleanup levels are less than the RDL, cleanup levels default to the RDL (WAC 173-340-707[2], 1996 and DOE-RL 2008).
[m] Toxicity data for this chemical are not available. RAGs for benzo(g,h,i)perylene and phenanthrene are based on the surrogate chemicals pyrene and anthracene, respectively.

--	= not applicable	RAG	= remedial action goal
BG	= background	RESRAD	= RESidual RADioactivity (dose assessment model)
COC	= contaminant of concern	RDL	= required detection limit
COPC	= contaminant of potential concern	WAC	= *Washington Administrative Code*

B.II-7.0 VERIFICATION SAMPLE DATA EVALUATION

This section describes the evaluation of the sampling data in terms of comparison to the RAGs, as listed in the tables reporting the sample results, the radionuclide dose and risk requirements, the nonradionuclide risk requirements, and the WAC 173-340-740(7)(e) three-part test.

Ideally, evaluation of the results listed in the tables reporting the sample results indicates that all COPCs were quantified below RAGs and lookup values. In this case, residual concentrations of site COPCs are protective in relation to the requirements for direct exposure, groundwater protection, and river protection.

Comparison of Sample Data to the RAGs

Typically, with the exception of a few contaminants, evaluation of the results from verification sampling at the waste site will indicate that all COCs and COPCs were quantified below RAGs and lookup values. Exceedance of cleanup levels for direct exposure seldom occurs but could trigger additional cleanup, a site-specific risk analysis, or other evaluation based on the likelihood of a threat to human health. Residual concentrations of a few contaminants will often exceed soil RAGs for groundwater and river protection. When soil RAGs for groundwater and river protection are exceeded the distribution coefficient (K_d) for the contaminant is evaluated against the determinations in the *100 Area Analogous Sites RESRAD Calculations* (BHI 2005) to predict if the contaminant would be expected to migrate vertically to groundwater in 1,000 years. The thickness of the vadose zone beneath the excavation must be determined. The contaminant depth/K_d value model assumes that uncontaminated soil exists in the vadose zone between the bottom of the waste site and groundwater. The assumption of an uncontaminated zone beneath the waste site is reasonable based on analogous site data that includes test pits and boreholes completed in the operable units in the 100 and 300 Areas. The test pit and/or borehole data show that contaminant concentrations that are below direct exposure cleanup levels decrease to background concentrations within less than 3 m (10 ft) below the elevation at which the contamination occurs.

Comparison of Sample Data to the Eco-Screening Levels. Text will be provided comparing sampling results against ecological screening levels meeting the criteria described in Section 2.2.3, Ecological Risk Evaluation, in this RDR/RAWP. The discussion in this section should be essentially the same discussion as the paragraph discussing the eco-screening results in the Executive Summary.

Evaluation of Remedial Action Goal Attainment

This section discusses how the verification sampling data are used in demonstrating RAG attainment.

Radionuclides

The individual radionuclide cleanup verification statistical values may be entered into the RESRAD computer code (current version 6.4 [ANL 2007]) to predict the dose rate and the impact on groundwater and the river from residual radionuclide concentrations. Separate RESRAD runs are performed for separate units of a waste site area (e.g., the excavation footprint, overburden/below cleanup limit decision unit, and waste sorting trenches).

The results of the RESRAD dose rate predictions for the all-pathways scenarios for the units of the waste site area are typically shown in figures of dose rate versus time (years). These dose rates represent the dose contributions from soils at relevant time periods. The 2018 date is included to correspond to the 30-year site cleanup schedule of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989). All dose rate predictions must be less than the 15 mrem/yr RAG to meet the RAGs. The RESRAD computations are shown in detail in calculation briefs presented in an appendix to the CVP/RSVP.

Alternatively, for waste sites with few radionuclide COCs at concentrations well below the individual radionuclide lookup values, Table B-4 provides a typical comparison of the shallow zone (including overburden) radionuclide cleanup verification statistically quantified values to direct exposure single radionuclide 15 mrem/yr dose-equivalence values using a sum of fractions evaluation. The columns on the left side of Table B-4 are the COCs and the 95% UCL values, corrected for background, as appropriate. The fourth column presents the single radionuclide 15 mrem/yr dose equivalence activity, and the last two columns present the statistical values divided by the dose equivalence activity.

Table B-4. Attainment of Radionuclide Direct Exposure RAG.

COCs	95% UCL Statistical Values (pCi/g)		Activity Equivalent to 15 mrem/yr Dose[a] (pCi/g)	Fraction	
	Shallow Zone	Overburden		Shallow Zone	Overburden
Example Results:					
Cesium-137	*0.044 (ND)*	*0 (<BG) (ND)*	*6.2*	*0.007*	*0*
Cobalt-60	*0.047 (ND)*	*0.049 (ND)*	*1.4*	*0.034*	*0.035*
Europium-152	*0.100 (ND)*	*0.15 (ND)*	*3.3*	*0.030*	*0.045*
Europium-154	*0.14 (ND)*	*0.14 (ND)*	*3*	*0.047*	*0.047*
Europium-155	*0.12 (ND)*	*0.08 (ND)*	*125*	*0.001*	*0.001*
			Sum of Fractions	*0.119*	*0.128*
			Equivalent Dose (mrem/yr)	*<1.8*	*<2*

Example Footnotes:

[a] Single radionuclide 15 mrem/yr dose-equivalence values and derivation methodology are presented in the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (DOE-RL 2008).

COC = contaminant of concern
ND = not detected (in all samples in the data set)
RAG = remedial action goal

Radionuclide Risk Information

If RESRAD modeling is performed for radionuclide dose evaluation, the radionuclide risk information provided by the RESRAD run must be presented. The radionuclide RAG for direct exposure is derived from the 300-FF-2 ROD (EPA 2001) and is expressed in terms of an allowable radiation dose above background (i.e., 15 mrem/yr). The RAG evaluation involved using the RESRAD model to estimate total annual radiation doses for 1,000 years for comparison to the RAG. Radiation presents a carcinogenic risk, and the RESRAD model also calculates the excess lifetime cancer risk associated with the estimated radiation doses. The "National Oil and Hazardous Substances Pollution Contingency Plan" (NCP) (40 CFR 300.430) establishes that CERCLA cleanups should generally achieve a level of residual risk of 10^{-4} to 10^{-6}. Although 15 mrem/yr represents a carcinogenic risk of approximately 3×10^{-4} the upper boundary of the risk range is not a discrete line at 10^{-4} and a specific risk estimate around 10^{-4} may be considered acceptable, if justified based on site-specific conditions. A figure(s) may be provided to illustrate excess lifetime cancer risk as estimated using the RESRAD model. Because of radioactive decay, the risk decreases over time.

Nonradionuclides

The comparison tables, using Table B-3 as an example, provide a comparison of the nonradionuclide cleanup verification maximum or statistical values to the direct exposure, groundwater protection, and river protection RAGs.

Attainment of Noncarcinogenic Risk Standards

For noncarcinogenic COCs, WAC 173-340-740(5)(a) and (b) specifies the evaluation of the hazard quotient, which is given as daily intake divided by a reference dose (DOE-RL 1995). For cleanup actions under the ROD and ESD (EPA 2001, 2004), a comparable conservative approach is used to demonstrate attainment of the noncarcinogenic risk requirements.

The direct exposure nonradionuclide RAGs for soil are based on the WAC 173-340-740(3) Method B limits. These cleanup limits were set to be compliant with a hazard quotient of 1.0. Therefore, the ratio of the cleanup verification statistical values to the noncarcinogenic direct exposure soil cleanup levels obtained from Table 2-1 of this RDR/RAWP provides a conservative approach to addressing the hazard quotient.

The fraction of cleanup level (Fc) is calculated as follows:

$$Fc = S/V$$

where:

Fc	=	fraction of cleanup level (dimensionless)
S	=	statistical value of the COCs (in mg/kg)
V	=	lookup value (WAC 173-340-740(3) Method B derived, direct exposure RAG in mg/kg).

If the Fc is less than 1 for an individual COC, then the hazard quotient has been addressed. For multiple COCs, a sum of the individual COC Fc values was used to address the hazard index or cumulative hazard quotient. The Fc values for all noncarcinogenic COCs were summed. If that sum was less than 1, then the hazard index or cumulative hazard quotient has been addressed.

Attainment of Carcinogenic Risk Standards

For individual carcinogenic nonradionuclide COCs, the WAC 173-340-750(3) Method B cleanup limits are based on an incremental cancer risk of 1×10^{-6}. For cumulative carcinogenic COCs, the cumulative excess cancer risk must be less than 1×10^{-5}. If a linear relationship is assumed between environmental concentration and risk, the ratio (Fc) of the statistical value from the verification samples divided by the WAC 173-340-750(3) Method B limit, multiplied by 10^{-6}, is an estimate of the risk associated with the statistical value.

For multiple carcinogenic COCs, the risks of the individual COCs (described above) are summed. If no risk associated with a single COC exceeds 1×10^{-6}, and if the sum of the individual COC risk does not exceed 1×10^{-5}, then the WAC 173-340-750(5)(a) and (b) Method B risk requirement has been addressed for this remedial action.

For the shallow zone, the individual COC and cumulative risk value are checked against the individual and cumulative WAC 173-340-750(5)(a) and (b) risk limits. This type of calculation is performed and documented in the 95% UCL calculation brief, which is included in an appendix to the CVP/RSVP.

Groundwater Remedial Action Goals Attained

The groundwater RAGs are applicable to all decision units (e.g., shallow zone, deep zone, and overburden).

Radionuclides

The estimated groundwater concentrations for all the radionuclide COCs contributed by the soils in the shallow zone (and deep zone, if present) are determined by RESRAD modeling, which is documented in a calculation brief. If the groundwater concentrations predicted by RESRAD indicate that COCs impact groundwater, then a separate calculation is needed to determine compliance with groundwater dose standards. Comparison of peak radionuclide concentrations to the groundwater RAGs is presented in a table similar to Table B-5.

Table B-5. Estimated Peak Radionuclide Groundwater Concentrations (Shallow Zone, Deep Zone, BCL Overburden, and Staging Pile Impacts) Compared to RAGs.

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

Example Footnotes:
BCL = below cleanup level
RAG = remedial action goal

Nonradionuclides

The comparison table(s), using Table B-3 as an example, provides a comparison of the nonradionuclide cleanup verification statistical values to the groundwater and river protection RAGs. When the residual concentrations of a COC exceed the RAGs, a site-specific evaluation must be performed to predict if the COC will reach groundwater within 1,000 years. The *100 Area Analogous Sites RESRAD Calculations* (BHI 2005) and contaminant-specific soil partitioning coefficient (K_d) values are used to indicate if the COC will not migrate from the bottom of the excavation footprint through the unsaturated vadose zone to groundwater within 1,000 years. The thickness of the vadose zone underlying the site must be determined to be greater than the distance the COC is predicted to migrate in 1,000 years and, as such, the contaminant will not reach groundwater (and, therefore, the Columbia River) in 1,000 years.

WAC 173-340 Three-Part Test for Nonradionuclides

This section documents application of the WAC 173-340-740(7)(e) three-part test for nonradionuclides using the most restrictive RAGs applicable for each zone. (The most restrictive RAG is defined as the lowest of the direct exposure, groundwater protection, and river protection RAGs. The direct exposure, groundwater protection, and river protection RAGs are applicable to the shallow zone and overburden. Groundwater and river protection RAGs are applicable to the deep zone.) The WAC 173-340-740(7)(e) three-part test consists of the following criteria: (1) the cleanup verification statistical value must be less than the cleanup level, (2) no single detection can exceed two times the cleanup criteria, and (3) the percentage of samples exceeding the cleanup criteria must be less than 10%. The duplicate sample is treated as a separate sample for the three-part test. The split sample is only used for data quality assessment (DQA) purposes and is not included in the three-part test.

The application of this test is usually included in the 95% UCL calculation and is included in an appendix to the CVP/RSVP. An explanation of which COCs/COPCs pass and which fail this test is listed. Of those that fail, an explanation of how RESRAD modeling is used to ensure the COCs/COPCs satisfy the three-part test criteria is listed. A table (see Table B-6 as an example) may be provided to demonstrate that the criteria of the three-part test have been met.

B.II-8.0 DATA QUALITY ASSESSMENT PROCESS

The DQA has been integrated into the CVP/RSVP and is presented here as a subsection. The DQA is very briefly summarized in the body of the CVP/RSVP, with the detailed DQA (as represented with the following sections) placed in an appendix to the CVP/RSVP. The DQA process involves the scientific and statistical evaluation of data to determine if the data are of the right type, quality, and quantity to support the intended use (EPA 2000). The DQA process completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the DQO process.

The DQA process is not intended to be a definitive analysis of a project or problem, but instead provides an initial assessment of the reasonableness of the data that have been generated (EPA 2000).

The DQA focuses on the laboratory data, statistical error tolerances, and the overall DQO, specifically by addressing the question, "Are the data of the right type, quality, and quantity to support their intended use?" The intended use of the data is to make the appropriate decision regarding whether the site meets the RAOs as defined by the RAGs. The site closeout or cleanup decision rules are the RAGs. Completion of a CVP/RSVP following this guidance inherently is the functional equivalent of performing a DQA for a waste site.

Table B-6. Summary of the WAC 173-340 Three-Part Test [a].

COC/COPC	Most Restrictive Applicable RAG	Statistical Cleanup Verification Value (mg/kg)[b]	Maximum Detected Cleanup Verification Value (mg/kg)[c]	Total Number of Samples[d]	Percentage of Cleanup Verification Data Set Exceeding RAG[e]	Cleanup Criteria Attained?
Example Data Waste Sorting Trenches						
Lead	10.2[g]	18	32	5	20%	Yes[f]
Example Data Overburden/BCL Piles						
Lead	10.2[g]	12	22.8	16	37.5%	Yes[f]

Example Footnotes

[a] Only the COCs/COPCs that failed the WAC 173-340 Three-Part Test are presented.
[b] Criterion is statistical value cannot exceed most restrictive applicable RAG.
[c] Criterion is no single detection can exceed two times the most restrictive applicable RAG.
[d] Total number of samples in the decision unit may include field duplicate samples, which are included in the evaluation as separate samples.
[e] Criterion is percentage of data set exceeding the most restrictive applicable RAG cannot exceed 10%.
[f] Based on the *100 Area Analogous Sites RESRAD Calculations* (BHI 2005) and contaminant-specific soil-portioning coefficient (K_d) value, contaminant will not migrate vertically more than 3 m (10 ft) in 1,000 years. As the vadose zone underlying the site is greater than 3 m (10 ft) thick, the contaminant will not reach groundwater (and thus the Columbia River) in 1,000 years.
[g] Where cleanup levels are less than background, cleanup levels default to background (WAC 173-340-700[4][d]) (1996).

BCL = below contaminant level
COC = contaminant of concern
COPC = contaminant of potential concern
RAG = remedial action goal
RESRAD = RESidual Radioactivity (dose model)
WAC = *Washington Administrative Code*

The DQA is not performed on field screening data, as field screening data are not used in decisions regarding the rejection of null hypothesis. Therefore, field decisions will be made based on the field screening data with the understanding that the decision to remediate a site shown to be contaminated based on field readings may not be within error tolerances. This is a risk management decision and is deemed as an acceptable risk by project decision makers.

After sampling is completed, confirmatory and verification sample data packages are validated to Level C per ENV-1, *Environmental Monitoring & Management,* Procedure ENV-1-2.12, "Data Package Validation." Level C validation procedures are specified in *Data Validation Procedure for Chemical Analysis* (BHI 2000a) and *Data Validation Procedure for Radiochemical Analysis* (BHI 2000b).

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

- Sample holding times
- Method blanks
- Matrix spike recovery
- Surrogate recovery
- Matrix spike/matrix spike duplicate results
- Sample replicates
- Associated batch laboratory control sample results
- Data package completeness.

For RSVPs and related documents (e.g., leachability study reports, data summary reports), all laboratory-applied "J" flags on radionuclide results will be deleted. A footnote will be included in the radionuclide data summary tables indicating that, because of laboratory reporting conventions, these results may have a nonrelevant "J" qualifier in the Hanford Environmental Information System database and/or in the analytical report.

Where the "J" qualifier is applied through the validation process, the qualifier will not be deleted and the traditional "estimated" footnote will be presented. The footnote will also direct the reader to the DQA section of the document. The DQA section provides additional discussion regarding the reasons why the "J" qualifier was applied during validation and also discusses the usability of the data.

Data flagged as below detection limits (i.e., "U") indicate that the analyte was analyzed for but not detected, and the concentration shown is the practical quantitation limit. Data flagged as rejected (i.e., "R") indicate that the data are not useable due to a quality assurance/quality control deficiency. All other validated results are considered accurate within the standard errors associated with the methods.

The adequacy of laboratory quality assurance/quality control is evaluated as a subset of the PARCC parameters (i.e., precision, accuracy, representativeness, completeness, and comparability) in the *300 Area Remedial Action Sampling and Analysis Plan* (300 Area SAP) (DOE-RL 2009). The laboratory data are validated by a contractor, which reports whether the laboratory met the required target detection limits, precision (+/-30%), accuracy (+/-30%), and completeness (>90%). The proportion of analytical results in which the detection limits exceed the 300 Area SAP (DOE-RL 2009) target detection limits are noted in the data evaluation section of the DQA.

Reported analytical detection levels are compared to the specified detection limits in the 300 Area SAP (DOE-RL 2009). The data validation notes any analyses in which the detection limit or minimal detectable activity was above the 300 Area SAP-specified detection limits. The detection limits are based on optimal conditions. Interferences and different matrices may significantly affect the values shown. Exceeding the specified detection limits does not necessarily invalidate the data for decision-making purposes; however, the exceedances need to be evaluated on a case-by-case basis within the DQA.

A statement is made regarding acceptability of the matrix spike/matrix spike duplicate samples percent recoveries and relative percent differences. Acceptable limits are in the 300 Area SAP (DOE-RL 2009).

B.II-9.0 SUMMARY FOR WASTE SITE RECLASSIFICATION

The purpose of this section is to provide a statement that the given waste site has been evaluated and remediated in accordance with the ROD and ESD and that the results of the verification sampling support a reclassification (in accordance with the TPA-MP-14 process [DOE-RL 2007]) of the given waste site to "interim closed out," "no action," or "rejected."

When confirmatory sampling results indicate that residual concentrations of contaminants at the site meet the RAOs for direct exposure, groundwater protection, and river protection, remediation is not necessary and it can be stated that a reclassification of the site to "no action" or "rejected" is supported. Per the conceptual site model stated in the 300 Area decision documents (EPA 2001, 2004) waste site contamination does not extent into deep zone soils if it is not found in the shallow zone. Hence, confirmatory sampling activities are normally not required for deep zone soils and institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

When the waste site has been remediated in accordance with the applicable ROD or other decision documents (EPA 2001, 2004, etc.) this is stated and the current version of the RDR/RAWP is cited. The amount of material for disposal at the Environmental Restoration Disposal Facility (ERDF) is noted. Sampling conducted to verify the completeness of remediation is briefly discussed and analytical results for the waste site shown to meet the cleanup objectives for direct exposure, groundwater protection, and river protection are noted. Accordingly, it is stated that waste site reclassification to "interim closed out" is supported for the waste site. The maximum depth of the waste site excavation area is discussed as to how it relates to the existence of a shallow zone and a deep zone and the possible need for institutional controls to prevent future intrusion into deep zone contamination. However, if the entire excavation area may be considered one decision unit, and closed out using the more restrictive shallow zone cleanup criteria; then institutional controls to prevent uncontrolled drilling or excavation into the deep zone may not be required.

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B.III SUPPLEMENTARY INFORMATION

The following sections are preserved as supplementary and background information for the CVP and RSVP processes because they have been previously approved by the Tri-Party decision makers and may be difficult to obtain in other venues.

B.III-1.0 SUMMARY OF REMEDIAL ACTION OBJECTIVES AND GOALS

Remedial Action Objectives

The RAOs presented in the 300-FF-2 ROD (EPA 2001) are requirements that must be met in order for the cleanup to be considered complete. The RAOs set forth in the 300-FF-1 and 300-FF-2 RODs (EPA 1996, 2001) are narrative statements that define the extent to which the waste sites require cleanup to protect human health and the environment. The RAOs that must be met by this remedial action are included in Section 2.0 of this document.

Remedial Action Goals/Cleanup Levels

The RAGs are the specific numeric goals applied to evaluate the attainment of the RAOs. In accordance with the 300-FF-2 ROD (EPA 2001), ESD (EPA 2004), and this RDR/RAWP, the RAGs/cleanup levels have been developed to support either an industrial land-use scenario or an unrestricted land-use scenario, as applicable to specific sites.

Industrial Land-Use Scenario. For radionuclides, the 300 Area industrial land-use scenario[1] assumes that the exposure pathways from residual contamination are (1) direct exposure to radiation, (2) ingestion of soil containing residual contamination, and (3) inhalation of particles in the air from residual contamination. It is assumed that drinking water is not obtained from the work site and food products are not grown on the site. The assumptions used for the 300 Area industrial land-use scenario are described in the *Focused Feasibility Study for the 300-FF-2 Operable Unit* (DOE-RL 2000) and the 300-FF-2 ROD (EPA 2001), and are reproduced below. Carcinogenic risk and radiological dose are evaluated using the RESRAD computer code developed by Argonne National Laboratory (ANL 2002) for the U.S. Department of Energy. Major assumptions for evaluation of radionuclides risk and dose include the following:

- <u>Direct exposure route</u>: The scenario assumes an adult worker is located in the area of residual contamination for approximately 1,500 hr/yr inside a building and 500 hr/yr outdoors for a period of 30 years (these correspond to a typical work year for an adult worker). When the worker is outdoors, it is assumed that clean fill does not provide shielding from residual contamination. Furthermore, it is assumed that indoor exposure to external radiation is 70% of the outdoor levels (based on the shielding provided by the building from direct exposure to radiation from residual contaminants in the soil).

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[1] Other land uses may also be appropriate as long as institutional controls limit human activities to those described.

- Soil ingestion route: The scenario assumes that a worker ingests 25 g of contaminated soil each year.

- Inhalation route: The scenario assumes that the air contamination inside a building is 40% of the outside air particle concentration (which is assumed to be 0.0002 g/m^3 from residual soil contamination).

The key modeling parameters that affect the direct exposure cleanup levels for radionuclides are (1) the depth of cover/clean fill over residual contamination (none is assumed for the 300 Area), and (2) the time spent on the former waste site location, both indoors and outdoors (approximately 1,500 hr/yr inside a building and 500 hr/yr outdoors). Other parameters affect the modeling results, but are not as significant as these two items.

Cleanup levels for nonradionuclides in the 300 Area industrial land-use scenario are based on *Washington Administrative Code* (WAC) 173-340-745(4), which assumes that the exposure pathway for residual contamination will be from ingestion of contaminated soil. Soil cleanup levels are calculated using the equations provided in WAC 173-340-745(4) for carcinogens and for noncarcinogens. For both carcinogens and noncarcinogens, the calculations assume that a person weighing 70 kg (155 lb) ingests soil at a rate of 50 mg/day (18.25 g/yr), with a contact frequency of 40% and a gastrointestinal absorption rate of 100%. For carcinogens, the calculation is based on achieving a lifetime cancer risk goal of 1 in 100,000 (1×10^{-5}) for an exposure duration of 20 years and a lifetime of 75 years. For noncarcinogens, the calculation is based on achieving a hazard quotient of 1.

The 300-FF-2 ROD (EPA 2001) also requires that the soil cleanup level used not cause contamination of groundwater above drinking water standards or WAC 173-340-720(3), Method B cleanup levels (even though groundwater ingestion is not an applicable exposure pathway in the industrial land-use scenario). The key modeling parameters that affect the analysis of groundwater protection are (1) the hydraulic parameters of the aquifer and contaminant characteristics (e.g., K_d factors and leach rates), (2) the evapotranspiration rate (i.e., evaporation and plant uptake of precipitation), and (3) the amount of water applied for irrigation purposes. The key assumptions in the 300 Area industrial land-use scenario that affect the groundwater protection determination are as follows: (1) vegetation not requiring irrigation will be grown on the waste site after the cleanup is complete, or the waste site will be resurfaced to reduce water infiltration (thus allowing for a evapotranspiration coefficient of 0.91 to be used; if an agreed to gravel surface is left, an evapotranspiration coefficient of 0.75 will be used.), and (2) no water will be applied to former waste site locations for irrigation purposes. These assumptions can only be modified if it can be demonstrated that there will be no negative impact on groundwater quality from residual contamination at former waste site locations (which requires EPA approval in advance).

Finally, it is assumed that (1) no sensitive human subpopulations (e.g., children) are permitted to come into contact with residual soil or debris contamination from waste sites (i.e., the cleanup levels are based on exposures to adults); (2) the period of analysis for evaluation of site risks and groundwater protection is 1,000 years; and (3) direct exposure of onsite workers to residual contamination to a depth of 4.6 m (15 ft) may occur (this represents a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of site development activities).

The first table included in the text of the CVP/RSVP usually summarizes the RAGs for the COCs at the waste site for which the CVP/RSVP is being prepared. The RAGs should be taken directly from the CVP/RSVP Section 2.0 tables.

Unrestricted Land-Use Scenario. For radionuclides the 300 Area unrestricted land-use scenario is identical to the 100 Area unrestricted or rural residential land-use scenario, except for site-specific hydrological parameters. For the purpose of evaluating radionuclide dose using RESRAD, unrestricted future use in the 300 Area is represented by an individual resident in a rural-residential setting. This resident is assumed to consume and irrigate crops raised in a backyard garden; consume animal products (e.g., meat and milk) from locally raised livestock or meat from game animals (including fish); and live in a residence on the waste site. The exposure pathways considered in estimating dose from radionuclides in soil are inhalation; soil ingestion; ingestion of crops, meat, fish, drinking water, and milk; and external gamma exposure. This individual is conservatively assumed to spend 80% of his/her lifetime onsite. It is assumed that drinking water and irrigation water is obtained from groundwater impacted by the waste site. Groundwater is considered to be a potential future drinking water source that must be restored to drinking water standards in a reasonable time frame, as established in the 300-FF-5 ROD (EPA 1996).

