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Draft A

Focused Feasibility Study for the 200-UP-2 Operable Unit

United States
Department of Energy
Richland, Washington

For External Review

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EXECUTIVE SUMMARY

This focused feasibility study (FFS) report supports the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation/ feasibility study (RI/FS) activities for the 200-UP-2 Source Operable Unit of the Hanford Site. In addition, a *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, or disposal unit is located within the boundaries of the operable unit (216-U-12 Crib). The 216-U-12 Crib has been determined, based on characterization at the analogous 216-U-8 Crib, to be closed under modified closure.

The objective of the FFS is to provide decisionmakers sufficient information on waste-site conditions and remedial alternatives to allow appropriate and timely decisions on remediation of sites to be addressed through interim remedial measures (IRM). The FFS accomplishes the following:

- updates and refines remedial action objectives (RAO), contaminants of potential concern (COPC), applicable or relevant and appropriate requirements (ARAR), and remedial alternatives

- performs detailed and comparative analysis of IRM based on the CERCLA criteria

- integrates the 216-U-12 Crib RCRA Closure/Post Closure with the 200-UP-2 IRM.

Supporting documents to the FFS include the Aggregate Area Management Study Report (AAMSR), the 200-UP-2 Limited Field Investigation (LFI) report (DOE-RL 1995a), that included a qualitative risk assessment (QRA), and other investigation reports.

For purposes of this FFS, a waste management land use assumption has been defined consistent with continued U. S. Department of Energy (DOE) control of the 200 Areas. The exposure scenario for this land use assumption is defined by waste management workers excavating for placement of an underground pipeline to a depth of 3 m (10 ft). This exposure scenario results in a less conservative estimate (relative to the QRA) of threats posed by the 200-UP-2 waste sites.

Based on the results of the QRA and the LFI and the assumed exposure scenario, the RAO for the 200-UP-2 Operable Unit are as follows:

- Reduce human exposure to radionuclides to attain an estimated annual dose rate of ≤100 mrem. Reduce human exposure to nonradioactive contaminants consistent with *Model Toxics Control Act* (MTCA) industrial Method C cleanup levels.

- Satisfy closure requirements established in Washington Administrative Code (WAC) 173-303-610 for the 216-U-12 Crib.

- Minimize any adverse ecological effects caused by site remediation.

Preliminary remediation goals (PRG) for radionuclides are developed based on a 100 mrem/yr exposure limit as identified in 10 Code of Federal Regulations (CFR) 835.208 (assuming DOE control and continued waste management activities). The PRG for nonradiological constituents are based on MTCA Method C (industrial formula values) consistent with WAC 173-340-745. The PRG are established for contaminants within 0 to 3 m (0 to 10 ft) of the surface.

Preliminary remediation goals for ecological receptors and protection of groundwater are not developed. Ecological impacts are evaluated qualitatively in the analysis of alternatives, and any impacts/improvements subsequent to remedial action are noted. Potential impacts to groundwater are evaluated; however, impacts, especially in the near-term are considered negligible.

Based on waste site contaminant characteristics, the 200-UP-2 IRM candidate waste sites have been grouped into sites with short-lived radionuclides and sites with long-lived radionuclides. Sites with contaminants that will decay in a relatively short period of time (e.g., cesium-137) may be effectively addressed by an interim action given proposed DOE control of the 200 Area for the foreseeable future. Other sites with long-lived radionuclides will most likely require more permanent long-term solutions at a later date once long-term land use of the 200 Area is defined. For these sites interim actions may only be protective in the near-term. Current and future contaminant levels are compared to PRG and the sites grouped into the following categories:

- Sites that pose no current threat (<100 mrem/yr) or future threat (<15 mrem/yr by 2128) (i.e., no contaminants are present in the exposure zone or all contaminants present in the exposure zone are below PRG; contaminants have short half-lives, mainly cesium-137; and contaminants will decay to acceptable levels by 2128):

    - 216-U-4 Reverse Well
    - 216-U-4a French Drain
    - 216-U-9 Ditch
    - 216-Z-20 Crib
    - 216-U-16 Crib.

    Alternatives are not evaluated for the sites identified above because no threats are present which warrant interim action.

- Sites that pose a current threat (>100 mrem/yr) but no future threat (e.g., decay to <15 mrem/yr by 2128) (i.e., all contaminants have short half-lives and will decay by 2128; however, they currently exceed PRG):

- 216-U-10 Pond
- 216-U-11 Trench
- 216-U-14 Ditch
- 207-U Retention Basins.

- Sites that pose a current threat (>100 mrem/yr) and a future threat (>15 mrem/yr) beyond 2128 (i.e., contaminants consist of short-lived radionuclides at concentrations that will not decay by 2128 or, for the Z-Ditches, of long-lived radionuclides such as plutonium-239 and americium-241):

  - 216-U-8 Crib/Vitrified Clay Pipeline
  - 216-U-12 Crib/Vitrified Clay Pipeline
  - 216-U-16 Crib/Vitrified Clay Pipeline
  - 216-U-1 Crib, 216-U-2 Crib, and pipeline
  - 241-U-361 Settling Tank
  - 216-Z-1D Ditch (contaminants are long-lived radionuclides)
  - 216-Z-11 Ditch (contaminants are long-lived radionuclides)
  - 216-Z-19 Ditch (contaminants are long-lived radionuclides).

Consistent with the general response actions developed in the AAMSR, the following alternatives are evaluated as potential IRMs for the 200-UP-2 IRM candidate sites identified above:

- no action
- surveillance and maintenance
- void grout (where applicable)/biointrusion barrier/surveillance and maintenance
- void grout (where applicable)/excavation/disposal.

These alternatives are evaluated against the CERCLA evaluation criteria for each waste unit system.

The FFS consists of a detailed analysis of alternatives that compares individual alternatives to the CERCLA criteria and a comparative analysis that compares alternatives against each other. Evaluations are conducted for both categories of sites: those with short-lived contaminants and those with long-lived contaminants. The following summarizes the comparative analysis for the short-lived radionuclide sites:

Overall Protection of Human Health and the Environment

All alternatives except No Action protect human health and the environment upon implementation by minimizing exposure to contaminants.

Compliance with ARAR

All of the alternatives except No Action comply with corresponding ARAR.

Long-Term Effectiveness and Permanence

The Excavation/Disposal alternative provides the highest degree of long-term effectiveness because contaminants are removed from the site and ecological resources are enhanced. The Biointrusion alternative provides for reduced surveillance and maintenance as compared to the Surveillance and Maintenance alternative; however, both are protective. The No Action alternative is not protective in the long-term because maintenance of the existing covers is not conducted; erosion and biological processes could expose contaminants at unacceptable levels.

Reduction of Toxicity, Mobility, or Volume

All the alternatives result in reduction of toxicity and volume through natural radioactive decay of the contaminants. The Surveillance and Maintenance, Biointrusion, and Excavation/Disposal alternatives all provide mobility reduction through control of biological intrusion.

Short-Term Effectiveness

The No Action alternative provides the highest degree of short-term protectiveness because no actions are taken that would pose risks to workers or the environment. Short-term risks associated with the Surveillance and Maintenance alternative are low and can be addressed through proper health and safety controls. The Biointrusion Barrier alternative is less effective in the short term because heavy equipment is required and ecological resources may be disturbed. The Excavation/Disposal alternative represents the lowest short-term effectiveness because of the heavy equipment required and intrusion into the waste.

Implementability

While all the alternatives are implementable, the Biointrusion Barrier and Excavation/Disposal alternatives have lower implementability because of interferences in the operable unit from utilities and active facilities.