Cleanup levels for nonradionuclides in the 300 Area unrestricted land-use scenario are based on WAC 173-340-740(3), Method B, which assumes that the exposure pathway for residual contamination will be from ingestion of contaminated soil. Soil cleanup levels are calculated using the equations provided by WAC 173-340-740(3) for carcinogens and noncarcinogens. For both carcinogens and noncarcinogens, the calculations assume that a resident with an average body weight of 16 kg (35 lb) over the period of exposure ingests soil at a rate of 200 mg/day (73 g/yr), with a contact frequency of 100% and a gastrointestinal absorption rate of 100%. For carcinogens, the calculation is based on achieving a lifetime cancer risk goal of 1 in 1,000,000 (1×10^{-6}) for an exposure duration of 6 years and a lifetime of 75 years. For noncarcinogens, the calculation is based on achieving a hazard quotient of 1.

The 300-FF-2 ROD (EPA 2001) also requires that the soil cleanup level used not cause contamination of groundwater above drinking water standards or WAC 173-340-720 (3), Method B cleanup levels. The key modeling parameters that affect the analysis of groundwater protection are (1) the hydraulic parameters of the aquifer and contaminant characteristics (e.g., K_d values and leach rates), (2) the evapotranspiration rate (i.e., evaporation and plant uptake of precipitation), and (3) the amount of water applied for irrigation purposes. Irrigation water is assumed to be applied at agronomic rates (76 cm/yr [30 in./yr]), surface vegetation is assumed to exist resulting in a evapotranspiration coefficient of 0.91, and the unrestricted land use exposure pathways are assumed to include drinking water ingestion.

A more detailed description of the rural-residential scenario and how it is applied is provided in Section 3.0 of this RDR/RAWP.

Direct Exposure RAGs

Under the rural-resident scenario, direct exposure RAGs are applicable to soils that are less than 4.6 m (15 ft) below ground surface (shallow zone soils including overburden). Direct exposure RAGs for individual contaminants are listed in appropriate tables in the text of the RDR/RAWP and are developed in Appendix D of the RDR/RAWP. The general requirements for direct exposure RAGs at radioactive and nonradioactive waste sites are summarized below.

- **Radionuclide COCs:** Dose above background of less than 15 mrem/yr (this RAG must be met for 1,000 years).
- **Nonradionuclide COCs:**
  - Individual and cumulative hazard quotients of less than 1.0 for noncarcinogenic contaminants
  - Excess cancer risks of less than 1 x 10^{-6} for individual carcinogenic contaminants
  - Cumulative excess cancer risk of less than 1 x 10^{-5}
  - Cleanup verification sample results pass the *Model Toxics Control Act Cleanup Regulations* (*Washington Administrative Code* [WAC] 173-340-740[7][e]) three-part test.

Groundwater and River Protection RAGs

Groundwater and river protection RAGs are applicable to all vadose zone soils (shallow and deep zone soils). The groundwater and river protection RAGs are listed in appropriate tables in the text of the RDR/RAWP and are developed in Appendix D of the RDR/RAWP. The general requirements for groundwater and river protection RAGs at radioactive and nonradioactive waste sites are summarized below.

- **Beta- and gamma-emitting radionuclide COCs:** Meet "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* [CFR] 141.5) dose standards (4 mrem/yr total body or organ dose) for a period of 1,000 years starting from site cleanup.
- **Alpha-emitting radionuclide COCs:** Meet "National Primary Drinking Water Regulations" (40 CFR 141.5) (15 pCi/L excluding radon and uranium). The drinking water maximum contaminant level for uranium is 30 µg/L, which corresponds to a total uranium activity of 21.2 pCi/L (BHI 2001).
- **Nonradionuclide COCs:** Meet the individual RAGs based on WAC 173-340-740(3)(a)(ii)(A) (January 1996), the "100 times dilution-attenuation factor (DAF) times surface water quality"

rule, Hanford Site or Washington State background, the laboratory analytical practical quantitation limit (PQL) with cleanup verification sample results passing the WAC 173-340-740(7)(e) three-part test, or demonstrate by site-specific modeling or other methods (e.g., leachability testing) that residual COC levels do not pose an unacceptable threat to groundwater or surface water for 1,000 years (i.e., residual soil levels do not have the potential to exceed groundwater or river water RAGs).

B.III-2.0 REMEDIAL ACTION FIELD ACTIVITIES WHERE RADIONUCLIDES ARE PRIMARY COCS

Field Screening and In-Process Sampling

Field screening and in-process sampling are conducted during the site remedial action as specified in the 300 Area SAP (DOE-RL 2009). Both techniques are used to guide the excavation to quickly assess for the presence and level of contamination, and to assess when remediation is complete. Field screening is applicable to those sites (typically the large liquid effluent sites) where radionuclides are primary COCs and generally includes using a radiological data mapping system survey and hand-held sodium iodide (NaI) detectors. In-process sampling generally consists of gamma energy analyses and nonradionuclide analyses. A description of each general technique is discussed below.

- **Radiological Data Mapping System Survey.** When the excavation reaches the subcontract design limits, a radiological data mapping system survey (i.e., the man-carried radiological data system, laser-assisted ranging and data system, or similar technology) is deployed to determine if further excavation is warranted. In the case of the man-carried radiological data system technology, NaI gamma-energy detector equipment is mounted to a portable cart (or backpack) that is pulled (or carried) around the site by an operator. The operator stops at regular intervals and allows the equipment to count the radioactivity at that location. Global positioning system coordinate information is transmitted with the radioactivity readings to computers in a nearby van. Operators in the van process the data, and maps of radioactivity at the site are plotted. If hot spots are detected during the survey, further excavation may be planned. The surveys are performed over a minimum of 50% of the site in accordance with field screening procedures. The data collection and mapping efforts are documented in the project files.

- **Sodium Iodide Detector.** If hot spots are identified during site excavation field screening, analysts attempt to confirm the presence of the hot spot with a hand-held NaI detector. If the hot spot is found, a sample is collected and analyzed using gamma energy analyses. If the hot spot is not confirmed, the radiological mapping survey results at that particular location are reevaluated.

- **Laboratory Analysis.** In-process samples are collected for quick-turnaround laboratory analyses of radionuclides and nonradionuclides at onsite and offsite laboratories. They are used to guide excavation (particularly at sites where nonradionuclides are the primary COCs) and to distinguish between potentially clean materials and contaminated materials for disposal at ERDF. Data from these samples are used to corroborate data obtained from field screening and to assist in waste characterization. The field screening and in-process sampling and analysis efforts are documented in field logbooks and in the project files.

Variance Sampling and Analysis

Variance analysis (as described in the 300 Area SAP [DOE-RL 2009]) determines the site-specific number of verification samples. The analysis is based on the minimum detectable difference approach presented in EPA guidance (EPA 1993). In this approach, contaminant variability is quantified and used to determine the number of samples required per EPA guidance to represent the site for clean site verification.

If required, variance analysis may be performed after field screening to indicate that RAGs are met. If variance samples are collected, they are collected from random sampling locations and submitted for analysis in accordance with the 300 Area SAP (DOE-RL 2009). The data are used for a preliminary assessment of whether the direct radionuclide exposure RAGs and variance requirements have been met. The data may indicate a low degree of variability and contaminant levels below the lookup values or RAGs.

The variance sampling section of the CVP/RSVP briefly describes the variance sampling, including sampling dates, number of variance samples, and type of analyses. The results of the variance analysis generally indicate that the number of verification samples to be taken is less than the default number of four; therefore, four final verification samples are usually collected from each shallow zone decision subunit. Variance analysis results and calculations are included in an appendix to the CVP/RSVP.

When a site is ready (based on field screening) for variance/cleanup verification sampling, the sample designs are developed for each decision unit (e.g., shallow zone, deep zone, overburden) in accordance with the 300 Area SAP (DOE-RL 2009). The layout and orientation of the sampling designs are based on the size and shape of the decision unit.

The sampling designs are used to verify site status after remedial action excavation. If statistical sampling is used, random samples are collected to assess variability in contaminant levels (variance assessment). Each decision unit is separated into several sampling areas. Within each of these sampling areas, a 16-node grid is established and random sampling locations are chosen. Based on the variance sample results, samples are then taken from the random points in each sampling area and are composited for analysis. These cleanup verification samples are used to verify that the site meets the RAGs. If focused sampling is used, the worst-case values are compared to the RAGs directly to verify cleanup. The sample design is documented in a calculation brief and is included in an appendix to the CVP/RSVP.

Cleanup Verification Sampling and Analysis

Final cleanup verification samples are generally collected following variance sampling, analysis, and data evaluation; however, depending on schedule needs, it is also acceptable to collect the variance and verification samples simultaneously. The 300 Area SAP (DOE-RL 2009) does not require variance sampling. Each verification sample is a composite formed by combining samples collected at four randomly-selected nodes within each sampling area. The sample design methodology and sample location figures are presented in the calculation briefs for variance analysis and sample design in an appendix to the CVP/RSVP.

B.III-3.0 CLEANUP VERIFICATION DATA EVALUATION

This section presents the process that the cleanup verification data undergoes for data quality assessment (DQA) prior to RAG attainment assessment. The DQA process involves the scientific and statistical evaluation of data to determine if the data are of the right type, quality, and quantity to support the intended use (EPA 2000). The DQA process completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objective (DQO) process. The DQA review was performed in accordance with ENV-1, *Environmental Monitoring & Management*. The DQA process is not intended to be a definitive analysis of a project or problem, but instead provides an initial assessment of the reasonableness of the data that have been generated (EPA 2000).

The DQA focuses on the laboratory data, statistical error tolerances, and the overall DQO, specifically by addressing the question, "Are the data of the right type, quality, and quantity to support their intended use?" The intended use of the data is to make the appropriate decision regarding whether the site meets the RAOs as defined by the RAGs. The site closeout or cleanup decision rules are the RAGs. Completion of a CVP or RSVP following this guidance inherently is the functional equivalent of performing a DQA for a waste site.

The DQA is not performed on field screening data, as field screening data are not used in decisions regarding the rejection of null hypothesis. Thus, field decisions will be made based on the field screening data with the understanding that the decision to remediate a site shown to be contaminated based on field readings may not be within error tolerances. This is a risk management decision and is deemed as an acceptable risk by project decision makers.

Error Tolerances

- Type I – false-positive error (site does not meet RAGs when data indicate that it does): A 5% false-positive rate is consistent with the need to calculate a 95% upper confidence limit (UCL) of the mean and was selected for the statistical calculations (DOE-RL 2009).

- Type II – false-negative error (site meets RAGs when data indicate that it does not): The sample design methodology is designed based on a false-negative error rate of 20%.

Data Validation

After sampling is completed, confirmatory and verification sample data packages are validated to Level C per ENV-1, *Environmental Monitoring & Management,* Procedure ENV-1-2.12, "Data Package Validation." Level C validation procedures are specified in *Data Validation Procedure for Chemical Analysis* (BHI 2000a) and *Data Validation Procedure for Radiochemical Analysis* (BHI 2000b).

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

- Sample holding times
- Method blanks
- Matrix spike (MS) recovery
- Surrogate recovery
- MS/matrix spike duplicate (MSD) results
- Sample replicates
- Associated batch laboratory control sample results
- Data package completeness.

For CVPs, RSVPs, and related documents (e.g., leachability study reports, data summary reports), all laboratory-applied "J" flags on radionuclide results will be deleted. A footnote will be included in the radionuclide data summary tables indicating that, because of laboratory reporting conventions, these results may have a nonrelevant "J" qualifier in the Hanford Environmental Information System database and/or on the analytical report.

Where the "J" qualifier is applied through the validation process, the qualifier will not be deleted and the traditional "estimated" footnote will be presented. The footnote will also direct the reader to the DQA section of the document. The DQA section provides additional discussion regarding the reasons why the "J" qualifier was applied during validation, and also discusses the usability of the data.

Data flagged as below detection limits (i.e., "U") indicate that the analyte was analyzed for but not detected, and the concentration shown is the PQL. Data flagged as rejected (i.e., "R") indicate that the data are not useable due to a quality assurance/quality control deficiency. All other validated results are considered accurate within the standard errors associated with the methods.

The adequacy of laboratory quality assurance/quality control is evaluated as a subset of the PARCC parameters (i.e., precision, accuracy, representativeness, completeness, and comparability) in the 300 Area SAP (DOE-RL 2009). The laboratory data are validated by a contractor, which reports whether the laboratory met the required target detection limits, precision (+/-30%), accuracy (+/-30%), and completeness (>90%). The proportion of analytical results in which the detection limits exceed the 300 Area SAP target detection limits are noted in the data evaluation section of the DQA.

Reported analytical detection levels are compared to the specified detection limits in the 300 Area SAP (DOE-RL 2009). The data validation notes any analyses in which the detection limit or minimal detectable activity was above the 300 Area SAP-specified detection limits. The detection limits are based on optimal conditions. Interferences and different matrices may significantly affect the values shown. Exceeding the specified detection limits does not necessarily invalidate the data for decision-making purposes; however, the exceedances need to be evaluated on a case-by-case basis within the DQA.

A statement is made regarding acceptability of the MS/MSD samples percent recoveries and relative percent differences (RPDs). Acceptable limits are in the 300 Area SAP.

Supplementary Data Validation

If formal data validation did not include evaluation of all cleanup verification samples taken from a site, investigators review the study objectives in the 300 Area SAP to determine the context for evaluating the data. This evaluation encompasses all verification samples. The context for evaluating the data includes a comparison of analytical results to the PARCC parameters as specified in the 300 Area SAP. This section of the CVP or RSVP summarizes the results of that comparison and presents an evaluation of the affected data.

Reported analytical detection levels are compared to the specified detection limits in the "Analytical Performance Requirements" table of the 300 Area SAP (DOE-RL 2009). The proportion of validated data with reported analytical detection levels above the specified detection limits are noted. Data qualification is not required if the reported analytical detection levels are sufficiently less than the RAGs and the associated data are of sufficient quality for decision-making purposes.

Analytical accuracy and precision are evaluated by examining and comparing the percent recovery and RPD between the main and duplicate samples. Only the COCs detected at five times the detection limit (or greater) are used for data analysis with regards to accuracy and precision. If all percent recoveries for laboratory control samples and inorganic MS and MSD were within acceptable limits, then the samples compare favorably.

- **Field Blank Samples.** Field blank samples are collected to detect any contamination from sampling equipment, cross-contamination from previously collected samples, or contamination from conditions during sampling. The blank sample results and anomalies are discussed in this section of the CVP or RSVP.

- **Field Duplicate Samples.** 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 duplicate samples for each COC. Only analytes with values above five times the detection limits for both the master and duplicate samples are compared. The RPD of the results is described in this section of the CVP or RSVP, and those that fall outside the +/-30% range are discussed.

- **Field Split Samples.** Split samples are collected and analyzed by different laboratories to provide a relative measure of the degree of variability in the sampling, sample handling, and analytical techniques used by commercial laboratories. The field master and split samples are evaluated by computing the RPD of the split samples for each COC. Only analytes with values above five times the detection limits for both the master and split samples are compared. The RPD of results is described in this section of the CVP or RSVP, and those that fall outside the +/-30% range are discussed and a decision made as to the usability of the data.

  If split samples are collected by regulatory agencies, the results are discussed in this section. Regulatory split sample data are compared to verification samples using the RPD as described in Section II.5.4 of the 300 Area SAP (DOE-RL 2009).

B.III-4.0 CLEANUP VERIFICATION RAG EVALUATION PROCESS

This section discusses the calculations and modeling necessary for assessing and demonstrating RAG attainment.

Contaminants of Concern 95% Upper Confidence Limit

The primary statistical calculation to support cleanup verification is the 95% UCL on the arithmetic mean of the data. The 95% UCL values for each COC and detected COPC are computed for each decision unit (e.g., for the shallow zone, deep zone, and overburden soils, as appropriate in consideration of the non-detected portion of the data set). If a COPC is not detected the constituent is excluded from the 95% UCL calculation. For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set. The statistical values represent the COC concentrations for each decision unit (e.g., shallow zone, deep zone, and overburden soils). The 95% UCL calculation brief is included in an appendix to the CVP/RSVP. The statistical value for each COC is compared to the cleanup criteria in the CVP/RSVP as part of the evaluation of attainment of the RAGs. A flowchart depicting the calculation methodology is presented in Figure B-1, and the following subsections describe the methodology.

- **Radionuclides:** The 95% UCL is calculated on the arithmetic mean for each radionuclide COC and detected COPC. The laboratory reported values, including negative values, are used in the UCL calculation. If a UCL is negative, the value is rounded to zero. In instances where the laboratory does not report a value below the minimum detectable activity, half of the minimum detectable activity value is used in calculating the 95% UCL value. The 95% UCL value for radionuclides is calculated assuming a nonparametric distribution without further evaluation of distributional form.

- **Nonradionuclides:** For nonradionuclides, the distribution of large data sets (10 or more data points per component) is examined per the guidelines presented in *Statistical Guidance for Ecology Site Managers* (Ecology 1992) and in *Statistical Guidance for Ecology Site*

Managers, Supplement S-6 (Ecology 1993). Small data sets (less than 10 data points per component) are evaluated assuming a nonparametric distribution.

For nonradionuclide data flagged with "U" (i.e., less than detection), a value equal to half the PQL is used in the 95% UCL calculation for COCs and detected COPCs. Also, if greater than 50% of the verification sample results for nonradionuclide COCs and detected COPCs are below detection, then the statistical value is set equal to the maximum detected concentration from the sample data set.

- **Accounting for Background:** Radionuclide background is accounted for only in overburden soil by subtracting the background concentration from the statistical value. This accounts for anthropogenic and naturally occurring radionuclide background in surface soils. Only uranium background concentrations are accounted for in shallow and deep zone soils by subtracting uranium isotope concentrations from the statistical values. The radionuclide statistical values, after subtracting for background as appropriate, are used in the RESRAD modeling and risk calculations for evaluation of RAOs and RAG attainment. Nonradionuclide background concentrations are not accounted for except that nonradionuclide concentrations below background are not compared to cleanup levels and are not included in carcinogenic and noncarcinogenic risk calculations.

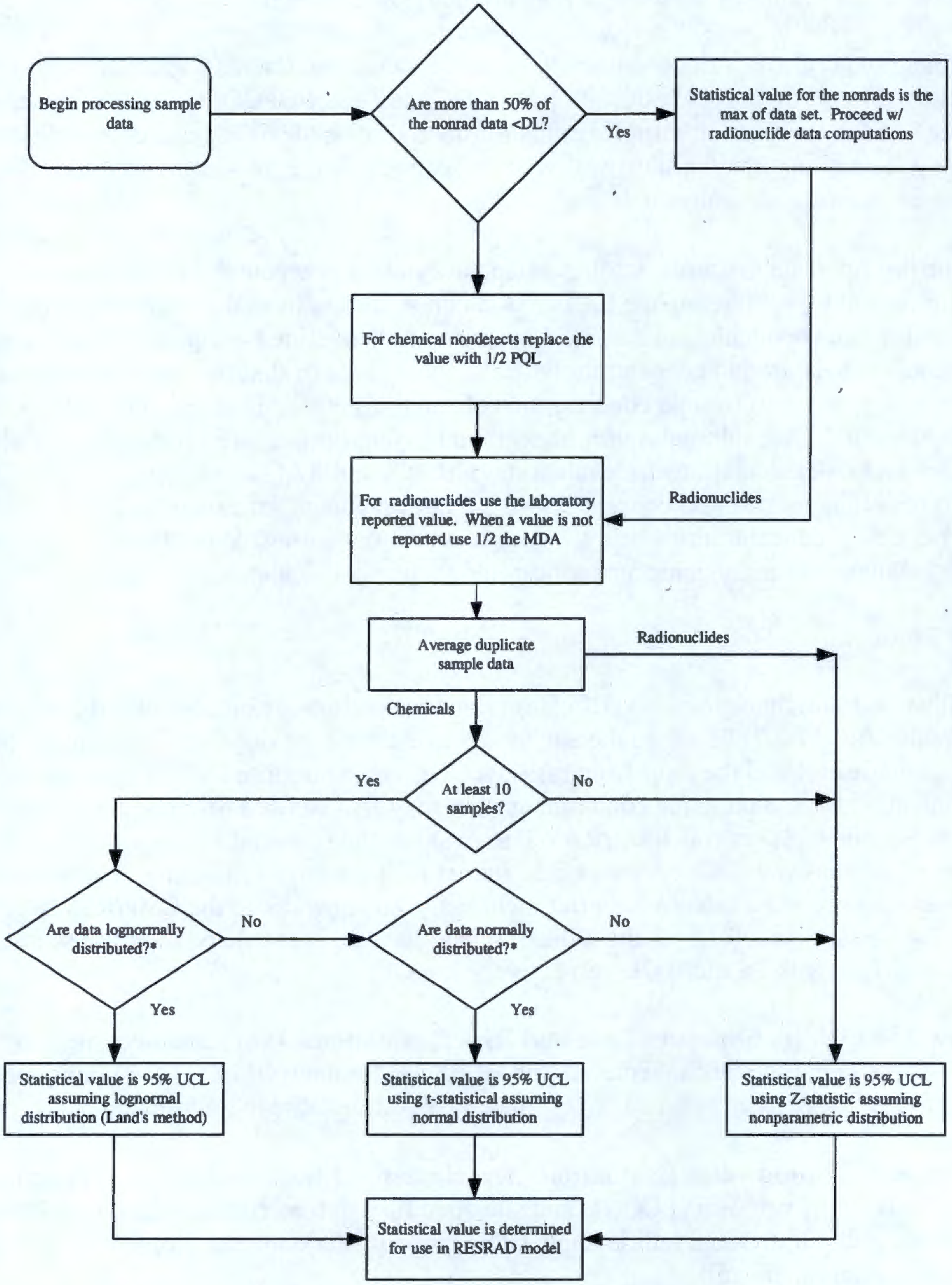
RESRAD Modeling

The individual radionuclide cleanup verification statistical values are entered into the RESRAD computer code (ANL 2007) based on the site model to estimate the dose, and to estimate the impact on groundwater and the river from residual COC concentrations. The RESRAD model is primarily intended for radionuclide contaminants but may also be used for nonradionuclides as discussed in Section C.3.1 of this RDR/RAWP to evaluate the potential for nonradionuclide COCs to reach groundwater. Overviews of the model runs are provided below. The RESRAD analysis is documented in a calculation brief included in an appendix to the CVP/RSVP. The RESRAD input parameters for both the industrial land-use and unrestricted land-use scenarios are provided in Tables B-7a and B-7b, respectively.

- **Shallow Zone Direct Exposure Dose and Risk Evaluation.** The cleanup verification values and site-specific parameters are entered into RESRAD for analysis of (1) total radionuclide dose (effective dose mrem/yr) and (2) estimated risk attributable to radionuclides.

- **Protection of Groundwater Evaluation.** The cleanup verification values (radionuclide and nonradionuclide [if necessary] COCs) and site-specific parameters are entered into RESRAD for analysis of the individual radionuclide COC groundwater concentrations from residual COC concentrations in soil.

Figure B-1. Statistical Value Calculation Decision Diagram.