The following summarizes the comparative analysis for IRM at the long-lived radionuclide sites:

Overall Protection of Human Health and the Environment

All alternatives except No Action protect human health and the environment during the IRM period upon implementation by minimizing exposure to contaminants. However, because the concentrations of contaminants will remain elevated for thousands of years, future actions may be required. These actions are dependent on land-use and cannot be addressed at this time; however, all the alternatives are potentially compatible with future actions.

Compliance with ARAR

All of the alternatives except No Action comply with corresponding ARAR for the IRM period.

Long-Term Effectiveness and Permanence

The Excavation/Disposal alternative provides the highest degree of long-term effectiveness because contaminants are removed from the site and ecological resources are enhanced; however, the potential for transuranic (TRU) contaminants affects the effectiveness. The Biointrusion Barrier alternative provides for reduced surveillance and maintenance as compared to the Surveillance and Maintenance alternative; however, both are protective in the IRM period. The No Action alternative is not protective because maintenance of the existing covers is not conducted; erosion and biological processes could expose contaminants at unacceptable levels.

Reduction of Toxicity, Mobility, or Volume

None of the alternatives result in near-term reduction of toxicity or volume because no treatment is proposed and the contaminants have long half lives. The Surveillance and Maintenance, Biointrusion, and Excavation/Disposal alternatives all provide mobility reduction through control of biological intrusion.

Short-Term Effectiveness

The No Action alternative provides the highest degree of short-term protectiveness because no actions are taken that would pose risks to workers or the environment. Short-term risks associated with the Surveillance and Maintenance alternative are low and can be addressed through proper health and safety controls. Short-term effectiveness for the Biointrusion Barrier alternative is lower because heavy equipment is required and ecological resources may be disturbed. The Excavation/Disposal alternative represents the lowest short-term effectiveness because of the heavy equipment required, the intrusion into the waste, and the potential for TRU waste.

Implementability

While all the alternatives are implementable, the Biointrusion Barrier and Excavation/Disposal alternatives have lower implementability because of interferences in the operable unit from utilities and active facilities. The implementability of the Excavation/Disposal alternative would be greatly reduced if TRU contaminants are present.

Cost

A comparison of costs for each of the alternatives at each of the 200-UP-2 IRM candidate waste sites is presented in Table ES-1.

With the exception of the sites which will not decay for thousands of years (216-Z-1D, -11, and -19), it is conceivable that DOE control will be in place until contaminants naturally decay. This being the case, interim actions implemented to protect the waste management worker from unacceptable exposures may in fact achieve final clean up goals. The sites with long-lived radionuclides, however will have to be addressed in the future by a more permanent, long-term solution.

Table ES-1 Cost Comparison of Alternatives

Waste Sites		No Action	Surveillance and Maintenance	Void Grout/ Biointrusion Barrier/ Surveillance and Maintenance	Excavation and Disposal
216-U-8 Crib/VCP	Capital	No Cost	$ 0	$ 1.650,000	$ 2,409,000
	O&M	No Cost	$ 63,000	$ 32,000	$ 0
	Total Cost*	No Cost	$ 0	$ 1,682,000	$ 2,409,000
216-U-10 Pond/216-U-11 Trench	Capital	No Cost	$ 0	$20,284,000	$65,387,000
	O&M	No Cost	$ 2,727,000	$ 1,039,000	$ 0
	Total Cost*	No Cost	$ 2,727,000	$ 21,323,000	$ 65,387,000
216-U-14 Ditch/207-U Retention Basins	Capital	No Cost	$ 0	$ 3,841,000	$ 8,577,000
	O&M	No Cost	$ 307,000	$ 154,000	$ 0
	Total Cost*	No Cost	$ 307,000	$ 3,995,000	$ 8,577,000
216-Z-1D Ditch/ 216-Z-11 Ditch/ 216-Z-19 Ditch	Capital	No Cost	$ 0	$ 4,889,000	$ 8,367,000
	O&M	No Cost	$ 429,000	$ 215,000	$ 0
	Total Cost*	No Cost	$ 429,000	$ 5,104,000	$ 8,367,000
216-U-1 Crib/216-U-2 Crib/ 216-U-361 Settling Tank/ 216-U-16 VCP	Capital	No Cost	$ 0	$ 1,947,000	$ 4,924,000
	O&M	No Cost	$ 153,000	$ 51,000	$ 0
	Total Cost*	No Cost	$ 153,000	$ 1,998,000	$ 4,924,000
216-U-12 Crib/VCP	Capital	No Cost	$ 0	$ 1,088,000	$ 1,524,000
	O&M	No Cost	$ 22,000	$ 11,000	$ 0
	Total Cost*	No Cost	$ 22,000	$ 1,099,000	$ 1,524,000

No Cost = No Action Taken, Therefore No Cost Developed.

* Net present value

ACRONYMS

AAMSR	Aggregate Area Management Study Report
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirements
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COPC	contaminants of potential concern
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
dpm	disintegrations/minute
Ecology	Washington Department of Ecology
EII	Environmental Investigation Instruction
EPA	US Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FFS	focused feasibility study
FS	feasibility study
GRA	general response actions
HFSUWG	Hanford Future Site Uses Working Group
HQ	hazard quotient
HSRAM	Hanford Site Risk Assessment Methodology
ICR	incremental cancer risk
IDW	investigation derived waste
IRM	interim remedial measure
LFI	limited field investigation
LLMW	low-level mixed waste
LLW	low-level waste
MSCM-II	Mobile Surface Contamination Monitor
MT	metric tons
MTCA	Model Toxics Control Act
MTR	minimum technology requirements
NCP	National Contingency Plan
NEPA	National Environmental Policy Act of 1969
NPL	National Priorities List
O&M	operation and maintenance
OJT	on-the-job training
PNL	Pacific Northwest Laboratory
PRG	preliminary remediation goal
PUREX	Plutonium Uranium Extraction Plan
QRA	qualitative risk assessment
RAO	remedial action objectives
RARA	Radiation Area Remedial Action
RCRA	Resource Conservation and Recovery Act of 1976
RI	remedial investigation
RLS	radionuclide logging system

ACRONYMS (cont)

ROD	record of decision
SCA	surface contamination areas
SVOC	semivolatile organic compound
TBC	to-be-considered
TEDF	Treated Effluent Disposal Facility
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TRU	transuranic waste
TSD	treatment, storage, or disposal
$U0_3$	uranium oxide
VCP	vitrified clay pipeline
VOC	volatile organic compound
WAC	Washington Administrative Code
WIDS	Waste Information Data System
WIPP	Waste Isolation Pilot Plant

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1.0 INTRODUCTION

This focused feasibility study (FFS) report supports the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation/ feasibility study (RI/FS) activities for the 200-UP-2 Source Operable Unit. The RI/FS process is described in the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988). In addition, a *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, or disposal (TSD) unit is located within the boundaries of the operable unit (216-U-12 Crib). The 200 Areas is one of four areas on the Hanford Site (Figure 1-1) that are on the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL) under CERCLA. The 200-UP-2 Operable Unit is one of two source operable units associated with the U-Plant Aggregate Area in the 200 West Area of the Hanford Site (Figure 1-2). The 200-UP-1 and 200-ZP-1 Groundwater Operable Units include the groundwater beneath the 200 West Area source operable units and the adjacent groundwater, surface water, and sediments impacted by the overlying source operable units.

The approach for the RI/FS activities for the 200 West Area operable units has been further defined in the *Hanford Past-Practice Strategy* (DOE-RL 1991). This strategy streamlines the past-practice remedial action process with a bias for action by using expedited response actions and interim remedial measures (IRM) (Figure 1-3). The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1994) Milestone M-27-02 required an aggregate area management study be conducted for the U-Plant Aggregate Area. This study compiled existing data, presented the conceptual model, and identified and screened technologies and alternatives on an aggregate-area basis. The Aggregate Area Management Study Report (AAMSR) serves as the baseline for operable unit-specific FFSs.