*Use W-test for distribution evaluation (uncensored data), or probability method for data sets with censored data, censored value taken at 1/2 PQL (nonrad)

DL = detection limit
MDA = minimum detectable activity
PQL = practical quantitation limit

Table B-7a. RESRAD Input Parameters for the 300-FF-2 Industrial Land-Use Scenario. (3 Pages)

Category	Parameter	Units	User Input, Industrial Scenario	User Input, Groundwater Protection	Reference
Exposure Pathways		Pathway External Gamma: Inhalation: Plant Ingestion: Meat Ingestion: Milk Ingestion: Aquatic Foods: Drinking Water: Soil Ingestion: Radon:	Soil Status Active Active Suppressed Suppressed Suppressed Suppressed Suppressed Active Suppressed	GW Status Suppressed Suppressed Suppressed Suppressed Suppressed Suppressed Active Suppressed Suppressed	DOE-RL 1997
R011 – CZ	Area of CZ[a]	m^2	10,000[a]	10,000[a]	
	Thickness of CZ[a]	m	4.6[a]	5[a]	
	Length parallel to aquifer flow[a]	m	100[a]	100[a]	
	Radiation dose limit	mrem/yr	15	4	DOE-RL 1997
	Elapsed time since waste placement	yr	0		RESRAD default
R013 – Cover and CZ Hydrological Data	Cover depth[a]	m	0	4.6[a]	
	Cover material density	g/cm^3	1.6		DOE-RL 1997
	Cover erosion rate	m/yr	0.001		RESRAD default
	Density of CZ	g/cm^3	1.6		DOE-RL 1997
	CZ erosion rate	m/yr	0.001		RESRAD default
	CZ total porosity		0.3		DOE-RL 1997
	CZ field capacity		0.25		DOE-RL 1997
	CZ hydraulic conductivity	m/yr	0.0022		DOE-RL 1997
	CZ b parameter		15		DOE-RL 1997
	Humidity in air	g/cm^3	8		RESRAD default
	Evapotranspiration coefficient		0.91	0.91	WDOH 1997
	Wind speed	m/sec	3.4		
	Precipitation	m/yr	0.1524		DOE-RL 1997
	Irrigation rate	m/yr	0		DOE-RL 1997
	Irrigation mode		Overhead		RESRAD default
	Runoff coefficient		0.2		RESRAD default
	Watershed area for nearby stream or pond	m^2	10,000,000		DOE-RL 1997
	Accuracy for water/soil computations		0.001		RESRAD default
R014 – SZ Hydrological Data	Density of SZ	g/cm^3	1.6		DOE-RL 1997
	SZ total porosity		0.3		DOE-RL 1997
	SZ effective porosity		0.3		DOE-RL 1997
	SZ hydraulic conductivity	m/yr	673,846		DOE-RL 1997
	SZ hydraulic gradient		0.0005		DOE-RL 1997
	SZ b parameter		3.5		DOE-RL 1997
	Water table drop rate	m/yr	0.001		RESRAD default

Table B-7a. RESRAD Input Parameters for the 300-FF-2 Industrial Land-Use Scenario. (3 Pages)

Category	Parameter	Units	User Input, Industrial Scenario	User Input, Groundwater Protection	Reference
R014 – SZ Hydrological Data	Well pump intake depth below water table	m	4.6 m (15 ft), typical RCRA well screen length		
	Nondispersion or mass balance		ND		RESRAD default
	Well pumping rate	m^3/yr	250	250	RESRAD default
R015 – Uncontaminated and Unsaturated Strata Hydrological Data	Number of unsaturated strata[a]		1[a]	0[a]	
	Thickness[a]	m	5[a]	0[a]	
	Soil density	g/cm^3	1.6		DOE-RL 1997
	Total porosity		0.3		DOE-RL 1997
	Effective porosity		0.3		DOE-RL 1997
	Field capacity		0.2		RESRAD default
	Soil-specific b parameter		15		DOE-RL 1997
	Hydraulic conductivity	m/yr	0.0022		DOE-RL 1997
R016 – k_d for Individual Radionuclides	K_d for contaminated zone, uncontaminated zone, and saturated zone	mL/g	See Tables B-2 and B-3		DOE-RL 1997, DOE-RL 2000, BHI 2002
	Saturated leach rate		0		RESRAD default
	Saturated solubility		0		RESRAD default
R017 – Inhalation and External Gamma	Inhalation rate	m^3/yr	8,400		DOE-RL 1997
	Mass loading for inhalation	g/m^3	0.0002		DOE-RL 1997
	Exposure duration	yr	30		RESRAD default
	Indoor dust filtration factor		0.4		RESRAD default
	External gamma shielding factor		0.7		DOE-RL 1997
	Indoor time fraction		0.165		DOE-RL 1997
	Outdoor time fraction		0.055		DOE-RL 1997
	Shape factor		Circular		RESRAD default
R018 – Ingestion Pathway Data, Dietary Parameters	Fruits, vegetables, and grain consumption	kg/yr	Not used in industrial scenario		
	Leafy vegetable consumption	kg/yr			
	Milk consumption	L/yr			
	Meat and poultry consumption	kg/yr			
	Fish consumption	kg/yr			
	Other seafood consumption	kg/yr			
	Soil ingestion	g/yr	25		DOE-RL 1997
	Drinking water intake	L/yr	0	250	DOE-RL 1997
	Drinking water contamination fraction		0	1	DOE-RL 1997
	Household water contamination fraction		Not used in industrial scenario		
	Livestock water contamination fraction				
	Irrigation water contamination fraction				
	Aquatic food contamination fraction				
	Plant food contamination fraction				
	Meat contamination fraction				
	Milk contamination fraction				

Table B-7a. RESRAD Input Parameters for the 300-FF-2 Industrial Land-Use Scenario. (3 Pages)

Category	Parameter	Units	User Input, Industrial Scenario	User Input, Groundwater Protection	Reference
R019 – Ingestion Pathway Data, Nondietary	Livestock fodder intake for meat	kg/d	Not used in industrial scenario		
	Livestock fodder intake for milk	kg/d			
	Livestock water intake for meat	L/d			
	Livestock water intake for milk	L/d			
	Livestock intake of soil	kg/d			
	Mass loading for foliar deposition	g/m^3			
	Depth of soil mixing layer	m			
	Depth of roots	m			
	Groundwater fractional usage – drinking water		0	1	DOE-RL 1997
	Groundwater fractional usage – household		0	0	DOE-RL 1997
	Groundwater fractional usage – livestock water		0	0	DOE-RL 1997
	Groundwater usage – irrigation		0	0	DOE-RL 1997
R021 – Radon			Not used		Radon is not a COPC

[a] The stated numeric values are only used when RESRAD is used to determine generic cleanup levels. Otherwise, site-specific input values for these parameters are determined on a site-by-site basis. All other values are fixed at the values shown unless modified with regulator approval.

COPC = contaminant of potential concern
CZ = contaminated zone
GW = groundwater
ND = non detect
RCRA = *Resource Conservation and Recovery Act of 1976*
SZ = saturated zone

Table B-7b. RESRAD Input Parameters for the 300-FF-2 Unrestricted Land-Use Scenario. (3 Pages)

Category	Parameter	Units	User Input, Unrestricted Land Use	User Input, Groundwater Protection	Reference
Exposure pathways		<u>Pathway</u> External Gamma: Inhalation: Plant Ingestion: Meat Ingestion: Milk Ingestion: Aquatic Foods: Drinking Water: Soil Ingestion: Radon:	<u>Soil Status</u> Active Active Active Active Active Active Active Active Suppressed	<u>GW Status</u> Suppressed Suppressed Suppressed Suppressed Suppressed Suppressed Active Suppressed Suppressed	DOE-RL 1997
R011 – CZ	Area of CZ[a]	m^2	10,000[a]	10,000[a]	
	Thickness of CZ[a]	m	4.6[a]	5[a]	
	Length parallel to aquifer flow[a]	m	100[a]	100[a]	
	Radiation dose limit	mrem/yr	15	4	DOE-RL 1997
	Elapsed time since waste placement	yr	0		RESRAD default
R013 – Cover and CZ Hydrological Data	Cover depth[a]	m	0	4.6[a]	
	Cover material density	g/cm^3	1.6		DOE-RL 1997
	Cover erosion rate	m/yr	0.001		RESRAD default

Table B-7b. RESRAD Input Parameters for the 300-FF-2 Unrestricted Land-Use Scenario. (3 Pages)

Category	Parameter	Units	User Input, Unrestricted Land Use	User Input, Groundwater Protection	Reference
	Density OF CZ	g/cm^3	1.6		DOE-RL 1997
	CZ erosion rate	m/yr	0.001		RESRAD default
	CZ total porosity		0.3		DOE-RL 1997
	CZ field capacity		0.25		DOE-RL 1997
	CZ hydraulic conductivity	m/yr	0.0022		DOE-RL 1997
	CZ b parameter		15		DOE-RL 1997
	Humidity in air	g/cm^3	8		RESRAD default
	Evapotranspiration coefficient		0.91		WDOH 1997
	Wind speed	m/sec	3.4		
	Precipitation	m/yr	0.1524		DOE-RL 1997
	Irrigation rate	m/yr	0.76		DOE-RL 2002
	Irrigation mode		Overhead		RESRAD default
	Runoff coefficient		0.2		RESRAD default
	Watershed area for nearby stream or pond	m^2	10,000,000		DOE-RL 1997
	Accuracy for water/soil computations		0.001		RESRAD default
R014 –SZ Hydrological Data	Density of SZ	g/cm^3	1.6		DOE-RL 1997
	SZ total porosity		0.3		DOE-RL 1997
	SZ effective porosity		0.3		DOE-RL 1997
	SZ hydraulic conductivity	m/yr	673,846		DOE-RL 1997
	SZ hydraulic gradient		0.0005		DOE-RL 1997
	SZ b parameter		3.5		DOE-RL 1997
	Water table drop rate	m/yr	0.001		RESRAD default
R014 – Saturated Zone (SZ) Hydrological Data	Well pump intake depth below water table	m	4.6 (15 ft), typical RCRA well screen length		
	Nondispersion or mass balance		ND		RESRAD default
	Well pumping rate	m^3/yr	250		RESRAD default
R015 – Uncontaminated and Unsaturated Strata Hydrological Data	Number of unsaturated strata[a]		1[a]	0[a]	
	Thickness[a]	m	5[a]	0[a]	
	Soil density	g/cm^3	1.6		DOE-RL 1997
	Total porosity		0.3		DOE-RL 1997
	Effective porosity		0.3		DOE-RL 1997
	Field capacity		0.2		RESRAD default
	Soil-specific b parameter		15		DOE-RL 1997
	Hydraulic conductivity	m/yr	0.0022		DOE-RL 1997
R016 – k_d for Individual Radionuclides	K_d for contaminated zone, uncontaminated zone, and saturated zone	mL/g	See Tables B-2 and B-3		DOE-RL 1997, DOE-RL 2000, BHI 2002
	Saturated leach rate		0		RESRAD default
	Saturated solubility		0		RESRAD default

Table B-7b. RESRAD Input Parameters for the 300-FF-2 Unrestricted Land-Use Scenario. (3 Pages)

Category	Parameter	Units	User Input, Unrestricted Land Use	User Input, Groundwater Protection	Reference
R017 – Inhalation and External Gamma	Inhalation rate	m^3/yr	7,300		DOE-RL 2002
	Mass loading for inhalation	g/m^3	0.0001		DOE-RL 2002
	Exposure duration	yr	30		DOE-RL 2002
	Indoor dust filtration factor		0.4		DOE-RL 2002
	External gamma shielding factor		0.8		DOE-RL 2002
	Indoor time fraction		0.6		DOE-RL 2002
	Outdoor time fraction		0.2		DOE-RL 2002
	Shape factor		Circular unless otherwise specified		
R018 – Ingestion Pathway Data, Dietary Parameters	Fruits, vegetables, and grain consumption	kg/yr	110		DOE-RL 2002
	Leafy vegetable consumption	kg/yr	2.7		DOE-RL 2002
	Milk consumption	L/yr	100		DOE-RL 2002
	Meat and poultry consumption	kg/yr	36		DOE-RL 2002
	Fish consumption	kg/yr	19.7		DOE-RL 2002
	Other seafood consumption	kg/yr	0.9		DOE-RL 2002
	Soil ingestion	g/yr	73		DOE-RL 2002
	Drinking water intake	L/yr	730		DOE-RL 2002
	Drinking water contamination fraction		1		DOE-RL 2002
	Household water contamination fraction		1		DOE-RL 2002
	Livestock water contamination fraction		1		DOE-RL 2002
	Irrigation water contamination fraction		1		DOE-RL 2002
	Aquatic food contamination fraction		0.5		DOE-RL 2002
	Plant food contamination fraction		-1		DOE-RL 2002
	Meat contamination fraction		-1		DOE-RL 2002
	Milk contamination fraction		-1		DOE-RL 2002
R019 – Ingestion Pathway Data, Nondietary	Livestock fodder intake for meat	kg/d	68		DOE-RL 2002
	Livestock fodder intake for milk	kg/d	55		DOE-RL 2002
	Livestock water intake for meat	L/d	50		DOE-RL 2002
	Livestock water intake for milk	L/d	160		DOE-RL 2002
	Livestock intake of soil	kg/d	0.5		DOE-RL 2002
	Mass loading for foliar deposition	g/m^3	0.0001		DOE-RL 2002
	Depth of soil mixing layer	m	0.15		DOE-RL 2002
	Depth of roots	m	0.9		DOE-RL 2002
	Groundwater fractional usage – drinking water		1		DOE-RL 2002
	Groundwater fractional usage – household		1		DOE-RL 2002
	Groundwater fractional usage – livestock water		1		DOE-RL 2002
	Groundwater usage – irrigation		1		DOE-RL 2002
R021 – Radon			Not used		Radon is not a COPC

[a] The stated numeric values are only used when RESRAD is used to determine generic cleanup levels. Otherwise, site-specific input values for these parameters are determined on a site-by-site basis. All other values are fixed at the values shown unless modified with regulator approval.

COPC = contaminant of potential concern
CZ = contaminated zone
GW = groundwater
ND = nondetect
RCRA = *Resource Conservation and Recovery Act of 1976*

- **Drinking Water/Groundwater Dose Assessment.** RESRAD estimates the site impact to groundwater. These RESRAD estimated radionuclide groundwater concentrations are used for calculating individual organ doses received from drinking water. A detailed approach for calculating the individual dose rates is given below.

Attainment of Radionuclide Direct Exposure Standards

The current version of the RESRAD computer code (ANL 2007) is used to demonstrate that the direct exposure radionuclide dose limit of 15 mrem/yr above background is not exceeded. For the shallow zone and overburden decision units, all contaminant pathways contribute to the direct exposure dose estimate. For the deep zone decision unit, only the water-dependent pathways contribute to the direct exposure dose estimate.

The statistical value (95% UCL) is used for input to the RESRAD model. The direct radiation exposure dose to the resident living in his/her basement is conservatively estimated by substituting (for analysis purposes) a case where the resident is standing on level ground with the soil containing concentrations representative of residual (i.e., post-cleanup) shallow zone soils. (This is conservative because it ignores the potential shielding effects of concrete basement walls and any clean backfill between residual soils and the basement walls.) The results of the RESRAD direct exposure dose estimate may be presented in a figure. This dose represents the summed dose contributions from soils at the relevant time frames. This computation is summarized in a calculation brief. The actual doses at the waste site will be considerably less than these calculations because the site will be backfilled with clean fill soil.

Attainment of Nonradionuclide Direct Exposure Standards

The shallow zone statistical value for the COC is compared to the cleanup criteria to evaluate the attainment of direct exposure RAGs. Comparison of nonradionuclide direct exposure RAGs to the shallow zone statistical values is summarized in a table.

Attainment of Nonradionuclide Noncarcinogenic Risk Standards

For noncarcinogenic COCs, WAC 173-340-740(5)(a) and (b) specifies the evaluation of the hazard quotient, which is given as daily intake divided by a reference dose (DOE-RL 1995). For cleanup actions under the ROD (EPA 2001), a comparable conservative approach is used to demonstrate attainment of the noncarcinogenic risk requirements.

The direct exposure nonradionuclide RAGs for soil are based on the WAC 173-340-745(4) (industrial) limits and the WAC 173-340(3) (unrestricted) limits. These cleanup limits were set to be compliant with a hazard quotient of 1.0; therefore, the ratio of the cleanup verification statistical values to the cleanup limits (lookup value obtained from Table 2-1 of this RDR/RAWP) provides a conservative approach to addressing the hazard quotient.

The fraction of cleanup level (Fc) is calculated using the formula Fc = S/V, where:

Fc = fraction of cleanup level (dimensionless)
S = statistical value of the COCs (in mg/kg)
V = lookup value (WAC 173-340-740(3) Method B derived, direct exposure RAG in mg/kg).

If the Fc is less than 1 for an individual COC, then the hazard quotient has been addressed.

For multiple COCs, a sum of the individual COC Fc values was used to address the hazard index or cumulative hazard quotient. The Fc values for all noncarcinogenic COCs were summed. If that sum was less than 1, then the hazard index or cumulative hazard quotient has been addressed.

Attainment of Nonradionuclide Carcinogenic Risk Standards

For individual carcinogenic nonradionuclide COCs, the WAC 173-340-750(3) Method B cleanup limits are based on an incremental cancer risk of 1×10^{-6}. For cumulative carcinogenic COCs, the cumulative excess cancer risk must be less than 1×10^{-5}. If a linear relationship is assumed between environmental concentration and risk, the ratio (Fc) of the statistical value from the verification samples divided by the WAC 173-340-750(3) Method B limit, multiplied by 10^{-6}, is an estimate of the risk associated with the statistical value.

For multiple carcinogenic COCs, the risks of the individual COCs (described above) are summed. If no risk associated with a single COC exceeds 1×10^{-6}, and if the sum of the individual COC risk does not exceed 1×10^{-5}, then the WAC 173-340-750(5)(a) and (b) Method B risk requirement has been addressed for this remedial action.

For the shallow zone, the individual COC and cumulative risk value are checked against the individual and cumulative WAC 173-340-750(5)(a) and (b) risk limits. This type of calculation is performed and documented in the 95% UCL calculation brief, which is included in an appendix to the CVP/RSVP.

Attainment of Groundwater Remedial Action Goals

The groundwater RAGs are applicable to all decision units (e.g., shallow zone, deep zone, and overburden). A contaminant depth/soil-partitioning coefficient (K_d) value model has been developed to predict if the concentrations of contaminants in soil that exceed cleanup levels for groundwater or river protection are protective of groundwater and the river at a site. The *100 Area Analogous Sites RESRAD Calculations* calculation brief (BHI 2005) predicts whether or not contaminants in 100 and 300 Area soils are expected to migrate to groundwater within a 1,000-year time frame based on their K_d value and the vertical distance to groundwater. The contaminant depth/K_d value model assumes that uncontaminated soil exists in the vadose zone between the bottom of the waste site and groundwater. The assumption of an uncontaminated zone beneath the waste site is reasonable based on analogous site data that include test pits and boreholes completed in the operable units in the 100 and 300 Areas. The test pit and/or borehole data show that contaminant concentrations that are below direct exposure cleanup levels decrease to background concentrations within less than 3 m (10 ft) below the elevation at which the contamination occurs.

- **Radionuclides.** The estimated groundwater concentrations for all the radionuclide COCs contributed by the soils in the shallow zone (and deep zone, if present) are determined by RESRAD modeling, which is documented in the RESRAD calculation brief. If the groundwater concentrations predicted by RESRAD indicate that COCs impact groundwater, then a separate calculation brief for comparison to drinking water standards is needed to determine compliance with groundwater dose standards.

  Depending on the ROD, the "National Primary Drinking Water Regulations" (40 CFR 141.66) establish a gross-alpha particle standard of 15 pCi/L for alpha-emitting radionuclides (excluding radon and uranium), or DOE Order 5400.5 establishes derived concentration guidelines (DCGs) for alpha emitters. For the DCG-based limits, 1/25th of the DCG is used.

  The 40 CFR 141.66 regulations establish a 4 mrem/yr dose standard for beta- and gamma-emitting radionuclides in drinking water. They also specify the method of calculating dose: the individual organ-dose calculational method given in National Bureau of Standards (NBS) Handbook 69 (NBS 1963). To determine if any organ receives a dose of more than 4 mrem/yr, the dose to each organ is calculated from the COC radionuclide mixture. The "National Primary Drinking Water Regulations" establish a maximum contaminant level for total uranium of 30 μg/L.

  There is a critical organ for each radionuclide (i.e., the organ that receives the highest dose from ingestion of that radionuclide). The critical organs for each radionuclide are determined from the maximum permissible concentration (MPCs) listed in Table 1 of NBS Handbook 69 (NBS 1963), and are denoted in bold in Table B-2. The factor C_4 (i.e., the concentration that will produce a dose of 4 mrem/yr to that organ) is calculated for each organ and radionuclide and compared to the applicable MPC. The equation for the calculation of C_4 for radionuclide "A" and organ "x" is as follows:

  $$C_4^A(x) = 4.4 \times 10^6 \text{ (MPC/ORL)}.$$

  The term "ORL" is the occupational radiation limit (in rems) for the organ given in the *National Primary Drinking Water Regulations* (EPA 1976). The ORLs for the individual organs are as follows:

  - Total body - 5
  - Gonads - 5
  - Thyroid - 30
  - Bone - 29.1
  - Other organs - 15.

The C_4 factors for the COCs are summarized in Table B-8.

Table B-8. Factors for Calculating Radionuclide-Specific Organ Doses Using Methodology Mandated by the Safe Drinking Water Act for Comparison to the 4 mrem/yr Standard for Beta and Gamma Emitters.

Radionuclide	Organ	4 mrem/yr Equivalent Concentration (C_4 in pCi/L)[a]
Cobalt-60	**GI(LLI)**	100
	Total Body	900
	Liver	3,000
Cesium-137	Bone	80
	GI(LLI)	2,000
	Total Body	200
	Liver	60
Europium-152	Bone	30,000
	GI(LLI)	200
	Total Body	2E+05
	Liver	1E+05
Europium-154	Bone	5,000
	GI(LLI)	60
	Total Body	7E+04
	Liver	6E+04
Europium-155	Bone	1E+05
	GI(LLI)	600
	Total Body	9E+05
	Liver	6E+05
Strontium-90	**Bone**	8
	GI(LLI)	100
	Total Body	8
Nickel-63	**Bone**	50
	GI(LLI)	3,000
	Total Body	2,000
	Liver	600
Carbon-14	Total Body	9,000
	Bone	2,000

NOTE: Critical organs are shown in bold.

[a] Calculated by methodology given in *National Interim Primary Drinking Water Regulations*, Appendix IV, "Dosimetric Calculations for Man-Made Radioactivity" (EPA 1997).

GI(LLI) = gastrointestinal tract-lower large intestine

The cumulative dose for each organ at time "t" needs to be calculated separately and the sum of fractions equation (EPA 1976) calculated, as shown below. If a radionuclide does not have an MPC for the organ of interest, the C_4 factor for total body dose is used in the calculation. The calculations performed are documented in the comparison to drinking water standards calculation brief. The organs for which doses need to be computed are total body, bone, gastrointestinal tract-lower large intestine, and liver. The individual organ doses are compared to 4 mrem/yr. Using this methodology, the doses are not summed for different organs for the comparison to 4 mrem/yr.

$$Dose_{organ\ x}(t) = [ConcA(t)/C_4^A(x) + ConcB(t)/C_4^B(x) + \ldots] \times (4\ mrem/yr)$$

If the dose for organ "x" is less than 4 mrem/yr, then the standard is met.

If the groundwater concentrations predicted by RESRAD indicate that COCs impact groundwater, a table is provided in the CVP/RSVP that shows the total peak concentration for each detected radionuclide COC and provides the individual RAGs for comparison, as shown in Table B-9. A figure may be provided in the CVP/RSVP that shows the calculated dose to organs from groundwater.

Table B-9. Estimated Peak Radionuclide Groundwater Concentrations (Summed over Shallow and Three Deep Zone Levels) Compared to RAGs.

Radionuclide	Peak Concentration (pCi/L)	Approximate Time of Peak Concentration (years)	RAG (pCi/L)
Americium-241	0	0	15
Carbon-14	0	0	2,000
Cobalt-60	0	0	100
Cesium-137	0	0	60
Europium-152	0	0	200
Europium-154	0	0	60
Europium-155	0	0	600
Nickel-63	0	0	50
Plutonium-238	0	0	15
Plutonium-239/240	0	0	15
Strontium-90	0	0	8

- **Nonradionuclides.** If the statistical value of a COC is below the soil background value, the COC is not considered further in the groundwater protection evaluation, and the groundwater protection RAG is considered to be attained.

To determine the RAG for a contaminant in soil that is protective of groundwater, WAC 173-340-740(3)(a)(ii)(A) (January 1996) is applied (as a first test) to the groundwater action level for each COC. Application of WAC 173-340-740(3)(a)(ii)(A) (January 1996) involves a conversion of groundwater action levels (µg/L) to equivalent soil action levels (mg/kg). This calculation is based on a kg/L density conversion factor assumption. For example, a RAG of 1 µg/L has a corresponding soil equivalent RAG of 0.1 mg/kg (e.g., 1 µg/L = 0.001 mg/L, 0.001 mg/L ÷ 1 kg/L = 0.001 mg/kg, 100 x 0.001 mg/kg = 0.1 mg/kg). After conversion of the groundwater action level to a soil equivalent value, the COC statistical values can be compared directly to the RAG soil equivalent value. Per WAC 173-340-740(3)a, the COC statistical values that are less than the RAG soil equivalent value are considered protective of the groundwater.

If the statistical value of a COC is determined to be equal to or lower than the analytical method PQL, which is the lowest detectable value, but the PQL is greater than the cleanup RAG, the RAG is considered to have been attained in accordance with WAC 173-340-707. For example, the groundwater action level for polychlorinated biphenyls (PCBs) is 0.01 µg/L (or 0.00001 mg/L), which after applying WAC 173-340-740(3)(a)(ii)(A) (January 1996) provides a soil RAG of 0.001 mg/kg. Direct comparison of the statistical value to this soil RAG is inappropriate because the PQL at which PCBs are detectable is greater than 0.001 mg/kg. Therefore, in this case, the PQL for PCB analysis and the corresponding statistical value are considered protective of the groundwater. In cases where the COC analytical PQL is below the RAG, the statistical value is directly compared to the soil equivalent RAG.

Attainment of Columbia River Remedial Action Goals

- **Radionuclides**. The individual radionuclide Columbia River RAG is equivalent to the groundwater RAG[1]; therefore, if the individual radionuclide groundwater RAG is attained, the individual Columbia River RAG is also attained.

- **Nonradionuclides**. If the statistical value of a COC is below the background value, it is not considered further in Columbia River protection cleanup verification evaluation, and the Columbia River RAG has been attained.

  To determine soil RAGs for other nonradionuclide contaminants that are protective of surface water, the "100 times surface water quality times DAF" rule is applied (as a first test) to the surface water protection action level for each COC. Application of the "100 times surface water quality times DAF" rule involves a conversion of surface water protection action levels (µg/L) to equivalent soil action levels (mg/kg). This calculation is based on a 1-kg/L density conversion factor assumption. A DAF based on a dilution of 2:1 has been established in Appendix D of the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005) for nonradionuclides. The "100 times surface water quality

[1] Because there are no ambient water quality criteria for radionuclides, the groundwater action levels apply to river protection.

times DAF" rule is then applied to provide a soil equivalent RAG that is protective of the Columbia River. The statistical value is then directly compared to the soil equivalent RAG for surface water protection. If the statistical value is lower, the Columbia River RAGs are attained.

If the statistical value of a COC is determined to be equal to the analytical method PQL, but the PQL is greater than the cleanup RAG, the RAG is considered to have been attained in accordance with WAC 173-340-707. For example, the ambient water quality criterion for PCBs is 0.014 μg/L (or 0.000014 mg/L), which after applying a DAF and WAC 173-340-740(3)(a)(ii)(A) (January 1996), provides a soil RAG of 0.0028 mg/kg. In this case, a direct comparison of the statistical value to the RAG of 0.0028 mg/kg is not made because the PQL for PCB analysis (i.e., statistical value) is considered protective of the Columbia River.