All work conducted at the 200 West Area waste sites is in accordance with the conditions set forth in the Tri-Party Agreement and its amendments, signed by the Washington Department of Ecology (Ecology), EPA, and the U.S. Department of Energy (DOE). Agreements made under the Tri-Party Agreement have resulted in the integration of the CERCLA cleanup process with the RCRA process. The 216-U-12 Crib is a RCRA disposal unit that will require closure in accordance with Washington Administrative Code (WAC) 173-303-610 and the Hanford Site RCRA permit. In the *Limited Field Investigation for the 200-UP-2 Operable Unit* (DOE-RL 1995a), a roadmap defines the integration of RCRA requirements into CERCLA documentation. This roadmap is further refined in Appendix C and contained in Table C-2. This FFS fulfills several of the RCRA requirements, as defined in Appendix A of the limited field investigation (LFI).

The 216-U-12 Crib has been determined, based on characterization at the analogous 216-U-8 Crib, to be closed under modified closure (see Appendix C for discussion).

1.1 PURPOSE AND SCOPE

The *Hanford Past-Practice Strategy* (DOE-RL 1991) defines the FFS as an evaluation of a limited number of alternatives that are focused to the scope of the response action planned. The FFS constitutes the detailed analysis phase that completes the FS evaluation process for the targeted IRM.

The FFS accomplishes the following:

- updates and refines remedial action objectives (RAO), contaminants of potential concern (COPC), applicable or relevant and appropriate requirements (ARAR), and remedial alternatives based on new information identified since the development of the AAMSR
- performs detailed and comparative analysis of IRMs
- integrates the 216-U-12 Crib RCRA Closure/Post Closure with the 200-UP-2 IRM (Appendix C).

The FFS provides a detailed analysis of remedial action alternatives for sites remaining on the IRM pathway, as identified in the operable unit-specific LFI reports.

The objective of the FFS is to provide decisionmakers sufficient information on waste-site conditions and remedial alternatives to allow appropriate and timely decisions on remediation of sites to be addressed through IRM. The FFS evaluates alternatives identified in the AAMSR and considers new information on technologies, operable unit characteristics, and areawide studies.

1.2 REPORT ORGANIZATION

The FFS is organized into the following sections:

- Section 1.0 - introduction and discussion of purpose of report and summaries of other studies that support the FFS.
- Section 2.0 - discussion of RAO including land use, COPC, ARAR, and remediation goals.
- Section 3.0 - operable unit background and summaries of wastesite characteristics.
- Section 4.0 - detailed descriptions of the remedial alternatives identified in the AAMSR, including any modifications to the alternatives based on new information concerning contaminants or technologies; discussion of uncertainties associated with the alternatives.
- Section 5.0 - discussion of detailed analysis methodology.

- Section 6.0 - comparative analysis of alternatives using the CERCLA nine criteria.
- Section 7.0 - references.
- Appendix A - Applicable or Relevant and Appropriate Requirements - Lists and summarizes state and federal ARAR and to-be-considered (TBC) guidance.
- Appendix B - Protection of Groundwater - Qualitative discussion of physical parameters that affect migration of contaminants to groundwater and description of RESRAD modeling for protection of groundwater.
- Appendix C - 216-U-12 Crib Closure/Post Closure Plan - Discussion of additional RCRA Closure Plan elements for 216-U-12 Crib and updated CERCLA/RCRA integration matrix.
- Appendix D - Extent of Contamination Estimates - Calculations and assumptions for extent of contamination and volume estimates.
- Appendix E - NEPA Considerations - Discussion of common elements such as ecological and cultural resources.
- Appendix F - RESRAD Modeling Results - Assumptions, inputs, and results of RESRAD modeling to determine preliminary remediation goals (PRG).
- Appendix G - Cost Estimates - Assumptions and unit costs associated with cost estimates.
- Appendix H - Detailed Analysis Tables - detailed analysis tables comparing each alternative to the nine CERCLA criteria.