If the Columbia River RAG is not attained by these methods, then the statistical values are modeled using RESRAD (as described in Appendix B) to determine if nonradionuclides reach the groundwater within 1,000 years after remediation. If these nonradionuclides do not reach the groundwater, then they do not reach the Columbia River; thus, Columbia River RAGs are attained.

If RESRAD modeling indicates that contaminants do reach the groundwater within 1,000 years, the travel time in the groundwater underlying the site to the Columbia River is estimated as described in Appendix C of DOE-RL (2008). If contaminants do not reach the Columbia River within 1,000 years in concentrations exceeding the RAGs, then Columbia River RAOs are attained.

WAC 173-340-740(7)(e) Three-Part Test for Nonradionuclides

This section documents application of the WAC 173-340-740(7)(e) three-part test for nonradionuclides using the most restrictive RAGs applicable for each zone. (The most restrictive RAG is defined as the lowest of the direct exposure, groundwater protection, and river protection RAGs. The direct exposure, groundwater protection, and river protection RAGs are applicable to the shallow zone and overburden. Groundwater and river protection RAGs are applicable to the deep zone.) The WAC 173-340-740(7)(e) three-part test consists of the following criteria: (1) the cleanup verification statistical value must be less than the cleanup level, (2) no single detection can exceed two times the cleanup criteria, and (3) the percentage of samples exceeding the cleanup criteria must be less than 10%. The duplicate sample is treated as a separate sample for the three-part test. The split sample is only used for DQA purposes and is not included in the three-part test.

A table is used to summarize the results of the WAC 173-340-740(7)(e) three-part test for the overburden, shallow zone, and deep zone sample data sets. For each nonradionuclide COC, the table lists the most restrictive applicable RAG, the maximum detected value, the total number of samples collected, and the number of samples exceeding the most restrictive RAG. The final column of the table describes the result of applying the three criteria using the values listed in the preceding columns.

B.III-5.0 RADIONUCLIDE RISK INFORMATION

The radionuclide RAG for direct exposure is derived from the ROD (EPA 2001), and is expressed in terms of an allowable radiation dose above background (i.e., 15 mrem/yr). The RAG evaluation involved using the RESRAD model to estimate total annual radiation doses for 1,000 years for comparison to the RAG. Radiation presents a carcinogenic risk, and the RESRAD model also calculates the excess lifetime cancer risk associated with the estimated radiation doses. The "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300) presents a target range for residual risk of 10^{-4} to 10^{-6}. A figure can be used to illustrate excess lifetime cancer risk as estimated using the RESRAD model. Because of radioactive decay, the risk decreases over time.

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APPENDIX C

REVEGETATION PLAN FOR THE 300 AREA

ACRONYMS

RDR/RAWP	remedial design report/remedial action work plan
OU	operable unit
BRMaP	*Hanford Site Biological Resources Management Plan*
MAP	mitigation action plan
VTS	vitrification test site

APPENDIX C

REVEGETATION PLAN FOR THE 300 AREA

C.1 INTRODUCTION

This revegetation plan is for the waste sites covered in this 300 Area remedial design report/ remedial action work plan (RDR/RAWP) that will be remediated as part of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* remedial action project. This appendix addresses primarily those sites in the 300-FF-2 Operable Unit (OU). As planning for additional waste site remediation is completed, this RDR/RAWP will be updated to address those sites. Each site requiring remediation and the associated support facilities (roads, spoils piles, etc.) that are disturbed during remediation will be revegetated under this plan.

This plan is generic; site-specific conditions will be evaluated and adjustments made when necessary. Land-use considerations will also affect the intensity of revegetation of the 300 Area waste sites. Some sites within the 300 Area have been designated for continued or future industrial land use. Other portions of the 300-FF-2 OU have been proposed as resources of concern by the *Hanford Site Biological Resources Management Plan* (BRMaP) (DOE-RL 2000) because they contain high-quality shrub-steppe habitat, which is classified as a priority habitat by the Washington Department of Natural Resources (WDNR 1995). Consultations with Tribes and the Natural Resource Trustee Council will also occur, as appropriate, for additional input.

This revegetation plan is based on the information provided in the *Revegetation Manual for the Environmental Restoration Contractor* (BHI 1997), the BRMaP (DOE-RL 2000), and preliminary results of other revegetation efforts that have occurred across the Hanford Site.

C.2 MITIGATION ACTION PLAN

The *Mitigation Action Plan for the 300 Area of the Hanford Site* (DOE-RL 2002) addresses mitigation actions for waste sites in the 300-FF-1 and 300-FF-2 OUs. The mitigation action plan (MAP) provides guidance to the design and field staff to ensure that natural and cultural resources are protected during field activities. The plan includes avoidance and minimization steps in mitigation. Special consideration is also given to the local Native American Tribes and nations for cultural resource concerns.

Waste sites that will be remediated in the 300-FF-2 OU consist of burial grounds, a liquid waste disposal crib, and other miscellaneous near-surface disposal areas. Much of the nonindustrial and less-disturbed 300 Area contains recovering mid-seral communities of shrub (bitterbrush [*Purshia tridentata*] and snow buckwheat [*Eriogonum niveum*]), perennial grass (e.g., Sandberg's bluegrass [*Poa sandbergii*]), and annual grass (e.g., cheatgrass [*Bromus tectorum*]) species on sandy soils. Portions of the habitat in this area have been proposed as a Level III resource of concern in the BRMaP (DOE-RL 2000). Level III biological resources are of concern because of their state listing; potential for Federal or state listing; unique or significant value for plant, fish, or wildlife species; special administrative designation; or environmental sensitivity. Two waste sites, 300-8 and 600-47, have been previously evaluated and portions have been designated as Level III habitat. Impacts to Level III resources associated with these two sites will be mitigated in accordance with the BRMaP. The BRMaP does not identify a resource level of concern for the southern portion of the 300-FF-2 OU adjacent to the industrialized 300 Area due to extensive disturbance and lack of vegetation. Sites 300-18, 316-4, 618-2, 618-3, 618-5, 618-8, and 618-13 were evaluated in *Ecological Resources Review of Remedial Design Package for Nine 300-FF-2 Waste Sites (00-ER-039)* (BHI 2000) and were not found to contain priority habitat. The 618-1 Burial Ground is located inside of the 300 Area perimeter fence and is not expected to contain cultural or ecological resources due to prior disturbance. Sites 618-1, 600-259, 300 Vitrification Test Site (VTS), and 618-7 will be evaluated for cultural and ecological resources prior to the commencement of remedial actions at those sites.

Remediation of the 300 Area waste sites is anticipated to involve extensive excavation, which has the potential to impact natural resources. These sites will be identified in field surveys prior to initiation of remediation. If remedial actions demonstrate the potential for disturbing species of concern or removing high-quality habitat, supplemental mitigation (in addition to actions listed in the MAP [DOE-RL 2002]) may be needed.

C.3 SITE DESCRIPTIONS

The vegetative status for waste sites that were remediated and the nearby areas for support facilities during remediation were assessed in various ecological and cultural resources reviews (BHI 2000, 2004, 2005; WCH 2006a, 2006b, 2006c, 2007a, 2007b, 2008). The remaining sites will be evaluated for cultural and ecological resources prior to the commencement of remedial actions at those sites. The vegetative status of the 300 Area varies, but ranges from nonvegetated/industrial (e.g., the parking lot above the 618-8 Burial Ground) to a mixture of nonvegetated and vegetated with low-quality communities, such as cheatgrass/Russian thistle (*Bromus tectorum/Salsola kali*) and rabbitbrush/cheatgrass (*Chrysothamnus nauseosus/Bromus tectorum*), and high-quality mature shrub-steppe habitat containing sagebrush (*Artemisia tridentata*), bitterbrush, rabbitbrush (*Chrysothamnus nauseosus*), and snow buckwheat. The soils in the 300-FF-2 OU are predominantly sandy soils, although remediated sites will consist of backfill from site stabilization. Wildlife that uses the 300 Area includes mule deer, coyotes, geese, badgers, birds, and small mammals such as Great Basin pocket mice and deer mice. Detailed descriptions of the habitat present at the 300-FF-2 OU sites were recorded in *Ecological Resources Review of Remedial Design Package for Nine 300-FF-2 Waste Sites (00-ER-039)* (BHI 2000) and other 300 Area ecological reports (e.g., DOE-RL 2002, Hulstrom and Landeen 1995, Rickard et al. 1990).

C.4 PURPOSE OF REVEGETATION

The goal of revegetation in the 300 Area is to restore the remediated waste sites and support areas not identified for future land use to communities dominated by native plant species, as appropriate. Revegetation is valuable for the prevention of runoff, erosion, and infiltration. In some areas, shrubs such as sagebrush and rabbitbrush may be planted to provide habitat and structure for nesting birds. Native grasses and forbs that are adapted to the site conditions will be planted to provide an understory. The methods used for revegetation will reflect what is feasible on a site-by-site basis. Future land use and the duration of project activities are factored into mitigation and revegetation planning.

C.5 TOPSOIL AND BACKFILL MATERIAL

Fine-grained topsoil, such as sandy loam, is of low availability on the Hanford Site. In the few places where it exists, such as McGee Ranch and the Fitzner Eberhardt Arid Lands Ecology Reserve, removal may cause unacceptable ecological effects at the borrow sites. The "Hanford Comprehensive Land-Use Plan Environmental Impact Statement" (64 *Federal Register* 61615) precludes the use of borrow materials from McGee Ranch; therefore, backfill from nearby borrow pits will be used. The backfill material from the borrow pits was originally deposited by the Columbia River, and a slow, natural revegetation of this backfill can be seen at the borrow sites that have been abandoned. Native species, including sagebrush and Sandberg's bluegrass, have become established in inactive borrow pits. The density of the vegetative cover at the abandoned borrow pits, however, is less than at other sites such as the abandoned Pre-Hanford farmland, which is usually dominated by cheatgrass and tumblemustard (*Sisymbrium altissimum*). The soils at the abandoned fields consist of much finer-grained materials, with greater moisture-holding capacity and nutrient properties than at the borrow sites. These fine-grained soils tend to favor cheatgrass, which often excludes establishment of shrubs.

Other sources of backfill that may be considered for use in the future include uncontaminated concrete rubble from nearby demolished buildings. Excavation and use of backfill material will comply with guidance stated in the *Mitigation Action Plan for the 300 Area of the Hanford Site* (DOE-RL 2002). If revegetation will occur at the site and secondary material (i.e., inert crushed concrete or other course material) is used as backfill, it will be placed at least 2 to 3 m (6 to 10 ft) below final grade to the extent practicable. The smaller-grained material (i.e., cobble, sand, soil) which is necessary for sufficient plant rooting, will be used near the surface.

C.6 SITE PREPARATION

For those sites currently not vegetated, the clean overburden can be used in the bottom of the excavation, and new material from the borrow pits placed on top. For those sites that are currently vegetated, the top 15 to 30 cm (6 to 12 in.) of clean overburden will be saved and used as the topsoil for the excavation. If needed, this material may be spread into a thinner layer (about 5 to 10 cm [2 to 4 in.]) and used as topsoil for several adjacent sites.

The final surface contour for revegetated sites will be graded to match the surrounding terrain by creating gentle slopes instead of a flat surface. Any large boulders remaining on the sites that are to be revegetated should be buried deep in the excavation or randomly grouped on the surface to create additional wildlife habitat. For those sites not requiring backfill to match the surrounding grade, depressions may remain. The depressions should have sides no steeper than 3:1 or 4:1 and irregular grade to more closely match the surrounding native terrain.

C.7 SPECIES TO BE PLANTED

The plant species seeded will be selected based on seed availability and species appropriateness for the structure of the soils to be revegetated. Native species of a Hanford genotype will be used for a majority of revegetation efforts. Sandberg's bluegrass and needle-and-thread grass (*Stipa comata*) have been collected on the Hanford Site and grown as an agricultural crop to provide a large quantity of seeds for revegetation. Seeds of other native plants, such as sagebrush, yarrow (*Achillea millefolium*), Carey's balsamroot (*Balsamorhiza careyana*), pine bluegrass (*Poa scabrella*), and snow buckwheat, may also be collected on the Hanford Site and will be added to the planting mixture as available and as appropriate to each site. Additional species that may be collected include scurf pea (*Psoralea lanceolata*) rhizomes and seeds of sand dropseed (*Sporobolus cryptandrus*) for use at sandy sites. Additional seeds of other species may be provided by the Tribes and Trustees and combined with the species described above.

Guidance on seeding rates is provided in the *Revegetation Manual for the Environmental Restoration Contractor* (BHI 1997). The methods used for seeding will vary, depending on soil type and conditions. For example, drill-seeding works best on soils with minimal amounts of rock, while broadcast or hydro-seeding may be preferable on rocky soils. Seeds that are uncleaned or of an unsuitable shape or size may be broadcast over the site before the other seeds are planted. The action of the planting and mulching equipment will help set the broadcast seeds. Areas that have been used for support facilities and haul roads may have excessively compacted the ground, making the area unsuitable for planting. If necessary, the soils in these areas will be loosened by ripping the soil with heavy equipment. If a seed drill is not appropriate at these areas, broadcast seeding (with subsequent harrowing or disking) or hydro-seeding may be used to plant seeds. Seeding each year will occur between November and mid-January.

On sites where more intensive revegetation is required, sagebrush tublings may be planted between November and January in the backfilled areas at a density ranging between 500 to 1,000 plants/ha (200 to 400 plants/acre), depending on the site.

C.8 FERTILIZER AND STRAW MULCH

While the usefulness of fertilizers is sometimes in question when seeding native species, the backfill material excavated from borrow pits is often deficient of nutrients. The cobble composition of excavated backfill material does not promote the establishment of cheatgrass as does finer-grained topsoil. Therefore, the addition of some fertilizers may help the native planted species become established. To help clarify the role of fertilizer on native plant

establishment, different types of fertilizer and rates may be applied to parts of revegetation sites. The success of each fertilized area will be monitored and compared after the first and second years for plant establishment and cost effectiveness. The fertilizer will be applied at the same time as the seeds, and the type and rate will be determined on a site-specific basis.
Straw mulch will be spread on the surface at a rate of 4.5 metric ton/ha (2 tons/acre) and crimped into the seedbed.

C.9 IRRIGATION

When irrigation is feasible, it will generally occur only at the time of initial seeding. No additional irrigation is planned at this time. The presence of cobble and larger gravels used as backfill on the sites act as a mulch, helping to conserve moisture. The effects of supplemental irrigation on restoration success were tested at a restoration site in the 100-B/C Area during 1999 and 2000. The results at this test site indicated that supplemental irrigation in the spring did little to improve the survival of planted sagebrush (Johnson et al. 2000). Vegetation analysis from other similar revegetation sites indicate that it is more beneficial to add supplemental water during the planting process to increase germination, with little observed benefit of irrigation after planting.

C.10 MONITORING AND SUCCESS CRITERIA

The revegetated areas will be monitored for 5 years following planting. Monitoring will be conducted using methods from Daubenmire (1970) to estimate percent canopy cover and frequency of occurrence for each species. All species observed on the sites, including those not captured in the sampling plot frames, will be recorded. If the canopy cover of seeded plants is less than 1% in the spring of the second year, reseeding may occur the following fall, if the cause of the reduced success can be identified and rectified. After 5 years, the criteria for success will be a total canopy cover of greater than 25% for native plants. If this is not achieved, the cause should be identified and rectified with additional plantings, fertilization, irrigation, or soil amendments, as applicable.

The vegetative cover and composition at each site following a revegetation effort will be site specific. Several factors, including seedbed, moisture regime, and topographic features, influence a native plant community establishment and success. Caution should be exercised when comparing success between different locations.

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APPENDIX D

REMEDIAL ACTION GOALS

APPENDIX D

REMEDIAL ACTION GOALS

D.1 INTRODUCTION

Remedial action goals (RAGs) are the contaminant-specific numerical cleanup criteria developed to ensure that the remedial actions to be implemented will meet the remedial action objectives set forth in Section 2.1 of this document and 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-FF-2 explanation of significant differences (ESD) (EPA 2004) does not generally change the RAOs identified in the ROD, although risk levels for individual chemical contaminants are modified to reflect the unrestricted land-use scenario for specific sites outside of the 300 Area security fence. The RAGs are based on applicable or relevant and appropriate requirements (ARARs), to-be-considered (TBC) information, points of compliance, and the remedial action selected to support the land use identified in the 300-FF-2 ROD (EPA 2001) and ESD (2004).

The objective of this appendix is to develop and document RAGs for nonradionuclides and radionuclides at the 300 Area that are protective of human health and the environment. Impacts to human health are addressed by evaluation of direct contact/exposure and groundwater/ Columbia River pathways. A screening-level ecological risk evaluation is also done during the interim action phase. The conclusion of this evaluation will be documented in the relevant cleanup verification package or remaining sites verification package. These actions are interim until the final RODs for the 100 and 300 Areas are issued and placed in the Administrative Record. The overall process that was used to develop the RAGs is documented through a series of tables, as described in the following sections.

D.1.1 Hanford Site Cleanup Approach

Within the framework of *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), a modified cleanup approach has been adopted for the Hanford Site in accordance with the *Hanford Past-Practice Strategy* (DOE-RL 1991). This strategy allows for the initiation of remedial actions based on a limited amount of pre-remediation site studies so that more resources can be allocated to the remedial action phase of cleanup. Remedial action goals are developed for specific contaminants based on available waste site data and historical and analogous site information.

D.1.2 Contaminants of Potential Concern and Contribution to Risk

Based on the results of characterization activities and historical and analogous site information, a comprehensive list of contaminants of potential concern (COPCs) was identified for the 300 Area waste sites. Final contaminants of concern (COCs) for individual waste sites will be presented in site-specific cleanup verification documents.

Remedial action goals are developed for COPCs to attain acceptable levels of human health risk and protect groundwater and the Columbia River. The suitability of using individual RAGs as final cleanup values must be evaluated based on site-specific information considering the potential for interaction between contaminants and any cumulative effects. Because of uncertainty with the nature and extent of contamination, the RAGs are evaluated as if exposure comes from individual constituents. Consequently, RAGs are set at acceptable risk levels for exposure to individual constituents. The presence of multiple constituents may require downward adjustment of the cleanup levels at the time of cleanup verification to achieve the cumulative risk goals specified by the remedial action objectives.

D.2 NONRADIONUCLIDE REMEDIAL ACTION GOALS

Numeric RAGs, expressed in terms of concentration (mg/kg), were developed for each 300 Area nonradionuclide COPCs using the version of *Washington Administrative Code* (WAC) 173-340 (Ecology 1996) that was in effect at the time the 300-FF-2 ROD (EPA 2001) was approved. Until different agreements are reached among the Tri-Parties, the Ecology 1996 WAC 173-340 Method B and C formulas will continue to be used to determine nonradionuclide direct exposure cleanup levels and the WAC 173-340 Method B "100 times rule" (Ecology 1996) will be used to determine soil cleanup levels protective of groundwater and the Columbia River. Development of RAGs for direct exposure, protection of groundwater, and protection of the Columbia River is summarized in the following subsections.

D.2.1 Groundwater Protection Remedial Action Goals for Nonradionuclide Contaminants in Soil

Nonradionuclide contaminant concentrations in soil equal to or less than 100 times the groundwater cleanup level are protective of groundwater per WAC 173-340-740(3)(a)(ii)(A) (Ecology 1996). Nonradionuclide groundwater cleanup levels based on maximum contaminant levels (MCLs) (40 *Code of Federal Regulations* [CFR] 141, 143) and Method B formulas for groundwater in WAC 173-340-720(3) (Ecology 1996), sections (a)(ii)(A) and (B) for noncarcinogenic or carcinogenic substances, respectively, are tabulated in Table D-1, columns 2, 3, and 4. The lowest of the groundwater cleanup levels or MCLs is used to calculate the soil cleanup level based on the "100 times" rule in the fifth column. The "100 times" rule values are then compared to background and the required detection limit (RDL). The lowest of the "100 times" rule value, background, or the RDL becomes the soil cleanup level protective of groundwater, per WAC 173-340-700(4)(d) and WAC 173-340-700(6) (Ecology 1996). Soil cleanup levels for individual COPCs based on the protection of groundwater and the Columbia River apply to the entire soil column per WAC 173-340-740(6)(b) (Ecology 1996).

D.2.2 Columbia River Protection Remedial Action Goals for Nonradionuclide Contaminants in Soil

To maintain consistency, the same methodology used to obtain contaminant concentrations in soil protective of groundwater is applied to obtain contaminant concentrations in soil protective of the Columbia River with the additional application of a dilution-attenuation factor (DAF) of 2 to represent dilution occurring between the groundwater and river interface. This is described in Table D-2 (i.e., the soil cleanup level to be protective of the river shall be 100 times the RAG with application of a DAF of 2). Nonradionuclide surface water cleanup levels based on ambient water quality criteria (40 CFR 131), "Water Quality Standards for Surface Waters of the State of Washington" (WAC 173-201A), and Method B formulas for surface water cleanup levels in WAC 173-340-730(3) (Ecology 1996), sections (a)(iii)(A) and (B) for noncarcinogenic or carcinogenic substances, respectively, are tabulated in Table D-2, columns 2, 3, and 4. The lowest of the cleanup levels is used to calculate the soil cleanup level based on the "100 times DAF" rule. The "100 times DAF" rule values are then compared to background and the RDL. The lowest of the "100 times DAF" rule value, background, or the RDL becomes the soil cleanup RAG protective of groundwater, per WAC 173-340-700(4)(d) and WAC 173-340-700(6) (Ecology 1996). Soil cleanup levels for individual COPCs based on the protection of groundwater and the Columbia River apply to the entire soil column per WAC 173-340-740(6)(b) (Ecology 1996).

D.2.3 Direct Exposure Remedial Action Goals for Nonradionuclide Contaminants in Soil

Nonradionuclide direct exposure cleanup levels for industrial land use were calculated using Method C formulas from the Ecology 1996 revision of WAC 173-340-745(4) for carcinogens and noncarcinogens. Cleanup levels for unrestricted land use are calculated using Method B formulas from WAC 173-340-740(3) for carcinogens and noncarcinogens. Exceptions to the use of WAC 173-340-740 and -745 are for lead, where the RAG is based on the *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children* (EPA 1994), and the use of WAC 173-340-750 to calculate direct exposure RAGs for contaminants where inhalation exposure is the controlling risk factor, such as for beryllium, cadmium, and hexavalent chromium.

For each nonradionuclide chemical constituent the carcinogenic and noncarcinogenic cleanup levels are cited (as available) for industrial land use in columns 4 and 5 and for unrestricted land use in columns 7 and 8 of Table D-3. The lowest of the values in the carcinogenic and noncarcinogenic columns becomes the overall RAG for protection of human health via direct contact with contaminated soil, provided it is greater than background and the required detection limit (RDL). If the lowest of the RAGs is lower than background or the RDL, the higher of background or the RDL becomes the cleanup level per WAC 173-340-700(4)(d) and WAC 173-340-700(6) (Ecology 1996). For purposes of this RDR/RAWP, the RDL is considered equivalent to the PQL as identified in WAC 173-340-700(6). The direct exposure cleanup levels tabulated in Table D-3 apply to the upper 4.6 m (15 ft) of the soil column per WAC 173-340-740(6)(c) (Ecology 1996) and represent concentrations for individual COPCs that will be protective of human health from direct contact with contaminated waste for a residential land-use scenario. Institutional controls to prevent deep excavation or well drilling will be required if direct exposure RAGs are not obtained in the soil below 4.6 m (15 ft) in depth.

D.2.4 Summary of Remedial Action Goals for Nonradionuclide Contaminants

Summaries of the cleanup levels for direct contact, protection of groundwater, and protection of the river are presented in Table D-4. For reference, the chemical abstract system (CAS) number, distribution coefficient (K_d value), and Hanford Site background for each contaminant are also included. The CAS number is used to identify contaminants when variations in chemical names or spelling occur. The K_d value is used in computer modeling to determine if a higher soil concentration is protective of groundwater or the river at a site where the soil cleanup levels protective of groundwater or the river are exceeded, per WAC 173-340-740(3)(a)(ii)(A) (Ecology 1996).

D.2.5 Cleanup Verification Evaluation of Sites With Multiple Contaminants

During cleanup verification, it must be noted that if a waste site involves multiple contaminants and/or multiple pathways of exposure, the total excess lifetime cancer risk for a site shall not exceed one in one hundred thousand (1×10^{-5}), and the total hazard index for substances with similar noncarcinogenic toxic effects shall not exceed one (WAC 173-340-705[4]) (Ecology 1996). Should the presence of multiple contaminants occur, WAC 173-340-705 (Ecology 1996) provides that Method B and C cleanup levels for individual substances must be modified in accordance with the human health risk assessment procedures outlined in WAC 173-340-708 (Ecology 1996) so that total excess lifetime cancer risk is less than 10^{-5} and the total hazard index is less than one. This modification of cleanup levels, if necessary, would take place during the verification of site cleanup following remediation. Calculation of cumulative excess cancer risk for comparison to a total excess cancer risk of 10^{-5} for detected nonradionuclides whose RDL or practical quantitation limit (PQL) is higher than the calculated cleanup level shall use the calculated cleanup level when analyses with "J" qualifiers or no qualifiers are available.

D.3 RADIONUCLIDE CLEANUP LEVELS

Soil radionuclide cleanup levels for the 300 Area of the Hanford Site are based upon determinations of individual radionuclide activities that will be protective of direct exposure dose (15 mrem/yr above background approximating the CERCLA risk range of 10^{-4} to 10^{-6}) and protective of groundwater and the Columbia River (a cumulative dose of 4 mrem/yr dose for photon and beta emitters, 20,000 pCi/L for tritium, 8 pCi/L for strontium-90, and 30 µg/L for total uranium). The RESidual RADioactivity (RESRAD) model was selected by the Tri-Parties as the dose assessment model for generating RAGs for radionuclide contaminants in soil and for verifying that concentrations remaining after remedial action achieve the 15 mrem/yr cleanup level. The RESRAD model was developed by Argonne National Laboratory (ANL 2001) to implement U.S. Department of Energy (DOE) guidelines for residual radioactive material in soil. The most current version of RESRAD will be used for conducting dose assessments.

D.3.1 Radionuclide Cleanup Levels For Direct Exposure

Single radionuclide soil concentrations corresponding to a 15 mrem/yr dose in a rural-residential scenario were calculated using RESRAD version 6.4 (ANL 2007) and the appropriate parameters from Appendix B, Table B-7a for an industrial land-use scenario and Table B-7b for an unrestricted land-use scenario. To perform the calculations, the parameters were entered into the RESRAD data menu, the radon gas exposure pathway was suppressed, a concentration in soil for each radionuclide was assigned (1,000 pCi/g), and appropriate times for calculations were selected. For the calculations, default times of 1, 3, 10, 30, 100, 300, and 1,000 years were used. The basic radiation dose limit of 15 mrem/yr was input to correspond to direct exposure in a rural-residential scenario. Values for some of the parameters in Tables B-7a and B-7b (e.g., thickness of the contaminated zone, thickness of the uncontaminated zone, and areal extent of the site) depend upon site-specific characteristics. For purposes of developing direct exposure cleanup levels to guide field excavation, generic values have been assumed such that the entire 4.6-m (15-ft)-thick shallow zone is assumed contaminated and the entire deep zone (assumed to be 12 m thick in the 300 Area generic site model) is assumed uncontaminated. No cover material is assumed to exist on top of the contaminated shallow zone.

After the RESRAD software was run, the summary report for radiological dose was accessed by viewing the RESRAD output document "summary.rep." The values provided in the RESRAD summary report under "Single Radionuclide Soil Guidelines," in the table headed "Summed Dose/Source Ratios and Single Radionuclide Soil Guidelines" copied into Table D-8 were examined. The concentration in the RESRAD output column headed by G(i, tmin) is the concentration (activity) of each radionuclide in soil corresponding to a 15 mrem/yr dose. These values were recorded in Table D-5, with an appropriate number of significant figures. The published and calculated radionuclide cleanup levels are compared against the Hanford Site soil background value and the RDL in Table D-7, for each radionuclide, to verify that the published or calculated soil concentrations corresponding to a 15 mrem/yr dose are not less than the background concentrations or the RDL. If a single radionuclide soil concentration corresponding to a 15 mrem/yr dose is less than background and/or the RDL the larger of the values becomes the cleanup level for remedial action per WAC 173-340-700(4)(d) and WAC 173-340-707(2) (Ecology 1996), respectively. The cleanup levels determined in this way are presented in columns 5 and 6 of Table D-7.

D.3.2 Radionuclide Cleanup Levels For Groundwater Protection

After remediation, residual radioactive and nonradioactive contaminants remaining in soil must be at such levels that concentrations of contaminants that could migrate through the soil column to groundwater do not exceed cleanup levels considered protective of groundwater. Protection of groundwater is intended to achieve RAGs derived from MCLs promulgated under the federal *National Primary Drinking Water Regulations* (40 CFR 141).

The average annual activity of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 mrem/yr, per 40 CFR 141.66. However, separate MCLs exist for strontium-90, tritium (H-3), radium-226, and radium-228. The MCLs for strontium-90 and tritium are 8 pCi/L and 20,000 pCi/L, respectively (40 CFR 141.66). The MCL for combined radium-226 and radium-228 is 5 pCi/L (40 CFR 141.66). The MCL for alpha-emitting radionuclides (excluding radon and uranium) is 15 pCi/L (40 CFR 141.66). However, the most stringent of 15 pCi/L MCL or 1/25th of the derived concentration guide from DOE Order 5400.5 is used as the limit for alpha-emitting radionuclides based on the 300-FF-2 ROD (EPA 2001).

The MCLs for all other man-made radionuclides (excluding radon and uranium) that would cause a 4-mrem/yr dose are calculated on the basis of a 2-L/day drinking water intake, using the 168-hour data listed in NBS Handbook 69 (NBS 1963). Using this guidance, the MCLs for many radionuclides have been calculated as shown in the *Soil Screening Guidance for Radionuclides: User's Guide* (EPA 2000). The MCL values obtained from EPA (2000) are used as noted in Table D-5. As appropriate, MCL values in Table D-5 are also cited from DOE Order 5400.5 and from 40 CFR 141.

Because uranium is naturally occurring, standards for man-made radionuclides do not apply to the uranium isotopes. A limit of 30 μg/L has been promulgated as the MCL for total uranium in groundwater in 40 CFR 141.66. This corresponds to a uranium activity of 21.2 pCi/L at the Hanford Site background distribution of uranium isotopes uranium-234, uranium-235, and uranium-238 (BHI 2001).

To determine the most conservative radionuclide soil concentrations for 300 Area groundwater and river protection using RESRAD, it is assumed that the entire thickness of the vadose zone is contaminated. The Columbia River protection RAGs for radionuclides are identical to the groundwater protection RAGs so the same soil cleanup levels will be protective of both groundwater and the river. To determine radionuclide activities in soil that are protective of groundwater for industrial land use, all exposure pathways in the RESRAD input file except the drinking water pathway are suppressed. To determine radionuclide activities in soil that are protective of groundwater for unrestricted land use, exposure pathways in the RESRAD input file for external gamma exposure, inhalation, soil ingestion and radon are suppressed. Pathways for ingestion of plants, meat, milk, aquatic foods, and drinking water are active. Appropriate input parameters including radionuclide K_d values (Table D-7) are entered into the RESRAD data menu; a concentration in soil for each radionuclide is assigned (1,000 pCi/g); and default times of 1, 3, 10, 30, 100, 300, and 1,000 years are used for the initial calculation. The basic radiation dose limit of 4 mrem/yr is input for groundwater protection.

The RESRAD software is run and the concentration report and graphical output for radionuclides in drinking water are accessed to determine which radionuclides do or do not reach groundwater in 1,000 years. The concentration report is accessed by viewing the file "concent.rep" in the RESRAD output. The graphical output for concentration of radionuclides in drinking water is accessed in the RESRAD version 6.4 Graphics Display (ANL 2007) by selecting:

Type: Concentration
Radionuclide: Individual
Media (Pathways): Drinking Water

If the drinking water concentration predicted in the concentration report and the graphical output displays zero for the full 1,000 years, the contaminant does not impact groundwater within 1,000 years. For industrial land use, the graphical output shows that technetium-99, tritium (H-3), and the uranium isotopes uranium-234, uranium-235, and uranium-238 are predicted to reach groundwater within 1,000 years. For unrestricted land use the graphical output shows that nickel-63, strontium-90, technetium-99, tritium (H-3), and the uranium isotopes uranium-234, uranium-235, and uranium-238 are predicted to reach groundwater within 1,000 years. The years of the maximum groundwater concentrations for these radionuclides are obtained from the RESRAD summary report for radiological dose in the RESRAD output table headed "Summed Dose/Source Ratios and Single Radionuclide Soil Guidelines." The year of maximum groundwater concentration for each radionuclide is in the column in Table D-9 headed by "tmin, years." For the current evaluation, the years of peak groundwater concentrations of cobalt-60, cesium-137, nickel-63, potassium-40, strontium-90, technetium-99, tritium (H-3), and the uranium isotopes uranium-234, uranium-235, and uranium-238 are shown in Table D-6.

The years of maximum concentration were entered as calculation times in the RESRAD calculation and the RESRAD software was rerun. For the current evaluation individual runs were performed for each radionuclide to avoid interference of daughter products. After the RESRAD software was rerun, the concentration report ("concent.rep" in the RESRAD output) was accessed and the predicted drinking water concentrations were read at the year of maximum dose and recorded in Table D-6. The soil activity of each of the radionuclides to meet groundwater MCLs was calculated using the drinking water concentration at the year of maximum dose. The soil activities to meet groundwater MCLs are calculated using the following relationship:

(Soil activity, pCi/g, to meet groundwater MCL) = (Input soil activity) x (MCL) / (Isotope drinking water concentration at peak year in the concentration report)

The soil activities calculated to meet groundwater RAGS in Table D-6 were entered into RESRAD and the software was rerun to determine that the predicted drinking water concentrations match the groundwater RAGs at the year of maximum dose for each radionuclide.

D.3.3 Summary of Determination of Radionuclide Cleanup Levels

Soil radionuclide cleanup levels are summarized in Table D-7. If the soil activity protective of groundwater is less than background or the PQL as represented by the RDL, the higher of these two values will be the cleanup level, per the Ecology (1996) revisions of WAC 173-340-700(4)(d) and WAC 173-340-707(2), respectively.

The single radionuclide soil concentrations corresponding to a 15 mrem/yr dose listed in column 4 of Table D -7 apply to the top 4.6 m (15 ft) below the surface and represent soil activities for individual radionuclides that would not pose an unacceptable dose to humans from direct exposure to contaminated waste/soil in the rural-residential land use scenario. These values would decrease based on the presence of cumulative effects if more than one radionuclide represented a significant share of the dose at the same waste site.

Radionuclides that are reported together (plutonium-239/240 and uranium-233/234) have cleanup levels based upon the predominant radionuclide, as described below.

- The calculated cleanup levels for plutonium-239 and plutonium-240 are so close together that analyses of contaminated soils will have higher associated errors than the differences in the cleanup levels. Therefore, the lower of the two values for plutonium-239 and plutonium-240 is used as the cleanup level for plutonium-239/240.
- Uranium-234 will be the predominant isotope of the pair uranium-233/234 in the 300 Area. Uranium-233 is effectively ignored for most applications because it will only be present in areas where irradiated thorium was processed, or in areas (none at the Hanford Site) specific to "use" of uranium-233. Therefore the value for uranium-234 is used as the cleanup level for the pair.

D.4 USING RESRAD FOR WASTE SITE RADIONUCLIDE CLEANUP VERIFICATION

The input parameters and assumptions used in RESRAD to generate the lookup values presented in this remedial design report/remedial action work plan are summarized in Tables B-7(a) and B-7(b). For the purpose of site cleanup verification, the RESRAD input values (e.g., the thickness of the contaminated zone, the thickness of the uncontaminated zone, and the size of the waste site) will be determined on a site-specific basis. RESRAD calculates all radionuclides in the decay chain (daughters) in calculating ingrowth and decay. It has not been determined if any daughters were present at the time of waste emplacement, but they would be insignificant dose contributors; therefore, estimated daughters are not included as input.

Values for some parameters (e.g., thickness of the contaminated zone, thickness of the uncontaminated zone, areal extent of the site, and leachability) depend on specific site characteristics. For purposes of developing lookup values to guide field excavation, generic values have been assumed; however, to verify whether a specific site has met cleanup goals, input values will be determined on a site-specific basis.

The general process will be to first determine the nature and extent of residual contamination (concentrations and thickness of contaminated zone[s]). This information will then be input to the RESRAD model to evaluate the direct exposure dose and the migration potential of contaminants. The specific process to determine the thickness of contaminated zone(s) and the associated contaminant profile will follow a hierarchy as shown in the following steps:

1. Assume worst case: Concentrations of residual contamination are assumed to be uniform from the bottom of the excavation to groundwater. If modeling using this assumption predicts that this is

	protective of groundwater and the river, no further evaluation will be performed.
2. Site-specific information:	Use process knowledge, historic sampling data, remediation data, etc., to determine the profile of residual contamination in soil. If modeling using this site-specific information is sufficient to predict that site conditions are protective of groundwater and the river, no further evaluation is required.
3. Analogous site information:	Compare the waste site to other sites for which profiles have been determined to see if appropriate analogies can be made. The factors considered could include site stratigraphy, depth to groundwater, volume of liquid disposed, and type of contaminants. If available analogous site information is sufficient, no further evaluation is required.
4. Subsurface sampling:	The safest, most cost-effective method (e.g., trenching, boreholes) will be used to obtain site-specific data. The data obtained from subsurface sampling are not intended to meet statistical criteria for representative sampling, but will provide a qualitative measure of the extent of contamination below the site. Location will be determined on a site-by-site basis by DOE using data collected during excavation.

It is anticipated that, through data collection in subsurface sampling events, information will be gained to determine if Option 4 is a viable option to verify the conceptual model to allow for site closeout. The Tri-Parties will evaluate the information to determine whether to continue this practice.

D.5 RESRAD VERSIONS HISTORY

The RESRAD versions history is available from the RESRAD Internet Website at (http://web.ead.anl.gov/resrad/home2/reshstry.cfm). This history is supplemented with notes presented at *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989) unit managers' meetings.

D.6 REFERENCES

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Table D-1. Development of 300 Area Unrestricted (Residential) Nonradionuclide Soil Cleanup Levels Protective of Groundwater. (6 Pages)

Contaminant	Residential Groundwater Cleanup Level (µg/L) [a]		Ground-water MCL [b] (µg/L)	Soil Cleanup Level based on "100 X Rule" [c] (mg/kg)	Back-ground (mg/kg)	RDL (mg/kg)	Residential Soil RAGs for Groundwater Protection (mg/kg)
	Carcinogen	Noncarcinogen					
Metals							
Antimony		6.40	6	0.6	5 [d]	0.6	5 [e]
Arsenic	0.0583	4.80	10	0.00583	6.5	10	20 [e]
Barium		3,200	2,000	200	132	2	200
Beryllium		32	4	0.4	1.51	0.5	1.51 [e]
Boron		3,200		320	NA	2	320
Cadmium		8.00	5	0.5	0.81 [d]	0.5	0.81 [e]
Chromium, Total		24,000	100	10	18.5	1	18.5 [e]
Chromium VI		48		4.8	NA	0.5	4.8
Cobalt		4.8		0.48	15.7	2	15.7 [e]
Copper		592	1,000	59.2	22.0	1	59.2
Lead			15	1.5	10.2	5	10.2 [e]
Lithium		32		3.2	33.5	2.5	33.5 [e]
Manganese		2,240	50	5	512	5	512 [e]
Mercury		4.80	2	0.2	0.33	0.2	0.33 [e]
Methyl Mercury		1.60		0.16	NA	NA	0.16
Molybdenum		80		8	NA	2	8
Nickel		320	100	10	19.1	4	19.1 [e]
Selenium		80	50	5	0.78 [d]	1	5
Silver		80	100	8	0.73	0.2	8
Strontium		9,600		960	NA	1	960
Tin		9,600		960	NA	10	960
Uranium (soluble salts)		48	30	3	3.21	1	53 [f]
Vanadium		112		11.2	85.1	2.5	85.1 [e]
Zinc		4,800	5,000	480	67.8	1	480
Inorganics and TPH							
Chloride			250,000	25,000	100	2	25,000
Cyanide		320	200	20	NA	0.5	20

Table D-1. Development of 300 Area Unrestricted (Residential) Nonradionuclide Soil Cleanup Levels Protective of Groundwater. (6 Pages)

Contaminant	Residential Groundwater Cleanup Level (µg/L) [a]		Groundwater MCL [b] (µg/L)	Soil Cleanup Level based on "100 X Rule" [c] (mg/kg)	Background (mg/kg)	RDL (mg/kg)	Residential Soil RAGs for Groundwater Protection (mg/kg)
	Carcinogen	Noncarcinogen					
Fluoride		960	4,000	96	2.81	5	96
Nitrate (as Nitrogen)		25,600	10,000	1,000	11.8	0.75	1,000
Nitrite (as Nitrogen)		1,600	1,000	100	NA	0.75	100
Sulfate			250,000	25,000	237	5	25,000
Sulfide				NA	NA	5	NA
TPH				200	NA	5	200
VOAs							
Acetone [g]		7,200		720	NA	0.02	720
Carbon Tetrachloride [g]	0.337	5.60	5	0.0337	NA	0.005	0.0337
Methylene Chloride [g]	5.83	480	5	0.5	NA	0.005	0.5
Toluene [g]		640	1,000	64	NA	0.005	64
Xylene [g]		1,600	10,000	160	NA	0.001	160
Semivolatiles							
Acenaphthene		960		96	NA	0.33	96
Acenaphthylene [h]		960		96	NA	0.33	96
Anthracene		2,400		240	NA	0.33	240
Benzo(a)anthracene	0.120			0.012	NA	0.015	0.015 [e]
Benzo(a)pyrene	0.0120		0.2	0.0012	NA	0.015	0.015 [e]
Benzo(b)fluoranthene	0.120			0.012	NA	0.015	0.015 [e]
Benzo(k)fluoranthene	0.120			0.012	NA	0.015	0.015 [e]
Benzo(g,h,i)perylene [h]		480		48	NA	0.33	48
Bis(2-chloro-1-methylethyl) ether	1.25			0.125	NA	0.33	0.33 [e]
Bis(2-chloroethoxy)methane [h]	0.0398			0.004	NA	0.33	0.33 [e]
Bis(2-chloroethyl) ether	0.0398			0.004	NA	0.33	0.33 [e]
Bis(2-ethylhexyl)phthalate	6.25	320	6	0.6	NA	0.33	0.6
Bromophenylphenyl ether; 4-				NA	NA	0.33	NA
Butylbenzylphthalate		3,200		320	NA	0.33	320
Carbazole	4.38			0.438	NA	0.33	0.438

Table D-1. Development of 300 Area Unrestricted (Residential) Nonradionuclide Soil Cleanup Levels Protective of Groundwater. (6 Pages)

Contaminant	Residential Groundwater Cleanup Level (µg/L) [a]		Groundwater MCL [b] (µg/L)	Soil Cleanup Level based on "100 X Rule" [c] (mg/kg)	Background (mg/kg)	RDL (mg/kg)	Residential Soil RAGs for Groundwater Protection (mg/kg)
	Carcinogen	Noncarcinogen					
Chloro-3-methylphenol; 4- [h]		800		80	NA	0.33	80
Chloroanilene; 4-		64		6.4	NA	0.33	6.4
Chloronaphthalene; 2-		640		64	NA	0.33	64
Chlorophenol;2-		40		4	NA	0.33	4
Chlorophenylphenyl ether; 4-				NA	NA	0.33	NA
Chrysene	1.2			0.12	NA	0.1	0.12
Dibenz(a,h)anthracene	0.12			0.012	NA	0.03	0.03 [e]
Dibenzofuran		32.0		3.20	NA	0.33	3.20
Dichlorobenzene; 1,2-		720	600	60	NA	0.33	60.0
Dichlorobenzene; 1,3-		240		24.0	NA	0.33	24.0
Dichlorobenzene; 1,4-	1.82		75	0.182	NA	0.33	0.33 [e]
Dichlorobenzidine; 3,3-	0.194			0.0194	NA	0.33	0.33 [e]
Dichlorophenol; 2,4-		48		4.80	NA	0.33	4.80
Diethylphthalate		12,800		1,280	NA	0.33	1,280
Dimethylphthalate		16,000		1,600	NA	0.33	1,600
Dimethylphenol; 2,4-		320		32.0	NA	0.33	32.0
Di-n-butylphthalate		1,600		160	NA	0.33	160
Di-n-octylphthalate		320		32	NA	0.33	32
Dinitro-2-methylphenol; 4,6-		1.60		0.160	NA	0.33	0.33 [e]
Dinitrophenol; 2,4-		32		3.20	NA	0.825	3.20
Dinitrotoluene; 2,4-		32		3.20	NA	0.33	3.20
Dinitrotoluene; 2,6-		16		1.60	NA	0.33	1.60
Ethylene glycol		3,200		320	NA	5	320
Fluoranthene		640		64	NA	0.33	64
Fluorene		640		64	NA	0.33	64
Hexachlorobenzene	0.0547	12.8	1	0.00547	NA	0.33	0.33 [e]
Hexachlorobutadiene	0.561	1.60		0.0561	NA	0.33	0.33 [e]
Hexachlorocyclopentadiene		96	50	5	NA	0.33	5

Table D-1. Development of 300 Area Unrestricted (Residential) Nonradionuclide Soil Cleanup Levels Protective of Groundwater. (6 Pages)

Contaminant	Residential Groundwater Cleanup Level (µg/L) [a]		Ground-water MCL [b] (µg/L)	Soil Cleanup Level based on "100 X Rule" [c] (mg/kg)	Back-ground (mg/kg)	RDL (mg/kg)	Residential Soil RAGs for Groundwater Protection (mg/kg)
	Carcinogen	Noncarcinogen					
Hexachloroethane	3.13	8		0.313	NA	0.33	0.313
Hydrazine	0.0146			0.00146	NA	0.33	0.33 [e]
Indeno(1,2,3-cd) pyrene	0.120			0.012	NA	0.33	0.33 [e]
Isophorone	92.1	3,200		9.21	NA	0.33	9.21
Methylnaphthalene; 2-		32		3.2	NA	0.33	3.2
Methylphenol; 2- (cresol;o-)		800		80	NA	0.33	80.0
Methylphenol; 4- (cresol;p-)		80		8.00	NA	0.33	8.00
Naphthalene		160		16	NA	0.33	16.0
Nitroaniline; 2-		24		2.4	NA	0.33	2.4
Nitroaniline; 3-	2.08	2.40		0.208	NA	0.33	0.33 [e]
Nitroaniline; 4-	2.08	24.0		0.208	NA	0.33	0.33 [e]
Nitrobenzene		16		1.6	NA	0.33	1.6
Nitrophenol; 2-				NA	NA	0.66	NA
Nitrophenol; 4-		128		12.8	NA	0.66	12.8
Nitroso-di-n-propylamine;N-	0.0125			0.00125	NA	0.33	0.33 [e]
Nitrosodiphenylamine;N-	17.9			1.79	NA	0.33	1.79
Pentachlorophenol	0.729	480	1	0.0729	NA	0.33	0.33 [e]
Phenanthrene [h]		2,400		240	NA	0.33	240
Phenol		4,800		480	NA	0.33	480
Pyrene		480		48	NA	0.33	48
Tributyl Phosphate	16.2	3,200		1.62	NA	3.3	3.3 [e]
Trichlorobenzene; 1,2,4-		80	70	7.0	NA	0.33	7
Trichlorophenol; 2,4,5-		1,600		160	NA	0.33	160
Trichlorophenol; 2,4,6-	7.95			0.795	NA	0.33	0.795
Pesticides, Herbicides, and PCBs							
Aldrin	0.00257	0.24		0.000257	NA	0.002	0.002 [e]
BHC, alpha	0.0139			0.00139	NA	0.002	0.002 [e]
BHC, beta (Hexachlorocyclohexane)	0.0486			0.00486	NA	0.002	0.00486

Table D-1. Development of 300 Area Unrestricted (Residential) Nonradionuclide Soil Cleanup Levels Protective of Groundwater. (6 Pages)

Contaminant	Residential Groundwater Cleanup Level (µg/L) [a]		Groundwater MCL [b] (µg/L)	Soil Cleanup Level based on "100 X Rule" [c] (mg/kg)	Background (mg/kg)	RDL (mg/kg)	Residential Soil RAGs for Groundwater Protection (mg/kg)
	Carcinogen	Noncarcinogen					
BHC, delta				NA	NA	0.00165	NA
BHC, gamma (Lindane)	0.0673	4.80	0.2	0.00673	NA	0.00165	0.00673
Chlordane (alpha, gamma)	0.25	8	2	0.025	NA	0.0165	0.025
Dalapon		480	200	20	NA	0.1	20
Db; 2,4-		128		12.8	NA	0.1	12.8
DDD, 4,4-	0.365			0.0365	NA	0.0033	0.0365
DDE, 4,4-	0.257			0.0257	NA	0.0033	0.0257
DDT, 4,4-	0.257	8.00		0.0257	NA	0.0033	0.0257
Dicambra		480		48	NA	0.1	48
Dichlorophenoxyacetic acid; 2,4-		160	70	7	NA	0.4	7
Dichloroprop [h]		128	70	7	NA	0.1	7
Dieldrin	0.00547	0.80		0.000547	NA	0.003	0.003 [e]
Dinoseb (DNBP)		16	7	0.7	NA	0.01	0.7
Endosulfan (I, II, sulfate)		96		9.6	NA	0.003	9.6
Endrin (and ketone, aldehyde)		4.8	2	0.2	NA	0.003	0.2
Heptachlor	0.0194	8	0.4	0.00194	NA	0.002	0.002 [e]
Heptachlor epoxide	0.00962	0.208	0.2	0.000962	NA	0.002	0.002 [e]
Methoxychlor		80	40	4	NA	0.02	4
Polychlorinated biphenyls [i]	0.0438		0.5	0.00438	NA	0.017	0.017 [e]
PCB Aroclor-1016	0.0438	1.12		0.00438	NA	0.017	0.017 [e]
PCB Aroclor-1221	0.0438			0.00438	NA	0.017	0.017 [e]
PCB Aroclor-1232	0.0438			0.00438	NA	0.017	0.017 [e]
PCB Aroclor-1242	0.0438			0.00438	NA	0.017	0.017 [e]
PCB Aroclor-1248	0.0438			0.00438	NA	0.017	0.017 [e]
PCB Aroclor-1254	0.0438	0.32		0.00438	NA	0.017	0.017 [e]
PCB Aroclor-1260	0.0438			0.00438	NA	0.017	0.017 [e]
Silvex (TP; 2,4,5-)		128	50	5	NA	0.02	5
Toxaphene	0.0795		3	0.00795	NA	0.2	0.2 [e]

Table D-1. Development of 300 Area Unrestricted (Residential) Nonradionuclide Soil Cleanup Levels Protective of Groundwater. (6 Pages)

Contaminant	Residential Groundwater Cleanup Level (µg/L) [a]		Groundwater MCL [b] (µg/L)	Soil Cleanup Level based on "100 X Rule" [c] (mg/kg)	Background (mg/kg)	RDL (mg/kg)	Residential Soil RAGs for Groundwater Protection (mg/kg)
	Carcinogen	Noncarcinogen					
Trichlorophenoxyacetic acid; 2,4,5-		160		16	NA	0.02	16

[a] Calculated using the appropriate formulas from Ecology (1996), WAC 173-340-720, with toxicity values updated through April 11, 2007, from the EPA Integrated Risk Information System (IRIS) at http://www.epa.gov/iris or from Oak Ridge National Laboratory's Risk Assessment Information System database on the Internet at http://risk.lsd.ornl.gov. Deep zone cleanup levels are the lower of soil values protective of groundwater and the river. Industrial and Unrestricted deep zone cleanup levels are identical because groundwater and river cleanup levels are based on MTCA Method B criteria. When deep zone cleanup levels are exceeded, site-specific RESRAD modeling will be performed to determine if constituent analyses are protective without irrigation for industrial land use and with irrigation for unrestricted land use.