1.3 SUMMARY OF THE AAMSR

The *U-Plant Aggregate Area Management Study Report* (DOE-RL 1992a) summarizes existing information for the waste units associated with the U-Plant in the 200 West Area. This information was used to develop the investigation strategy for the 200-UP-2 LFI. In addition, the report reviewed potential remedial alternatives that served as the starting point for this FFS. Specific information from the AAMSR used in this FFS is detailed in subsequent sections.

1.4 SUMMARY OF THE 200-UP-2 LFI

The *Limited Field Investigation for the 200-UP-2 Operable Unit* (DOE-RL 1995a) summarizes the investigation activities for the operable unit and provides a roadmap to integrate the CERCLA and RCRA requirements. Table 1-1 identifies all the waste sites in the 200-UP-2

Operable Unit. Of the sites listed, a select number of sites were investigated during the LFI. These sites were considered "high-priority" sites and are to be considered for interim action. Not all sites considered in the LFI were investigated. The 200-UP-2 Operable Unit employs the analogue unit approach where only the "worst case" sites are investigated.

The following analogue units were investigated in the LFI:

- The 216-U-1/2 Cribs system, consisting of the 216-U-1/2 Crib structure, ancillary equipment (such as the 241-U-361 Settling Tank and influent stainless steel pipeline), the adjacent 2607-W5 Septic Tank and Drain Field, and the 216-U-16 Crib

- The 216-U-4 Reverse Well/4a French Drain system, consisting of the 216-U-4 Reverse Well and the adjacent 216-U-4a French Drain

- The 216-U-8 Crib system, consisting of the 216-U-8 Crib and 216-U-12 Crib structures and the vitrified clay effluent pipeline from the 222-U and 224-U facilities

- The 216-U-10 Pond system, consisting of the 216-U-10 Pond which was the central collection area, the inlet ditches (Z-Ditches and 216-U-14 Ditch) which fed the 216-U-10 Pond, and the 216-U-11 Trench and 216-U-9 Ditch which received overflow from the pond.

Table 1-1 also identifies those waste sites evaluated in this FFS. Sites evaluated in the FFS are selected based on recommendations from the LFI. The LFI report consolidates the information from several different reports and presents a current conceptual model of the operable unit. The LFI includes a qualitative risk assessment (QRA) as defined in the *Hanford Site Risk Assessment Methodology* (HSRAM) (DOE-RL 1995b). The QRA was developed to estimate the potential risks to a hypothetical, unprotected worker under an industrial-use scenario to contaminants in 200-UP-2 Operable Unit soils. The results of the QRA indicated unacceptable risks from all four analogue sites investigated. Specifics from the LFI report are included in subsequent sections of the FFS to provide the technical bases to develop and evaluate alternatives. Other resources supporting the RI/FS process for 200-UP-2 are identified in Table 1-2.