[b] MCL (40 CFR 141) and secondary MCLs (40 CFR 143).

[c] Per WAC 173-340-740(3)(a)(ii)(A) (Ecology 1996) in effect at the time the 300-FF-2 ROD was approved, nonradioactive contaminant concentrations in soil equal to or less than 100 times the groundwater cleanup level are protective of groundwater. The following example calculation assumes unit density for soil: Y µg/L x 100 x 1 L/1,000 mL x 1 mL/1g x 1,000 g/1 kg x 1 mg/1,000 µg = 0.Y mg/kg.

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

[e] Where cleanup levels are less than background or RDLs, cleanup levels default to background or RDLs per Ecology (1996), WAC 173-340-700(4)(d) and WAC 173-340-707(2), respectively. The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement Project Managers.

[f] From the *Explanation of Significant Difference for the 300-FF-2 Operable Unit Record of Decision*, Table 1 (EPA 2004). Based on the calculated isotopic distribution of uranium in the 300 Area and a groundwater protective cleanup level of 37 pCi/g for total uranium, the corresponding uranium concentration is 53 mg/kg.

[g] Common laboratory contaminant unlikely to be found in soil. If detected in soil, all analyses of blanks, duplicates, and splits should be checked and the original soil sample reanalyzed.

[h] Toxicity data for these chemicals are not available. Cleanup levels are based on surrogate chemicals.
Contaminant: acenaphthylene; surrogate: acenaphthene
Contaminant: benzo(g,h,i)perylene; surrogate: pyrene
Contaminant: bis(2-chloroethoxyl)methane; surrogate: bis(2-chloroethyl)ether
Contaminant: chloro-3-methylphenol; 4-; surrogate: methylphenol; 3-
Contaminant: phenathrene; surrogate: anthracene
Contaminant: dichloroprop; surrogate: Dichlorophenoxyacetic acid; 2,4-; (2,4-D)

[i] The soil cleanup value for PCBs is based on the formula presented in WAC 173-340-740(3)(a)(iii)(B) (Ecology 1996) and the cancer potency factor for ingestion of PCBs of 2.0 kg-day/mg (high risk and persistence) from the EPA IRIS on the Internet at http://www.epa.gov/iris on January 3, 2006.

CFR = *Code of Federal Regulations*
EPA = U.S. Environmental Protection Agency
MCL = maximum contaminant level
NA = not available
PCB = polychlorinated biphenyl
RDL = required detection limit from "Statement of Work for Environmental and Waste Characterization Analytical Services," RFSH-SOW-93-0003, Rev. 6, February 1999, updated in 2004.
RAG = Remedial Action Goal
ROD = record of decision
TPH = total petroleum hydrocarbon
VOA = volatile organic analyte
WAC = *Washington Administrative Code*

Table D-2. Development of Unrestricted (Residential) Nonradionuclide Soil Cleanup Levels Protective of the Columbia River. (6 Pages)

Contaminant	Residential Surface Water Cleanup Level (µg/L) [a]		Surface Water AWQC [b] (µg/L)	Soil RAG based on "100 X DAF" [c] (mg/kg)	Back-ground (mg/kg)	RDL (mg/kg)	Residential Soil Cleanup Levels for River Protection (mg/kg)
	Carcinogen	Noncarcinogen					
Metals							
Antimony		1,040	14	2.8	5 [d]	0.6	5 [e]
Arsenic	0.0982	17.7	0.018	0.0036	6.5	10	20 [e]
Barium		2,000 (MCL)		400	132	2	400
Beryllium		273	4	0.8	1.51	0.5	1.51 [e]
Boron				NA	NA	2	NA
Cadmium		20.3	0.91	0.182	0.81 [d]	0.5	0.81 [e]
Chromium, Total		243,000	65	13	18.5	1	18.5 [e]
Chromium VI		486	10	2	NA	0.5	2
Cobalt				NA	15.7	2	NA
Copper		2,660	7.8	1.56	22.0	1	22.0 [e]
Lead			2.1	0.42	10.2	5	10.2 [e]
Lithium				NA	33.5	2.5	NA
Manganese				NA	512	5	512 [e]
Mercury			0.012	0.0024	0.33	0.2	0.33 [e]
Methyl Mercury				NA	NA	NA	NA
Molybdenum				NA	NA	2	NA
Nickel		1,100	137	27.4	19.1	4	27.4
Selenium		2,700	5	1	0.78 [d]	1	1
Silver		25,900	2.6	0.52	0.73	0.2	0.73 [e]
Strontium				NA	NA	1	NA
Tin				NA	NA	10	NA
Uranium (soluble salts)			30	3	3.21	1	106
Vanadium				NA	85.1	2.5	NA
Zinc		16,500	91	18.2	67.8	1	67.8 [e]
Inorganics and TPH							
Chloride				NA	100	2	NA
Cyanide		51,900	5.2	1.04	NA	0.5	1.04

Table D-2. Development of Unrestricted (Residential) Nonradionuclide Soil Cleanup Levels Protective of the Columbia River. (6 Pages)

Contaminant	Residential Surface Water Cleanup Level (µg/L) [a]		Surface Water AWQC [b] (µg/L)	Soil RAG based on "100 X DAF" [c] (mg/kg)	Back-ground (mg/kg)	RDL (mg/kg)	Residential Soil Cleanup Levels for River Protection (mg/kg)
	Carcinogen	Noncarcinogen					
Fluoride			2,000	400	2.81	5	400
Nitrate (as Nitrogen)		10,000		2,000	11.8	0.75	2,000
Nitrite (as Nitrogen)		1,000		200	NA	0.75	200
Sulfate				NA	237	5	NA
Sulfide				NA	NA	5	NA
TPH				200	NA	5	200
VOAs							
Acetone [f]				NA	NA	0.02	NA
Carbon Tetrachloride [f]	2.66	96.8	0.25	0.05	NA	0.005	0.05
Methylene Chloride [f]	960	173,000	4.70	0.94	NA	0.005	0.94
Toluene [f]		19,400	6,800	1,360	NA	0.005	1,360
Xylene [f]				NA	NA	0.001	NA
Semivolatiles							
Acenaphthene		643		129	NA	0.33	129
Acenaphthylene [g]		643		129	NA	0.33	129
Anthracene		25,900	9,600	1,920	NA	0.33	1,920
Benzo(a)anthracene	0.296		0.0028	0.00056	NA	0.015	0.015 [e]
Benzo(a)pyrene	0.0296		0.0028	0.00056	NA	0.015	0.015 [e]
Benzo(b)fluoranthene	0.296		0.0028	0.00056	NA	0.015	0.015 [e]
Benzo(k)fluoranthene	0.296		0.0028	0.00056	NA	0.015	0.015 [e]
Benzo(g,h,i)perylene [g]		2,590	960	192	NA	0.33	192
Bis(2-chloro-1-methylethyl) ether			37.5	7.50	NA	0.92	7.50
Bis(2-chloroethoxy)methane [g]	0.854			0.017	NA	0.33	0.33 [e]
Bis(2-chloroethyl) ether	0.854			0.017	NA	0.33	0.33 [e]
Bis(2-ethylhexyl)phthalate	3.56	399	1.8	0.36	NA	0.33	0.36
Bromophenylphenyl ether; 4-				NA	NA	0.33	NA
Butylbenzylphthalate		1,250		250	NA	0.33	250

Table D-2. Development of Unrestricted (Residential) Nonradionuclide Soil Cleanup Levels Protective of the Columbia River. (6 Pages)

Contaminant	Residential Surface Water Cleanup Level (µg/L)[a]		Surface Water AWQC[b] (µg/L)	Soil RAG based on "100 X DAF"[c] (mg/kg)	Back-ground (mg/kg)	RDL (mg/kg)	Residential Soil Cleanup Levels for River Protection (mg/kg)
	Carcinogen	Noncarcinogen					
Carbazole				NA	NA	0.33	NA
Chloro-3-methylphenol; 4-[g]				NA	NA	0.33	NA
Chloroanilene; 4-				NA	NA	0.33	NA
Chloronaphthalene; 2-		1,030		206	NA	0.33	206
Chlorophenol;2-		96.7		19.34	NA	0.33	19.34
Chlorophenylphenyl ether; 4-				NA	NA	0.33	NA
Chrysene	2.96		0.00280	0.00056	NA	0.1	0.1[e]
Dibenz(a,h)anthracene	0.296		0.00280	0.00056	NA	0.03	0.03[e]
Dibenzofuran				NA	NA	0.33	NA
Dichlorobenzene; 1,2-		4,200	2,700	540	NA	0.33	540
Dichlorobenzene; 1,3-		1,400	400	80	NA	0.33	80
Dichlorobenzene; 1,4-	4.86		400	0.972	NA	0.33	0.972
Dichlorobenzidine; 3,3-	0.0462		400	0.0080	NA	0.33	0.33[e]
Dichlorophenol; 2,4-		191	93	18.6	NA	0.33	18.6
Diethylphthalate		28,400	23,000	4,600	NA	0.33	4,600
Dimethylphthalate		72,000	313,000	14,400	NA	0.33	14,400
Dimethylphenol; 2,4-		553		110.6	NA	0.33	110.6
Di-n-butylphthalate		2,910	2,700	540	NA	0.33	540
Di-n-octylphthalate				NA	NA	0.33	NA
Dinitro-2-methylphenol; 4,6-				NA	NA	0.33	NA
Dinitrophenol; 2,4-		3,460	70	14.0	NA	0.825	14
Dinitrotoluene; 2,4-		1,360	0.110	0.022	NA	0.33	0.33[e]
Dinitrotoluene; 2,6-		682		136	NA	0.33	136
Ethylene glycol				NA	NA	5	NA
Fluoranthene		90.2		18.0	NA	0.33	18.0
Fluorene		3,460	1,300	260	NA	0.33	260
Hexachlorobenzene	0.000466	0.239	0.000750	0.0000932	NA	0.33	0.33[e]
Hexachlorobutadiene	29.9	187	0.440	0.088	NA	0.33	0.33[e]

Table D-2. Development of Unrestricted (Residential) Nonradionuclide Soil Cleanup Levels Protective of the Columbia River. (6 Pages)

Contaminant	Residential Surface Water Cleanup Level (µg/L) [a]		Surface Water AWQC [b] (µg/L)	Soil RAG based on "100 X DAF" [c] (mg/kg)	Back-ground (mg/kg)	RDL (mg/kg)	Residential Soil Cleanup Levels for River Protection (mg/kg)
	Carcinogen	Noncarcinogen					
Hexachlorocyclopentadiene		3,580	240	48	NA	0.33	48
Hexachloroethane	5.33	29.8	1.90	0.38	NA	0.33	0.38
Hydrazine				NA	NA	0.33	NA
Indeno(1,2,3-cd) pyrene	0.296		0.00280	0.00056	NA	0.33	0.33 [e]
Isophorone	1,560	118,000	8.40	1.68	NA	0.33	1.68
Methylnaphthalene; 2-				NA	NA	0.33	NA
Methylphenol; 2- (cresol;o-)				NA	NA	0.33	NA
Methylphenol; 4- (cresol;p-)				NA	NA	0.33	NA
Naphthalene		4,940		988	NA	0.33	988
Nitroaniline; 2-				NA	NA	0.33	NA
Nitroaniline; 3-				NA	NA	0.33	NA
Nitroaniline; 4-				NA	NA	0.33	NA
Nitrobenzene		1,790	17	3.4	NA	0.33	3.4
Nitrophenol; 2-				NA	NA	0.66	NA
Nitrophenol; 4-		6,270		1,254	NA	0.66	1,254
Nitroso-di-n-propylamine;N-	0.819			0.164	NA	0.33	0.33 [e]
Nitrosodiphenylamine;N-	9.73			1.946	NA	0.33	1.946
Pentachlorophenol	4.91	7,070	0.28	0.056	NA	0.33	0.33 [e]
Phenanthrene [g]		25,900	9,600	1,920	NA	0.33	1,920
Phenol		1,110,000	21,000	4,200	NA	0.33	4,200
Pyrene		2,590	960	192	NA	0.33	192
Tributyl Phosphate					NA	3.3	NA
Trichlorobenzene; 1,2,4-		227		45.4	NA	0.33	45.4
Trichlorophenol; 2,4,5-				NA	NA	0.33	NA
Trichlorophenol; 2,4,6-	3.93		2.10	0.42	NA	0.33	0.42
Pesticides, Herbicides, and PCBs							
Aldrin	0.0000816	0.0167	0.00013	0.0000163	NA	0.002	0.002 [e]
BHC, alpha	0.00791			0.00158	NA	0.002	0.002 [e]

Table D-2. Development of Unrestricted (Residential) Nonradionuclide Soil Cleanup Levels Protective of the Columbia River. (6 Pages)

Contaminant	Residential Surface Water Cleanup Level (µg/L) [a]		Surface Water AWQC [b] (µg/L)	Soil RAG based on "100 X DAF" [c] (mg/kg)	Back-ground (mg/kg)	RDL (mg/kg)	Residential Soil Cleanup Levels for River Protection (mg/kg)
	Carcinogen	Noncarcinogen					
BHC, beta (Hexachlorocyclohexane)	0.0277			0.00554	NA	0.002	0.00554
BHC, delta				NA	NA	0.00165	NA
BHC, gamma (Lindane)	0.0384	5.98	0.019	0.0038	NA	0.00165	0.0038
Chlordane (alpha, gamma)	0.00131	0.0919	0.00057	0.000114	NA	0.0165	0.0165 [e]
Dalapon				NA	NA	0.1	NA
Db; 2,4-				NA	NA	0.1	NA
DDD, 4,4-	0.000504		0.00083	0.000101	NA	0.0033	0.0033 [e]
DDE, 4,4-	0.000356		0.00059	0.0000712	NA	0.0033	0.0033 [e]
DDT, 4,4-	0.000356	0.0242	0.00059	0.0000712	NA	0.0033	0.0033 [e]
Dicambra				NA	NA	0.1	NA
Dichlorophenoxyacetic acid; 2,4-				NA	NA	0.4	NA
Dichloroprop [g]				NA	NA	0.1	NA
Dieldrin	0.0000867	0.0278	0.00014	0.0000173	NA	0.003	0.003 [e]
Dinoseb (DNBP)				NA	NA	0.01	NA
Endosulfan (I, II, sulfate)		57.6	0.056	0.0112	NA	0.003	0.0112
Endrin (and ketone, aldehyde)		0.196	0.76	0.039	NA	0.003	0.039
Heptachlor	0.000129	0.116	0.000210	0.00000258	NA	0.002	0.002 [e]
Heptachlor epoxide	0.0000636	0.00301	0.0001	0.00000127	NA	0.002	0.002 [e]
Methoxychlor		8.36		1.67	NA	0.02	1.67
Polychlorinated Biphenyls [h]	0.000104		0.00017	0.000021	NA	0.017	0.017 [e]
PCB Aroclor-1016	0.00297	0.00582		0.00059	NA	0.017	0.017 [e]
PCB Aroclor-1221	0.000104			0.000021	NA	0.017	0.017 [e]
PCB Aroclor-1232	0.000104			0.000021	NA	0.017	0.017 [e]
PCB Aroclor-1242	0.000104			0.000021	NA	0.017	0.017 [e]
PCB Aroclor-1248	0.000104			0.000021	NA	0.017	0.017 [e]
PCB Aroclor-1254	0.000104	0.00166		0.000021	NA	0.017	0.017 [e]
PCB Aroclor-1260	0.000104			0.000021	NA	0.017	0.017 [e]
Silvex (TP; 2,4,5-)					NA	0.02	NA

Table D-2. Development of Unrestricted (Residential) Nonradionuclide Soil Cleanup Levels Protective of the Columbia River. (6 Pages)

Contaminant	Residential Surface Water Cleanup Level (µg/L) [a]		Surface Water AWQC [b] (µg/L)	Soil RAG based on "100 X DAF" [c] (mg/kg)	Background (mg/kg)	RDL (mg/kg)	Residential Soil Cleanup Levels for River Protection (mg/kg)
	Carcinogen	Noncarcinogen					
Toxaphene	0.00045		0.0002	0.00004	NA	0.2	0.2 [e]
Trichlorophenoxyacetic acid; 2,4,5-					NA	0.02	NA

[a] Calculated using the appropriate formulas from Ecology (1996), WAC 173-340-730, with toxicity values updated through April 11, 2007, from the EPA Integrated Risk Information System (IRIS) at http://www.epa.gov/iris or from Oak Ridge National Laboratory's Risk Assessment Information System database on the Internet at http://risk.lsd.ornl.gov. Deep zone cleanup levels are the lower of soil values protective of groundwater and the river. Industrial and Unrestricted deep zone cleanup levels are identical because groundwater and river cleanup levels are based on MTCA Method B criteria. When deep zone cleanup levels are exceeded, site-specific RESRAD modeling will be performed to determine if constituent analyses are protective without irrigation for industrial land use and with irrigation for unrestricted land use.

[b] Ambient Water Quality Criteria (AWQC) or criterion continuous concentration from 40 CFR 131.36 and WAC 173-201A-040 calculated using water hardness of 85 ppm $CaCO_3$.

[c] The same methodology used to obtain contaminant concentrations in soil protective of groundwater was applied to obtain contaminant concentrations in soil protective of the Columbia River (i.e., 100 times the remedial action goal with application of a dilution-attenuation factor of 2).

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

[e] Where cleanup levels are less than background or RDLs, cleanup levels default to background or RDLs per Ecology (1996), WAC 173-340-700(4)(d) and WAC 173-340-707(2), respectively. The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement Project Managers.

[f] Common laboratory contaminant unlikely to be found in soil. If detected in soil, all analyses of blanks, duplicates, and splits should be checked and the original soil sample reanalyzed.

[g] Toxicity data for these chemicals are not available. Cleanup levels are based on surrogate chemicals.
Contaminant: acenaphthylene; surrogate: acenaphthene
Contaminant: benzo(g,h,i)perylene; surrogate: pyrene
Contaminant: bis(2-chloroethoxyl)methane; surrogate: bis(2-chloroethyl)ether
Contaminant: chloro-3-methylphenol; 4-; surrogate: methylphenol; 3-
Contaminant: phenathrene; surrogate: anthracene
Contaminant: dichloroprop; surrogate: Dichlorophenoxyacetic acid; 2,4-; (2,4-D)

[h] The soil cleanup value for PCBs is based on the formula presented in WAC 173-340-740(3)(a)(iii)(B), Ecology (1996), and the cancer potency factor for ingestion of PCBs of 2.0 kg-day/mg (high risk and persistence) from the EPA IRIS on the Internet at http://www.epa.gov/iris on January 3, 2006.

CFR = *Code of Federal Regulations*
DAF = dilution-attenuation factor
EPA = U.S. Environmental Protection Agency
MCL = maximum contaminant level
NA = not available
PCB = polychlorinated biphenyl
RAG = remedial action goal
RDL = required detection limit
TPH = total petroleum hydrocarbon
VOA = volatile organic analyte
WAC = *Washington Administrative Code*

Table D-3. Development of 300 Area Nonradionuclide Direct Exposure Cleanup Levels (6 Pages).

Contaminant	Back-ground (mg/kg)	RDL (mg/kg)	Industrial Direct Exposure Cleanup Levels (mg/kg)[a]			Unrestricted Direct Exposure Cleanup Levels (mg/kg)[a]		
			Carcin-ogen	Noncar-cinogen	Overall	Carcin-ogen	Noncar-cinogen	Overall
Metals								
Antimony	5[b]	0.6		1,400	1,400		32[c]	32[c]
Arsenic	6.5	10	58	1,050	58	0.667	24	20[c]
Barium	132	2	4,900[d]	700,000	4,900[d]	1,600[c]	16,000	1,600[c]
Beryllium	1.51	0.5	104[d]	7,000	104[d]	10.4[d]	160	10.4[d]
Boron	NA	2		700,000	700,000		16,000	16,000
Cadmium	0.81[b]	0.5	139[d]	3,500	139[d]	13.9[d]	80	13.9[d]
Chromium, Total	18.5	1		5.25E+06	5.25E+06		120,000	120,000
Chromium VI	NA	0.5	21[d]	10,500	21[d]	2.1[d]	240	2.1[d]
Cobalt	15.7	2		1,050	1,050		24	24
Copper	22.0	1		130,000	130,000		2,960[c]	2,960[c]
Lead	10.2	5		1,000	1,000		353[d]	353[d]
Lithium	33.5	2.5		7,000	7,000		160	160
Manganese	512	5		165,000	165,000		3,760	3,760
Mercury	0.33	0.2		1,050	1,050		24	24
Methyl Mercury	NA	NA		350	350		8	8
Molybdenum	NA	2		17,500	17,500		400	400
Nickel	19.1	4		70,000	70,000		1,600[c]	1,600[c]
Selenium	0.78[b]	1		17,500	17,500		400	400
Silver	0.73	0.2		17,500	17,500		400	400
Strontium	NA	1		2.10E+06	2.10E+06		48,000[c]	48,000[c]
Tin	NA	10		2.10E+06	2.10E+06		48,000[c]	48,000[c]
Uranium	3.21	1		505[e]	505[e]		81[f]	81[f]
Vanadium	85.1	2.5		24,500	24,500		560[c]	560[c]
Zinc	67.8	1		1.05E+06	1.05E+06		24,000[c]	24,000[c]
Inorganics and TPH								
Chloride	100	2		NA	NA		NA	NA
Cyanide	NA	0.5		70,000	70,000		1,600	1,600

Table D-3. Development of 300 Area Nonradionuclide Direct Exposure Cleanup Levels (6 Pages).

Contaminant	Back-ground (mg/kg)	RDL (mg/kg)	Industrial Direct Exposure Cleanup Levels (mg/kg) [a]			Unrestricted Direct Exposure Cleanup Levels (mg/kg) [a]		
			Carcin-ogen	Noncar-cinogen	Overall	Carcin-ogen	Noncar-cinogen	Overall
Fluoride	2.81	5		210,000	210,000		4,800	4,800
Nitrate (as Nitrogen)	11.8	0.75		5.60E+06	5.60E+06		8,000 [c]	8,000 [c]
Nitrite (as Nitrogen)	NA	0.75		350,000	350,000		8,000 [c]	8,000 [c]
Sulfate	237	5		NA	NA		NA	NA
Sulfide	NA	5		NA	NA		NA	NA
TPH	NA	5		200	200		200	200
VOAs								
Acetone [g]	NA	0.02		3.15E+06	3.15E+06		72,000	72,000
Carbon Tetrachloride [g]	NA	0.005	1,010	2,450	1,010	7.69	56	7.69
Methylene Chloride [g]	NA	0.005	17,500	210,000	17,500	133	4,800	133
Toluene [g]	NA	0.005		28,000	28,000		6,400	6,400
Xylene [g]	NA	0.001		700,000	700,000		16,000	16,000
Semivolatiles								
Acenaphthene	NA	0.33		210,000	210,000		4,800	4,800
Acenaphthylene [h]	NA	0.33		210,000	210,000		4,800	4,800
Anthracene	NA	0.33		1.05E+06	1.05E+06		24,000	24,000
Benzo(a)anthracene	NA	0.33	180		180	1.37		1.37
Benzo(a)pyrene	NA	0.33	18		18	0.137		0.137
Benzo(b)fluoranthene	NA	0.33	180		180	1.37		1.37
Benzo(k)fluoranthene	NA	0.33	180		180	1.37		1.37
Benzo(g,h,i)perylene [h]	NA	0.33		105,000	105,000		2,400	2,400
Bis(2-chloro-1-methylethyl) ether	NA	0.92	1,880		1,880	14.3		14.3
Bis(2-chloroethoxy)methane [h]	NA	0.33	119		119	0.909		0.909
Bis(2-chloroethyl) ether	NA	0.33	119		119	0.909		0.909
Bis(2-ethylhexyl)phthalate	NA	0.33	9,380	70,000	9,380	71.4	1,600	71.4
Bromophenylphenyl ether; 4-	NA	0.33	NA		NA		NA	NA
Butylbenzylphthalate	NA	0.33		700,000	700,000		16,000	16,000
Carbazole	NA	0.33	6,560		6,560	50		50
Chloro-3-methylphenol; 4- [h]	NA	0.33		175,000	175,000		4,000	4,000
Chloroanilene; 4-	NA	0.33		14,000	14,000		320	320

Table D-3. Development of 300 Area Nonradionuclide Direct Exposure Cleanup Levels (6 Pages).

Contaminant	Back-ground (mg/kg)	RDL (mg/kg)	Industrial Direct Exposure Cleanup Levels (mg/kg) [a]			Unrestricted Direct Exposure Cleanup Levels (mg/kg) [a]		
			Carcin-ogen	Noncar-cinogen	Overall	Carcin-ogen	Noncar-cinogen	Overall
Chloronaphthalene; 2-	NA	0.33		280,000	280,000		6,400	6,400
Chlorophenol;2-	NA	0.33		17,500	17,500		400	400
Chlorophenylphenyl ether; 4-	NA	0.33		NA	NA		NA	NA
Chrysene	NA	0.33	1,800		1,800	13.7		13.7
Dibenz(a,h)anthracene	NA	0.33	180		180	1.37		1.37
Dibenzofuran	NA	0.33		7,000	7,000		160	160
Dichlorobenzene; 1,2-	NA	0.33		315,000	315,000		7,200	7,200
Dichlorobenzene; 1,3-	NA	0.33		105,000	105,000		2,400	2,400
Dichlorobenzene; 1,4-	NA	0.33	5,470	70,000	5,470	41.7	1,600	41.7
Dichlorobenzidine; 3,3-	NA	0.33	292		292	2.22		2.22
Dichlorophenol; 2,4-	NA	0.33		10,500	10,500		240	240
Diethylphthalate	NA	0.33		2.80E+06	2.80E+06		64,000	64,000
Dimethylphthalate	NA	0.33		3.50E+06	3.50E+06		80,000	80,000
Dimethylphenol; 2,4-	NA	0.33		70,000	70,000		1,600	1,600
Di-n-butylphthalate	NA	0.33		350,000	350,000		8,000	8,000
Di-n-octylphthalate	NA	0.33		70,000	70,000		1,600	1,600
Dinitro-2-methylphenol; 4,6-	NA	0.33		350	350		8.00	8.00
Dinitrophenol; 2,4-	NA	0.825		7,000	7,000		160	160
Dinitrotoluene; 2,4-	NA	0.33		7,000	7,000		160	160
Dinitrotoluene; 2,6-	NA	0.33		3,500	3,500		80.0	80.0
Ethylene glycol	NA	5		7.00E+06	7.00E+06		160,000	160,000
Fluoranthene	NA	0.33		140,000	140,000		3,200	3,200
Fluorene	NA	0.33		140,000	140,000		3,200	3,200
Hexachlorobenzene	NA	0.33	82	2,800	82	0.625	64	0.625
Hexachlorobutadiene	NA	0.33	1,680	700	700	12.8	16	12.8
Hexachlorocyclopentadiene	NA	0.33		21,000	21,000		480	480
Hexachloroethane	NA	0.33	9,380	3,500	3,500	71.4	80	71.4
Hydrazine	NA	0.33	43.8		43.8	0.333		0.333
Indeno(1,2,3-cd) pyrene	NA	0.33	180		180	1.37		1.37
Isophorone	NA	0.33	138,000	700,000	138,000	1,050	16,000	1,050

Table D-3. Development of 300 Area Nonradionuclide Direct Exposure Cleanup Levels (6 Pages).

Contaminant	Back-ground (mg/kg)	RDL (mg/kg)	Industrial Direct Exposure Cleanup Levels (mg/kg) [a]			Unrestricted Direct Exposure Cleanup Levels (mg/kg) [a]		
			Carcin-ogen	Noncar-cinogen	Overall	Carcin-ogen	Noncar-cinogen	Overall
Methylnaphthalene; 2-	NA	0.33		14,000	14,000		320	320
Methylphenol; 2- (cresol;o-)	NA	0.33		175,000	175,000		4,000	4,000
Methylphenol; 4- (cresol;p-)	NA	0.33		17,500	17,500		400	400
Naphthalene	NA	0.33		70,000	70,000		1,600	1,600
Nitroaniline; 2-	NA	0.33		105,000	105,000		240	240
Nitroaniline; 3-	NA	0.33	6,250	1,050	1,050	47.6	24	24
Nitroaniline; 4-	NA	0.33	6,250	10,500	6,250	47.6	240	47.6
Nitrobenzene	NA	0.33		7,000	7,000		160	160
Nitrophenol; 2-	NA	0.66		NA	NA		NA	NA
Nitrophenol; 4-	NA	0.66		28,000	28,000		640	640
Nitroso-di-n-propylamine;N-	NA	0.33	18.8		18.8	0.143		0.33 [i]
Nitrosodiphenylamine;N-	NA	0.33	26,800		26,800	204		204
Pentachlorophenol	NA	0.33	1,090	105,000	1,090	8.33	2,400	8.33
Phenanthrene [h]	NA	0.33		1.05E+06	1.05E+06		24,000	24,000
Phenol	NA	0.33		1.05E+06	1.05E+06		24,000	24,000
Pyrene	NA	0.33		105,000	105,000		2,400	2,400
Tributyl Phosphate	NA	3.3	24,300	700,000	24,300	185	16,000	185
Trichlorobenzene; 1,2,4-	NA	0.33		35,000	35,000		800	800
Trichlorophenol; 2,4,5-	NA	0.33		350,000	350,000		8,000	8,000
Trichlorophenol; 2,4,6-	NA	0.33	11,900		11,900	90.9		90.9
Pesticides and PCBs								
Aldrin	NA	0.00165	7.72	105	7.72	0.0588	2.40	0.0588
BHC, alpha	NA	0.00165	20.8		20.8	0.159		0.159
BHC, beta	NA	0.00165	72.9		72.9	0.556		0.556
BHC, delta	NA	0.00165	NA		NA	NA		NA
BHC, gamma (Lindane)	NA	0.00165	101	1,050	101	0.769	24	0.769
Chlordane (alpha, gamma)	NA	0.0165	375	1,750	375	2.86	40	2.86
Dalapon	NA	0.1		105,000	105,000		2,400	2,400
Db; 2,4-	NA	0.1		28,000	28,000		640	640
DDD, 4,4'-	NA	0.0033	547		547	4.17		4.17

Table D-3. Development of 300 Area Nonradionuclide Direct Exposure Cleanup Levels (6 Pages).

Contaminant	Back-ground (mg/kg)	RDL (mg/kg)	Industrial Direct Exposure Cleanup Levels (mg/kg) [a]			Unrestricted Direct Exposure Cleanup Levels (mg/kg) [a]		
			Carcin-ogen	Noncar-cinogen	Overall	Carcin-ogen	Noncar-cinogen	Overall
DDE, 4,4'-	NA	0.0033	386		386	2.94		2.94
DDT, 4,4'-	NA	0.0033	386	1,750	386	2.94	40	2.94
Dicambra	NA	0.1		105,000	105,000		2,400	2,400
Dichlorophenoxyacetic acid; 2,4-	NA	0.4		35,000	35,000		640	640
Dichloroprop [h]	NA	0.1		35,000	35,000		800	800
Dieldrin	NA	0.003	8.2	175	8.2	0.0625	4	0.0625
Dinoseb (DNBP)	NA	0.01		3,500	3,500		80	80
Endosulfan (I, II, sulfate)	NA	0.003		21,000	21,000		480	480
Endrin (and ketone, aldehyde)	NA	0.003		1,050	1,050		24	24
Heptachlor	NA	0.002	29.2	1,750	29.2	0.222	40	0.222
Heptachlor epoxide	NA	0.002	14.4	45.5	14.4	0.11	1.04	0.11
Methoxychlor	NA	0.02		17,500	17,500		400	400
Polychlorinated Biphenyls [j]	NA	0.017	65.6		65.6	0.5		0.5
PCB Aroclor-1016	NA	0.017	65.6	245	65.6	14.3	5.6	5.6
PCB Aroclor-1221	NA	0.017	65.6		65.6	0.5		0.5
PCB Aroclor-1232	NA	0.017	65.6		65.6	0.5		0.5
PCB Aroclor-1242	NA	0.017	65.6		65.6	0.5		0.5
PCB Aroclor-1248	NA	0.017	65.6		65.6	0.5		0.5
PCB Aroclor-1254	NA	0.017	65.6	70.0	65.6	0.5	1.6	0.5
PCB Aroclor-1260	NA	0.017	65.6		65.6	0.5		0.5
Silvex (tp;2,4,5-)	NA	0.02		28,000	28,000		640	640
Toxaphene	NA	0.2	119		119	0.909		0.909

Table D-3. Development of 300 Area Nonradionuclide Direct Exposure Cleanup Levels (6 Pages).

Contaminant	Background (mg/kg)	RDL (mg/kg)	Industrial Direct Exposure Cleanup Levels (mg/kg)[a]			Unrestricted Direct Exposure Cleanup Levels (mg/kg)[a]		
			Carcinogen	Noncarcinogen	Overall	Carcinogen	Noncarcinogen	Overall
Trichlorophenoxyacetic acid; 2,4,5-	NA	0.02		35,000	35,000		800	800

[a] Calculated using the appropriate formulas from Ecology (1996), WAC 173-340-740, with toxicity values updated through October 2008, from the EPA Integrated Risk Information System (IRIS) at http://www.epa.gov/iris or from Oak Ridge National Laboratory's Risk Assessment Information System database on the Internet at http://risk.lsd.ornl.gov.

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

[c] Value is from the *Explanation of Significant Differences from the 300-FF-2 Operable Unit Record of Decision* (EPA 2004). 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 DOE-RL (2005).

[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). Lead direct exposure cleanup levels are calculated using *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children* (EPA 1994).

[e] Based on the calculated isotopic distribution of uranium in the 300 Area and an activity-based industrial direct exposure cleanup level of 350 pCi/g for total uranium, the corresponding mass-based uranium concentration is 505 mg/kg (BHI 2002) for 300-FF-2 Operable Unit sites.

[f] Value is from the *Explanation of Significant Difference for the 300-FF-2 Operable Unit Record of Decision*, Table 1 (EPA 2004). Based on the calculated isotopic distribution of uranium in the 300 Area, the activity-based direct exposure cleanup level of 56 pCi/g corresponding to a dose rate of 15 mrem/yr is equivalent to a mass-based uranium concentration of 81 mg/kg.

[g] Common laboratory contaminant unlikely to be found in soil. If detected in soil, all analyses of blanks, duplicates, and splits should be checked and the original soil sample reanalyzed.

[h] Toxicity data for these chemicals are not available. Cleanup levels are based on surrogate chemicals:
Contaminant: acenaphthylene; surrogate: acenaphthene
Contaminant: benzo(g,h,i)perylene; surrogate: pyrene
Contaminant: bis(2-chloroethoxyl)methane; surrogate: bis(2-chloroethyl)ether
Contaminant: chloro-3-methylphenol; 4-; surrogate: methylphenol; 3-
Contaminant: dichloroprop (pesticide); surrogate: Dichlorophenoxyacetic acid; 2,4-; (2,4-D)
Contaminant: phenathrene; surrogate: anthracene

[i] Where cleanup levels are less than background or RDLs, cleanup levels default to background or RDLs per Ecology (1996), WAC 173-340-700(4)(d) and WAC 173-340-707(2), respectively.

[j] The soil cleanup value for PCBs is based on the formula presented in WAC 173-340-740(3)(a)(iii)(B), Ecology (1996), and the cancer potency factor for ingestion of PCBs of 2.0 kg-day/mg (soils) from the EPA IRIS on the Internet at http://www.epa.gov/iris on January 3, 2006.

EPA = U.S. Environmental Protection Agency
NA = not available
PCB = polychlorinated biphenyl
RDL = required detection limit
TPH = total petroleum hydrocarbon
VOA = volatile organic analyte
WAC = *Washington Administrative Code*

Table D-4. Summary of 300 Area Industrial and Unrestricted Nonradionuclide Cleanup Levels. (6 Pages)

Contaminant	CAS Number	K_d Value (mL/g)	Back-ground (mg/kg)	Soil Cleanup Levels (mg/kg) [a]			
				Industrial Direct Exposure	Residential Direct Exposure	Residential Protective of Groundwater	Residential Protective of the River
Metals							
Antimony	7440-36-0	45	5 [b]	1,400	32 [c]	5 [d]	5 [d]
Arsenic	7440-38-2	3	6.5	58 [e]	20 [d]	20 [d]	20 [d]
Barium	7440-39-3	25	132	4,900 [e]	1,600 [e]	200 [f]	400 [f]
Beryllium	7440-41-7	790	1.51	104 [e]	10.4 [e]	1.51 [d]	1.51 [d]
Boron	7440-42-8	3	NA	700,000	16,000 [g]	320	NA
Cadmium	7440-43-9	30	0.81 [b]	139 [e]	13.9 [e]	0.81 [d]	0.81 [d]
Chromium, Total	16065-83-1	200	18.5	5.25E+06	120,000 [f]	18.5 [d]	18.5 [d]
Chromium VI	18540-29-9	0	NA	21 [e]	2.1 [e]	4.8	2
Cobalt	7440-48-4	50	15.7	1,050	24	15.7 [d]	NA
Copper	7440-50-8	22	22.0	130,000	2,960 [g]	59.2	22.0 [d]
Lead	7439-92-1	30	10.2	1,000	353 [h]	10.2 [d]	10.2 [d]
Lithium	7439-93-2	50	33.5	7,000	160	33.5 [d]	NA
Manganese	7439-96-5	50	512	165,000	3,760	512 [d]	512 [c]
Mercury	7439-97-6	30	0.33	1,050	24 [b]	0.33 [d]	0.33 [d]
Methyl mercury	22967-92-6	NA	NA	350	8 [g]	0.16 [g]	NA
Molybdenum	7439-98-7	20	NA	17,500	400 [g]	8	NA
Nickel	7440-02-0	65	19.1	70,000	1,600 [g]	19.1 [d]	27.4
Selenium	7782-49-2	5	0.78 [b]	17,500	400 [c]	5	1
Silver	7440-22-4	90	0.73	17,500	400 [c]	8	0.73 [d]
Strontium	7440-24-6	25	NA	2.10E+06	48,000	960	NA
Tin	7440-31-5	130	NA	2.10E+06	48,000	960	NA
Uranium	7440-61-1	8.9	3.21	505	81	53	106
Vanadium	7440-62-2	1,000	85.1	24,500	560 [g]	85.1 [d]	NA
Zinc	7440-66-6	30	67.8	1.05E+06	24,000 [c]	480	67.8 [d]
Inorganics and TPH							
Chloride	16887-006	0	100	NA	NA	25,000	NA
Cyanide	57-12-5	0	NA	70,000	1,600 [g]	20	1.04
Fluoride	16984-48-8	150	2.81	210,000	4,800	96	400

Table D-4. Summary of 300 Area Industrial and Unrestricted Nonradionuclide Cleanup Levels. (6 Pages)

Contaminant	CAS Number	K_d Value (mL/g)	Background (mg/kg)	Soil Cleanup Levels (mg/kg)[a]			
				Industrial Direct Exposure	Residential Direct Exposure	Residential Protective of Groundwater	Residential Protective of the River
Nitrate (as Nitrogen)	14797-55-8	0	11.8	5.60E+06	8,000	1,000	2,000
Nitrite (as Nitrogen)	14797-65-0	0	NA	350,000	8,000	100	200
Sulfate	14808-79-8	0	237	NA	NA	25,000	NA
Sulfide	18496-25-8	0	NA	NA	NA	NA	NA
TPH	NA	50	NA	200	200	200	200
VOAs							
Acetone[i]	67-64-1	0.0006	NA	3.15E+06	72,000[g]	720	NA
Carbon Tetrachloride[i]	56-23-5	0.152	NA	1,010	7.69[j]	0.0337	0.05
Methylene Chloride[i]	75-09-2	0.01	NA	17,500	133[j]	0.5	0.94
Toluene[i]	108-88-3	0.14	NA	28,000	6,400[g]	64	1,360
Xylene[i]	1330-20-7	0.233	NA	700,000	16,000	160	NA
Semivolatiles							
Acenaphthene	83-32-9	4.9	NA	210,000	4,800[g]	96	129
Acenaphthylene[k]	208-96-8	6.12	NA	210,000	4,800[g]	96	129
Anthracene	120-12-7	23.5	NA	1.05E+06	24,000[g]	240	1,920
Benzo(a)anthracene	56-55-3	360	NA	180	1.37[f]	0.015[d]	0.015[d]
Benzo(a)pyrene	50-32-8	5,500	NA	18	0.137	0.015[d]	0.015[d]
Benzo(b)fluoranthene	205-99-2	1,230	NA	180	1.37[f]	0.015[d]	0.015[d]
Benzo(k)fluoranthene	207-08-9	1,230	NA	180	1.37[f]	0.015[d]	0.015[d]
Benzo(g,h,i)perylene[k]	191-24-2	2,680	NA	105,000	2,400[g]	48	192
Bis(2-chloro-1-methylethyl) ether	108-60-1	0.0392	NA	1,880	14.3[j]	0.33[d]	7.50
Bis(2-chloroethoxy)methane[k]	111-91-1	0.00277	NA	119	0.909[j]	0.33[d]	0.33[d]
Bis(2-chloroethyl) ether	111-44-4	0.0760	NA	119	0.909[j]	0.33[d]	0.33[d]
Bis(2-ethylhexyl)phthalate	117-81-7	110	NA	9,380	71.4	0.6	0.36
Bromophenylphenyl ether; 4-	101-55-3	4.16	NA	NA	NA	NA	NA
Butylbenzylphthalate	85-68-7	13.8	NA	700,000	16,000[g]	320	250
Carbazole	86-74-8	200	NA	6,560	50[j]	0.438	NA
Chloro-3-methylphenol; 4-[k]	59-50-7	NA	NA	175,000	4,000[g]	80	NA
Chloroanilene; 4-	106-47-8	0.0725	NA	14,000	320[g]	6.4	NA

Table D-4. Summary of 300 Area Industrial and Unrestricted Nonradionuclide Cleanup Levels. (6 Pages)

Contaminant	CAS Number	K_d Value (mL/g)	Back-ground (mg/kg)	Soil Cleanup Levels (mg/kg) [a]			
				Industrial Direct Exposure	Residential Direct Exposure	Residential Protective of Groundwater	Residential Protective of the River
Chloronaphthalene; 2-	91-58-7	2.98	NA	280,000	6,400 [g]	64	206
Chlorophenol;2-	95-57-8	0.388	NA	17,500	400 [g]	4	19.34
Chlorophenylphenyl ether; 4-	7005-72-3	NA	NA	NA	NA	NA	NA
Chrysene	218-01-9	200	NA	1,800	13.7 [f]	0.12 [f]	0.1 [f]
Dibenz(a,h)anthracene	53-70-3	1,790	NA	180	1.37 [f]	0.03 [d]	0.03 [d]
Dibenzofuran	132-64-9	11.3	NA	7,000	160 [g]	3.20	NA
Dichlorobenzene; 1,2-	95-50-1	0.379	NA	315,000	7,200 [g]	60.0	540
Dichlorobenzene; 1,3-	541-73-1	0.434	NA	105,000	2,400 [g]	24.0	80
Dichlorobenzene; 1,4-	106-46-7	0.616	NA	5,470	41.7 [j]	0.33 [d]	0.972
Dichlorobenzidine; 3,3-	91-94-1	0.724	NA	292	2.22 [j]	0.33 [d]	0.33 [d]
Dichlorophenol; 2,4-	120-83-2	0.147	NA	10,500	240 [g]	4.80	18.6
Diethylphthalate	84-66-2	0.0820	NA	2.80E+06	64,000 [g]	1,280	4,600
Dimethylphthalate	131-11-3	0.0371	NA	3.50E+06	80,000 [g]	1,600	14,400
Dimethylphenol; 2,4-	105-67-9	0.209	NA	70,000	1,600 [g]	32.0	110.6
Di-n-butylphthalate	84-74-2	1.57	NA	350,000	8,000 [g]	160	540
Di-n-octylphthalate	117-84-0	83,200	NA	70,000	1,600 [g]	32	NA
Dinitro-2-methylphenol; 4,6-	534-52-1	0.6015	NA	350	8.00 [g]	0.33 [d]	NA
Dinitrophenol; 2,4-	51-28-5	0.00001	NA	7,000	160 [g]	3.20	14
Dinitrotoluene; 2,4-	121-14-2	0.0955	NA	7,000	160 [g]	3.20	0.33 [d]
Dinitrotoluene; 2,6-	606-20-2	0.0692	NA	3,500	80.0 [g]	1.60	136
Ethylene glycol	107-21-1	0.001	NA	7.00E+06	160,000	320	NA
Fluoranthene	206-44-0	49.1	NA	140,000	3,200 [g]	64	18.0
Fluorene	86-73-7	7.71	NA	140,000	3,200 [g]	64	260
Hexachlorobenzene	118-74-1	80	NA	82	0.625 [j]	0.33 [d]	0.33 [d]
Hexachlorobutadiene	87-68-3	53.7	NA	700	12.8 [j]	0.33 [d]	0.33 [d]
Hexachlorocyclopentadiene	77-47-4	200	NA	21,000	480 [g]	5	48
Hexachloroethane	67-72-1	1.78	NA	3,500	71.4 [j]	0.313	0.38
Hydrazine	302-01-2	0.0143	NA	43.8	0.333 [j]	0.33 [d]	NA
Indeno(1,2,3-cd) pyrene	193-39-5	3,470	NA	180	1.37 [j]	0.33 [d]	0.33 [d]
Isophorone	78-59-1	0.0468	NA	138,000	1,050 [j]	9.21	1.68

Table D-4. Summary of 300 Area Industrial and Unrestricted Nonradionuclide Cleanup Levels. (6 Pages)

Contaminant	CAS Number	K_d Value (mL/g)	Back-ground (mg/kg)	Soil Cleanup Levels (mg/kg) [a]			
				Industrial Direct Exposure	Residential Direct Exposure	Residential Protective of Groundwater	Residential Protective of the River
Methylnaphthalene; 2-	91-20-3	2.98	NA	14,000	320 [g]	3.2	NA
Methylphenol; 2- (cresol;o-)	95-48-7	0.434	NA	175,000	4,000 [g]	80.0	NA
Methylphenol; 4- (cresol;p-)	106-44-5	0.434	NA	17,500	400 [g]	8.00	NA
Naphthalene	91-20-3	1.19	NA	70,000	1,600 [g]	16.0	988
Nitroaniline; 2-	88-74-4	0.0527	NA	105,000	240 [g]	2.4	NA
Nitroaniline; 3-	99-09-2	0.0516	NA	1,050	24 [g]	0.33 [d]	NA
Nitroaniline; 4-	100-01-6	0.0516	NA	6,250	47.6 [j]	0.33 [d]	NA
Nitrobenzene	98-95-3	0.191	NA	7,000	160	1.6	3.4
Nitrophenol; 2-	88-75-5	0.309	NA	NA	NA	NA	NA
Nitrophenol; 4-	100-02-7	0.309	NA	28,000	640 [g]	12.8	1,254
Nitroso-di-n-propylamine;N-	621-64-7	0.0240	NA	18.8	0.33 [d]	0.33 [d]	0.33 [d]
Nitrosodiphenylamine;N-	86-30-6	1.29	NA	26,800	204 [j]	1.79	1.946
Pentachlorophenol	87-86-5	0.592	NA	1,090	8.33 [j]	0.33 [d]	0.33 [d]
Phenanthrene [k]	88-01-8	23.5	NA	1.05E+06	24,000 [g]	240	1,920
Phenol	108-95-2	0.0288	NA	1.05E+06	24,000 [g]	480	4,200
Pyrene	129-00-0	68	NA	105,000	2,400 [g]	48	192
Tributyl Phosphate	126-73-8	1.89	NA	24,300	185 [j]	3.3 [d]	NA
Trichlorobenzene; 1,2,4-	120-82-1	1.66	NA	35,000	800 [g]	7	45.4
Trichlorophenol; 2,4,5-	95-95-4	1.60	NA	350,000	8,000 [g]	160	NA
Trichlorophenol; 2,4,6-	88-06-2	0.381	NA	11,900	90.9 [j]	0.795	0.42
Pesticides and PCBs							
Aldrin	309-00-2	48.7	NA	7.72	0.0588 [j]	0.002 [d]	0.002 [d]
BHC, alpha	319-84-6	1.76	NA	20.8	0.159 [j]	0.002 [d]	0.002 [d]
BHC, beta	319-85-7	2.14	NA	72.9	0.556 [j]	0.00486	0.00554
BHC, delta	319-86-8	3.38	NA	NA	NA	NA	NA
BHC, gamma (Lindane)	58-89-9	1.35	NA	101	0.769 [j]	0.00673	0.0038
Chlordane (alpha, gamma)	57-74-9	51	NA	375	2.86 [f]	0.025 [f]	0.0165 [d]
Dalapon	75-99-0	0.00274	NA	105,000	2,400 [g]	20	NA
Db; 2,4-	94-82-6	0.1	NA	28,000	640 [g]	12.8	NA
DDD, 4,4'-	72-54-8	45.8	NA	547	4.17 [j]	0.0365	0.0033 [d]

Table D-4. Summary of 300 Area Industrial and Unrestricted Nonradionuclide Cleanup Levels. (6 Pages)

Contaminant	CAS Number	K_d Value (mL/g)	Back-ground (mg/kg)	Soil Cleanup Levels (mg/kg) [a]			
				Industrial Direct Exposure	Residential Direct Exposure	Residential Protective of Groundwater	Residential Protective of the River
DDE, 4,4'-	72-55-9	86.4	NA	386	2.94 [j]	0.0257	0.0033 [d]
DDT, 4,4'-	50-29-3	678	NA	386	2.94 [j]	0.0257	0.0033 [d]
Dicambra	1918-00-9	0.0288	NA	105,000	2,400 [g]	48	NA
Dichlorophenoxyacetic acid; 2,4-	94-75-7	0.0294	NA	35,000	640 [g]	7	NA
Dichloroprop [k]	120-36-5	0.0294	NA	35,000	800	7	NA
Dieldrin	60-57-1	25.6	NA	8.2	0.0625 [j]	0.003 [d]	0.003 [d]
Dinoseb (DNBP)	88-85-7	3.54	NA	3,500	80 [g]	0.7	NA
Endosulfan (I, II, sulfate)	115-29-7	2.04	NA	21,000	480 [g]	9.6	0.0112
Endrin (and ketone, aldehyde)	72-20-8	10.8	NA	1,050	24 [g]	0.2	0.039
Heptachlor	76-44-8	9.53	NA	29.2	0.222 [j]	0.002 [d]	0.002 [d]
Heptachlor epoxide	1024-57-3	83.2	NA	14.4	0.11 [j]	0.002 [d]	0.002 [d]
Methoxychlor	72-43-5	80	NA	17,500	400 [g]	4	1.67
Polychlorinated Biphenyls	1336-36-3	309	NA	65.6	0.5 [l,c]	0.017 [d]	0.017 [d]
PCB Aroclor-1016	12674-11-2	107	NA	65.6	0.5 [j]	0.017 [d]	0.017 [d]
PCB Aroclor-1221	11104-28-2	10.3	NA	65.6	0.5 [j]	0.017 [d]	0.017 [d]
PCB Aroclor-1232	11141-16-5	10.3	NA	65.6	0.5 [j]	0.017 [d]	0.017 [d]
PCB Aroclor-1242	53469-21-9	44.8	NA	65.6	0.5 [j]	0.017 [d]	0.017 [d]
PCB Aroclor-1248	12672-29-6	43.9	NA	65.6	0.5 [j]	0.017 [d]	0.017 [d]
PCB Aroclor-1254	11097-69-1	75.6	NA	65.6	0.5 [j]	0.017 [d]	0.017 [d]
PCB Aroclor-1260	11096-82-5	822	NA	65.6	0.5 [j]	0.017 [d]	0.017 [d]
Silvex (tp;2,4,5-)	93-72-1	0.08	NA	28,000	640 [g]	5	NA
Toxaphene	8001-35-2	95.8	NA	119	0.909 [j]	0.2 [d]	0.2 [d]

Table D-4. Summary of 300 Area Industrial and Unrestricted Nonradionuclide Cleanup Levels. (6 Pages)

Contaminant	CAS Number	K_d Value (mL/g)	Back-ground (mg/kg)	Soil Cleanup Levels (mg/kg) [a]			
				Industrial Direct Exposure	Residential Direct Exposure	Residential Protective of Groundwater	Residential Protective of the River
Trichlorophenoxyacetic acid;2,4,5-	93-76-5	0.049	NA	35,000	800 [g]	16	NA

[a] Values from the last column of Tables D-1 or D-2, or from the "Overall" columns for Industrial and Unrestricted in Table D-3, as appropriate. Deep zone cleanup levels are the lower of soil values protective of groundwater and the river. Industrial and Unrestricted deep zone cleanup levels are identical because groundwater and river cleanup levels are based on MTCA Method B criteria. When deep zone cleanup levels are exceeded, site-specific RESRAD modeling will be performed to determine if constituent analyses are protective without irrigation for industrial land use and with irrigation for unrestricted land use.

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

[c] Remedial action goal established in the 300-FF-2 ROD (EPA 2001).

[d] Where cleanup levels are less than background or RDLs, cleanup levels default to background or RDLs per Ecology (1996), WAC 173-340-700(4)(d) and WAC 173-340-707(2), respectively. The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement Project Managers.

[e] Carcinogenic cleanup level calculated based on the inhalation exposure pathway; WAC 173-340-750(3), 1996.

[f] Calculated using the appropriate formulas from Ecology (1996), WAC 173-340-740, with toxicity values updated through February 12, 2009, from the EPA Integrated Risk Information System (IRIS) at http://www.epa.gov/iris or from the Oak Ridge National Laboratory's Risk Assessment Information System database on the Internet at < http://risk.lsd.ornl.gov >. Parameters have been checked against the Washington State Department of Ecology's (Ecology's) CLARC Database on the Internet at < http://www.ecy.wa.gov >.

[g] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), Method B (Ecology 1996).

[h] Calculated using *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children* (EPA 1994).

[i] Common laboratory contaminant unlikely to be found in soil. If detected in soil, all analyses of blanks, duplicates, and splits should be checked and the original soil sample reanalyzed.

[j] Carcinogenic cleanup level calculated per WAC 173-340-740(3), Method B, 1996.

[k] Toxicity data for this chemical are not available. Cleanup levels are based on surrogate chemicals:
Contaminant: acenaphthylene; surrogate: acenaphthene
Contaminant: benzo(g,h,i)perylene; surrogate: pyrene
Contaminant: bis(2-chloroethoxyl)methane; surrogate: bis(2-chloroethyl)ether
Contaminant: chloro-3-methylphenol; 4-; surrogate: methylphenol; 3-
Contaminant: dichloroprop (pesticide); surrogate: Dichlorophenoxyacetic acid; 2,4-; (2,4-D)
Contaminant: phenathrene; surrogate: anthracene

[l] The soil cleanup value for PCBs is based on the formula presented in WAC 173-340-740(3)(a)(iii)(B), Ecology (1996), and the cancer potency factor for ingestion of PCBs of 2.0 kg-day/mg (soils) from the EPA IRIS on the Internet at http://www.epa.gov/iris on January 3, 2006.

CAS = Chemical Abstract System
EPA = U.S. Environmental Protection Agency
K_d = Distribution coefficient discussed in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005), Appendix E. When unavailable from DOE-RL (2005), K_d values are taken from the Ecology CLARC Database on the Internet at < https://www.ecy.wa.gov > or from the Risk Assessment Information System database maintained by the Oak Ridge National Laboratory on the Internet at < http://risk.lsd.ornl.gov >.
NA = not available
PCB = polychlorinated biphenyl
RDL = required detection limit
ROD = record of decision
TPH = total petroleum hydrocarbon
VOA = volatile organic analyte
WAC = *Washington Administrative Code*

Table D-5. RESRAD Determination of 300 Area Direct Exposure Soil Lookup Values for Radionuclides.

Radionuclides	Back-ground (pCi/g) [b]	RDL (pCi/g) [c]	Soil Concentrations for 15 mrem/yr Dose (pCi/g) [a]		Direct Exposure Lookup Values (pCi/g)	
			Industrial Direct Exposure	Unrestricted Direct Exposure	Industrial Direct Exposure	Unrestricted Direct Exposure
Americium-241	NA [d]	1	210	32.1	210	32.1
Carbon-14	NA [d]	2	82	8.7	82	8.7
Cesium-137	1.1	0.1	25	6.2	25	6.2
Cobalt-60	0.008	0.05	5.2	1.4	5.2	1.4
Europium-152	NA [d]	0.1	12	3.3	12	3.3
Europium-154	0.033	0.1	11	3.0	11	3.0
Europium-155	0.054	0.1	518	125	518	125
Nickel-63	NA [d]	30 [e]	3.37E+06	4,026	3.37E+06	4,026
Plutonium-238	0.004	1	155	38.8	155	38.8
Plutonium-239/240	0.025	1	245	35.1	245	35.1
Plutonium-241	NA [d]	1	12,900	854	12,900	854
Strontium-90	0.18	1 [e]	2,500	4.5	2,500	4.5
Technetium-99	NA [d]	15	410,000	34.7	410,000	34.7
Thorium-228	NA [d]	1 [e]	10.8	2.3	10.8	2.3
Thorium-230	NA [d]	1 [e]	23.2	3.0	23.2	3.0
Thorium-232	1.3	1 [e]	4.8	1.0	4.8	1.0
Tritium (H-3) [f]	NA [d]	10 [e]	1,980	711	1,980	711
Uranium-233/234	1.1	1 [e]	167	27.2	167	27.2
Uranium-235	0.11	0.5	16	2.7	16	2.7
Uranium-238	1.1	1 [e]	167	26.2	167	26.2
Total Uranium	2.27	1 [e]	350	56.1	350	56.1

[a] The RESRAD methodology used to calculate the single radionuclide soil concentrations is presented in the text of this appendix. Values in the table are lookup values based on the 300 Area generic site model using input parameters found in Tables B-7(a) and B-7(b).

[b] Background concentrations are the 90th percentile values of the log normal distribution of site-wide soil background data. However, when comparing maximum concentrations at a site to background, it is appropriate to use the 95th percentile. When this is done it should be stated in a footnote. Source: Table 5-1 of *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE-RL 1996).

[c] The RDLs are based on contract-required quantitation limits/contract-required detection limits for offsite laboratories.

[d] NA = Not available; contaminant not evaluated during the background study.

[e] This RDL is not available via rapid turnaround; it is only available via a protocol method requiring a longer turnaround time.

[f] Tritium samples will be taken 15.2 cm (6 in.) below the excavation surface. If tritium is detected, a path forward will be developed with the lead regulatory agency for appropriate cleanup verification sampling (per TPA-CN-177).

RDL = required detection limit
RESRAD = RESidual RADioactivity

Table D-6(a). RESRAD Determination of 300 Area Industrial Soil Radionuclide Lookup Values Protective of Groundwater. (2 Pages)

Radionuclides	RESRAD Input Soil Activity (pCi/g)	Peak Year of Groundwater Concentration (yr)	Radionuclide Drinking Water RAG (pCi/L)	Drinking Water Concentration at Peak Year (pCi/L)	Calculated Soil Activity Protective of Groundwater [a] (pCi/g)	Hanford Site Background Activity (pCi/g) [b]	Required Detection Limit (pCi/g)	Lookup Value Protective of Groundwater (pCi/g)
Americium-241	1,000	NA	1.2	NA	NA	NA	1	NA
Carbon-14	1,000	NA	2,000	NA	NA	NA	2	NA
Cesium-137	1,000	NA	60	NA	NA	1.1	0.1	NA
Cobalt-60	1,000	NA	100	NA	NA	0.008	0.05	NA
Europium-152	1,000	NA	200	NA	NA	NA	0.1	NA
Europium-154	1,000	NA	60	NA	NA	0.033	0.1	NA
Europium-155	1,000	NA	600	NA	NA	0.054	0.1	NA
Nickel-63	1,000	NA	50	NA	NA	NA	30 [c]	NA
Plutonium-238	1,000	NA	1.6	NA	NA	0.004	1	NA
Plutonium-239/240	1,000	NA	1.2	NA	NA	0.025	1	NA
Plutonium-241	1,000	NA	1.3	NA	NA	NA	1	NA
Strontium-90	1,000	NA	8	NA	NA	0.18	1 [c]	NA
Technetium-99	1,000	0.2	900	3,772	33.2	NA	15	239
Thorium-228	1,000	NA	15	NA	NA	NA	1 [c]	NA
Thorium-230	1,000	NA	15	NA	NA	NA	1 [c]	NA
Thorium-232	1,000	NA	2	NA	NA	1.3	1 [c]	NA
Tritium (H-3)	1,000	0.2	20,000	3,730	746	NA	10 [c]	5,360
Uranium-233/234	1,000	0.28	10.3	10.3	131.6	1.1	1 [c]	131.6
Uranium-235	1,000	0.28	1.0	1.0	13.2	0.11	0.5	13.2

Table D-6(a). RESRAD Determination of 300 Area Industrial Soil Radionuclide Lookup Values Protective of Groundwater. (2 Pages)

Radionuclides	RESRAD Input Soil Activity (pCi/g)	Peak Year of Groundwater Concentration (yr)	Radionuclide Drinking Water RAG (pCi/L)	Drinking Water Concentration at Peak Year (pCi/L)	Calculated Soil Activity Protective of Groundwater[a] (pCi/g)	Hanford Site Background Activity (pCi/g)[b]	Required Detection Limit (pCi/g)	Lookup Value Protective of Groundwater (pCi/g)
Uranium-238	1,000	0.28	9.9	9.9	127.2	1.1	1[c]	127.2
Total Uranium		0.28	21.2	21.2	272	2.27	1[c]	272

[a] Calculated with RESRAD Version 6.4 using drinking water concentrations at peak year with 4.6-m (15-ft) cover and no uncontaminated deep zone (5-m contaminated zone and no uncontaminated unsaturated zone). Calculated using the following formula: (Soil activity protective of groundwater) = (Input soil activity) x (MCL) / (Drinking water concentration at peak year).

[b] Background concentrations are 90th percentile values of the log normal distribution of Hanford Site soil background data from Table 5-1 of DOE-RL (1996).

[c] This required detection limit (RDL) is not available via rapid turnaround; it is only available via a method requiring a longer turnaround time. Prior notification and concurrence with the laboratory is necessary to analyze to meet this RDL. Actual detection limits may differ from any RDL.

NA = Not applicable or not available. For calculated soil activities or lookup values protective of groundwater RESRAD predicts these radionuclides will not reach groundwater within 1,000 years assuming that no uncontaminated vadose zone exists between contamination and groundwater.

RAG = Remedial action goal or drinking water maximum contaminant level (MCL) obtained from 40 CFR 141.66 or from EPA/540-R-00-007 (EPA 2000a) as calculated using National Bureau of Standards (NBS Handbook 69) (NBS 1963) maximum permissible concentrations.

Table D-6(b). RESRAD Determination of 300 Area Unrestricted Soil Radionuclide Lookup Values Protective of Groundwater. (2 Pages)

Radionuclides	RESRAD Input Soil Activity (pCi/g)	Peak Year of Groundwater Concentration (yr)	Radionuclide Drinking Water RAG (pCi/L)	Drinking Water Concentration at Peak Year (pCi/L)	Calculated Soil Activity Protective of Groundwater[a] (pCi/g)	Hanford Site Background Activity (pCi/g)[b]	Required Detection Limit (pCi/g)	Lookup Value Protective of Groundwater (pCi/g)
Americium-241	1,000	NA	1.2	NA	NA	NA	1	NA
Carbon-14	1,000	NA	2,000	NA	NA	NA	2	NA
Cesium-137	1,000	NA	60	NA	NA	1.1	0.1	NA
Cobalt-60	1,000	NA	100	NA	NA	0.008	0.05	NA
Europium-152	1,000	NA	200	NA	NA	NA	0.1	NA
Europium-154	1,000	NA	60	NA	NA	0.033	0.1	NA
Europium-155	1,000	NA	600	NA	NA	0.054	0.1	NA

Table D-6(b). RESRAD Determination of 300 Area Unrestricted Soil Radionuclide Lookup Values Protective of Groundwater. (2 Pages)

Radionuclides	RESRAD Input Soil Activity (pCi/g)	Peak Year of Groundwater Concentration (yr)	Radionuclide Drinking Water RAG (pCi/L)	Drinking Water Concentration at Peak Year (pCi/L)	Calculated Soil Activity Protective of Groundwater[a] (pCi/g)	Hanford Site Background Activity (pCi/g)[b]	Required Detection Limit (pCi/g)	Lookup Value Protective of Groundwater (pCi/g)
Nickel-63	1,000	36.7	50	129.8	385	NA	30[c]	385
Plutonium-238	1,000	NA	1.6	NA	NA	0.004	1	NA
Plutonium-239/240	1,000	NA	1.2	NA	NA	0.025	1	NA
Plutonium-241	1,000	NA	1.3	NA	NA	NA	1	NA
Strontium-90	1,000	24.2	8	113.9	70.2	0.18	1[c]	70.2
Technetium-99	1,000	0.2	900	27,100	33.2	NA	15	33.2
Thorium-228	1,000	NA	15	NA	NA	NA	1[c]	NA
Thorium-230	1,000	NA	15	NA	NA	NA	1[c]	NA
Thorium-232	1,000	NA	2	NA	NA	1.3	1[c]	NA
Tritium (H-3)	1,000	0.2	20,000	26,800	746	NA	10[c]	746
Uranium-233/234	1,000	0.28	10.3	10.3	17.9	1.1	1[c]	17.9
Uranium-235	1,000	0.28	1.0	1.0	1.8	0.11	0.5	1.8
Uranium-238	1,000	0.28	9.9	9.9	17.3	1.1	1[c]	17.3
Total Uranium		0.28	21.2	21.2	37	2.27	1[c]	37

[a] Calculated with RESRAD Version 6.4 using drinking water concentrations at peak year with 4.6-m (15-ft) cover and no uncontaminated deep zone (5-m contaminated zone and no uncontaminated unsaturated zone). Calculated using the following formula: (Soil activity protective of groundwater) = (Input soil activity) x (MCL) / (Drinking water concentration at peak year).

[b] Background concentrations are 90th percentile values of the log normal distribution of Hanford Site soil background data from Table 5-1 of DOE-RL (1996).

[c] This required detection limit (RDL) is not available via rapid turnaround; it is only available via a method requiring a longer turnaround time. Prior notification and concurrence with the laboratory is necessary to analyze to meet this RDL. Actual detection limits may differ from any RDL.

NA = Not applicable or not available. For calculated soil activities or lookup values protective of groundwater RESRAD predicts these radionuclides will not reach groundwater within 1,000 years assuming that no uncontaminated vadose zone exists between contamination and groundwater.

RAG = Remedial action goal or drinking water maximum contaminant level (MCL) obtained from 40 CFR 141.66 or from EPA/540-R-00-007 (EPA 2000a) as calculated using National Bureau of Standards (NBS Handbook 69) (NBS 1963) maximum permissible concentrations.

Table D-7. Summary of 300 Area Industrial and Unrestricted Radionuclide Lookup Values.

Radionuclides	K_d Value (mL/g)	Back-ground (pCi/g)	RDL (pCi/g)	Soil Lookup Values (pCi/g) [a]			
				Industrial Direct Exposure	Unrestricted Direct Exposure	Industrial GW/River Protection	Unrestricted GW/River Protection
Americium-241	200	NA	1	210	32.1	NA	NA
Carbon-14	200	NA	2	82	8.7	NA	NA
Cesium-137	50	1.1	0.1	25	6.2	NA	NA
Cobalt-60	50	0.008	0.05	5.2	1.4	NA	NA
Europium-152	200	NA	0.1	12	3.3	NA	NA
Europium-154	200	0.033	0.1	11	3.0	NA	NA
Europium-155	200	0.054	0.1	518	125	NA	NA
Nickel-63	30	NA	30 [b]	3.37E+06	4,026	NA	385
Plutonium-238	200	0.004	1	155	38.8	NA	NA
Plutonium-239/240	200	0.025	1	245	35.1	NA	NA
Plutonium-241	200	NA	1	12,900	854	NA	NA
Strontium-90	25	0.18	1 [b]	2,500	4.5	NA	70.2
Technetium-99	0	NA	15	410,000	34.7	239	33.2
Thorium-228	200	NA	1 [b]	10.8	2.3	NA	NA
Thorium-230	200	NA	1 [b]	23.2	3.0	NA	NA
Thorium-232	200	1.3	1 [b]	4.8	1.0	NA	NA
Tritium (H-3)	0	NA	10 [b]	1,980	711	5,360	746
Uranium-233/234	8.9 [c]	1.1	1 [b]	167	27.2	131.6	17.9
Uranium-235	8.9 [c]	0.11	0.5	16	2.7	13.2	1.8
Uranium-238	8.9 [c]	1.1	1 [b]	167	26.2	127.2	17.3
Total Uranium	8.9 [c]	2.27	1 [b]	350	56.1	272.0	37.0

[a] Lookup values established in *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington* (EPA 2001) or calculated using RESRAD 6.4 with input parameters from Appendix B of this document.

[b] This required detection limit (RDL) is not available via rapid turnaround; it is only available via a method requiring a longer turnaround time. Prior notification and concurrence with the laboratory is necessary to analyze to meet this RDL. Actual detection limits may differ from any RDL.

[c] Value is from the *Explanation of Significant Differences from the 300-FF-2 Operable Unit Record of Decision* (EPA 2004). Details of unrestricted land use uranium lookup values are from BHI (2003).

GW = groundwater

K_d = Distribution coefficient discussed in Appendix E of DOE-RL (2005). The K_d for uranium is 8.9 mL/g from the *Explanation of Significant Differences from the 300-FF-2 Operable Unit Record of Decision* (EPA 2004).

NA = not available

RESRAD = RESidual RADioactivity

Table D-8. RESRAD Output Showing Calculated Single Radionuclide Soil Concentrations Corresponding to a 15 mrem/yr Direct Exposure Dose Rate.

```
RESRAD, Version 6.4      T« Limit = 180 days        10/27/2008  12:33  Page  40
Summary : 300 Area Industrial Lookup Values wth 0.91 Evapo. Coef.
File    : C:\RESRAD_FAMILY\RESRAD\10-27-08_300-AREA_INDUSTRIAL_15_MREM.RAD

            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

Nuclide  Initial        tmin        DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
  (i)    (pCi/g)       (years)                   (pCi/g)               (pCi/g)
ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ
Am-241   1.000E+03    0.000E+00     3.860E-02  3.886E+02  3.860E-02  3.886E+02
C-14     1.000E+03    0.000E+00     1.211E-04  1.239E+05  1.211E-04  1.239E+05
Co-60    1.000E+03    0.000E+00     2.602E+00  5.764E+00  2.602E+00  5.764E+00
Cs-137   1.000E+03    0.000E+00     5.448E-01  2.753E+01  5.448E-01  2.753E+01
Eu-152   1.000E+03    0.000E+00     1.126E+00  1.332E+01  1.126E+00  1.332E+01
Eu-154   1.000E+03    0.000E+00     1.233E+00  1.217E+01  1.233E+00  1.217E+01
Eu-155   1.000E+03    0.000E+00     2.987E-02  5.022E+02  2.987E-02  5.022E+02
H-3      1.000E+03    0.000E+00     2.482E-05  6.043E+05  2.482E-05  6.043E+05
Ni-63    1.000E+03    0.000E+00     3.334E-06  4.499E+06  3.334E-06  4.499E+06
Pu-238   1.000E+03    0.000E+00     2.764E-02  5.426E+02  2.764E-02  5.426E+02
Pu-239   1.000E+03    0.000E+00     3.048E-02  4.921E+02  3.048E-02  4.921E+02
Pu-240   1.000E+03    0.000E+00     3.046E-02  4.925E+02  3.046E-02  4.925E+02
Pu-241   1.000E+03    60.4 ñ 0.1    1.167E-03  1.286E+04  5.901E-04  2.542E+04
Sr-90    1.000E+03    0.000E+00     4.816E-03  3.115E+03  4.816E-03  3.115E+03
Tc-99    1.000E+03    0.000E+00     2.872E-05  5.223E+05  2.872E-05  5.223E+05
Th-228   1.000E+03    0.000E+00     1.652E+00  9.082E+00  1.652E+00  9.082E+00
Th-230   1.000E+03    1.000E+03     6.469E-01  2.319E+01  1.154E-02  1.300E+03
Th-232   1.000E+03    134.7 ñ 0.3   2.676E+00  5.605E+00  5.701E-02  2.631E+02
U-233    1.000E+03    1.000E+03     3.222E-02  4.656E+02  5.267E-03  2.848E+03
U-234    1.000E+03    1.000E+03     7.236E-03  2.073E+03  4.996E-03  3.002E+03
U-235    1.000E+03    0.000E+00     1.276E-01  1.175E+02  1.276E-01  1.175E+02
U-238    1.000E+03    0.000E+00     2.889E-02  5.191E+02  2.889E-02  5.191E+02
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Table D-9. RESRAD Output Showing Calculated Single Radionuclide Soil Concentrations Corresponding to a 15 mrem/yr Unrestricted Direct Exposure Dose Rate.

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RESRAD, Version 6.4      T« Limit = 180 days        10/27/2008  14:58  Page  40
Summary : 300 Area Unrestricted Lookup Values wth 0.91 Evapo. Coef.
File    : C:\RESRAD_FAMILY\RESRAD\10-23-08_300-AREA_UNRESTRICTED_15_MREM.RAD

         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
```

Nuclide (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
Am-241	1.000E+03	0.000E+00	4.667E-01	3.214E+01	4.667E-01	3.214E+01
C-14	1.000E+03	0.000E+00	1.726E+00	8.692E+00	1.726E+00	8.692E+00
Co-60	1.000E+03	0.000E+00	1.057E+01	1.419E+00	1.057E+01	1.419E+00
Cs-137	1.000E+03	0.000E+00	2.428E+00	6.177E+00	2.428E+00	6.177E+00
Eu-152	1.000E+03	0.000E+00	4.491E+00	3.340E+00	4.491E+00	3.340E+00
Eu-154	1.000E+03	0.000E+00	4.918E+00	3.050E+00	4.918E+00	3.050E+00
Eu-155	1.000E+03	0.000E+00	1.194E-01	1.256E+02	1.194E-01	1.256E+02
H-3	1.000E+03	0.000E+00	2.110E-02	7.110E+02	2.110E-02	7.110E+02
Ni-63	1.000E+03	0.000E+00	3.738E-03	4.013E+03	3.738E-03	4.013E+03
Pu-238	1.000E+03	0.000E+00	3.866E-01	3.880E+01	3.866E-01	3.880E+01
Pu-239	1.000E+03	0.000E+00	4.276E-01	3.508E+01	4.276E-01	3.508E+01
Pu-240	1.000E+03	0.000E+00	4.275E-01	3.509E+01	4.275E-01	3.509E+01
Pu-241	1.000E+03	56.9 ñ 0.1	1.414E-02	1.061E+03	8.269E-03	1.814E+03
Sr-90	1.000E+03	0.000E+00	3.327E+00	4.508E+00	3.327E+00	4.508E+00
Tc-99	1.000E+03	0.000E+00	4.325E-01	3.468E+01	4.325E-01	3.468E+01
Th-228	1.000E+03	0.000E+00	6.642E+00	2.258E+00	6.642E+00	2.258E+00
Th-230	1.000E+03	1.000E+03	4.862E+00	3.085E+00	7.749E-02	1.936E+02
Th-232	1.000E+03	112.9 ñ 0.2	1.445E+01	1.038E+00	3.831E-01	3.915E+01
U-233	1.000E+03	19.25 ñ 0.04	2.110E-01	7.108E+01	7.067E-02	2.122E+02
U-234	1.000E+03	19.25 ñ 0.04	2.033E-01	7.379E+01	6.858E-02	2.187E+02
U-235	1.000E+03	19.25 ñ 0.04	6.748E-01	2.223E+01	5.550E-01	2.702E+01
U-238	1.000E+03	19.25 ñ 0.04	2.876E-01	5.216E+01	1.619E-01	9.266E+01
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