1.5 INCORPORATION OF NATIONAL ENVIRONMENTAL POLICY ACT VALUES

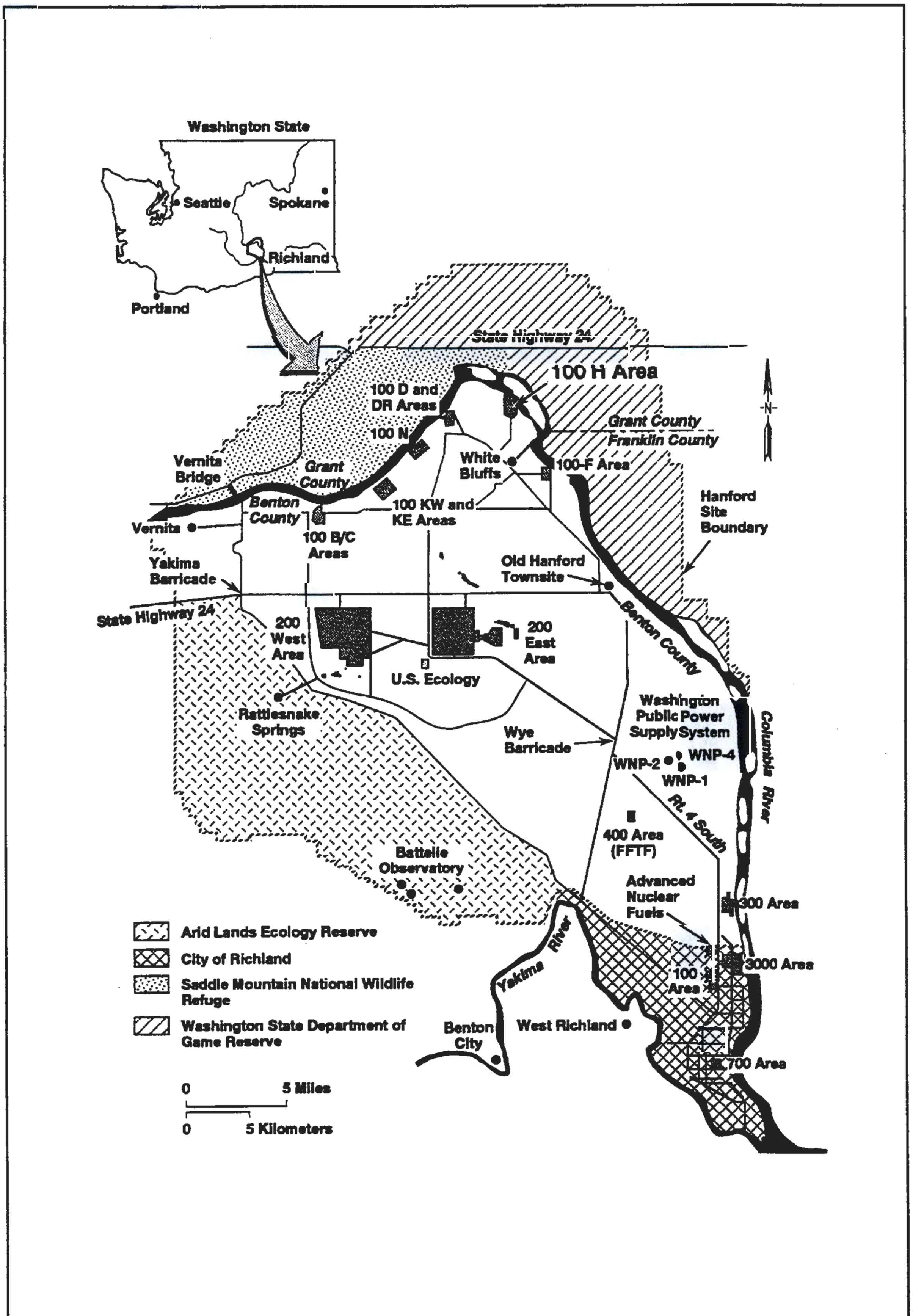
In accordance with DOE Order 5400.4 and Chapter 10 of the *Code of Federal Regulations* (CFR) Part 1021, the considerations (values) of the *National Environmental Policy Act of 1969* (NEPA) must be evaluated during the CERCLA process. U.S. Department of Energy Order 0 451.1 issued in September 1995 states:

> "Each Secretarial Officer and Head of a Field Organization shall, for matters under the office's purview:

.......(13) Incorporate NEPA values, such as analysis of cumulative, off-site, ecological, and socioeconomic impacts, to the extent practicable, in DOE documents prepared under the Comprehensive Environmental Response, Compensation, and Liability Act."

The NEPA values are incorporated in Appendix E.

Figure 1-1 Hanford Site Map



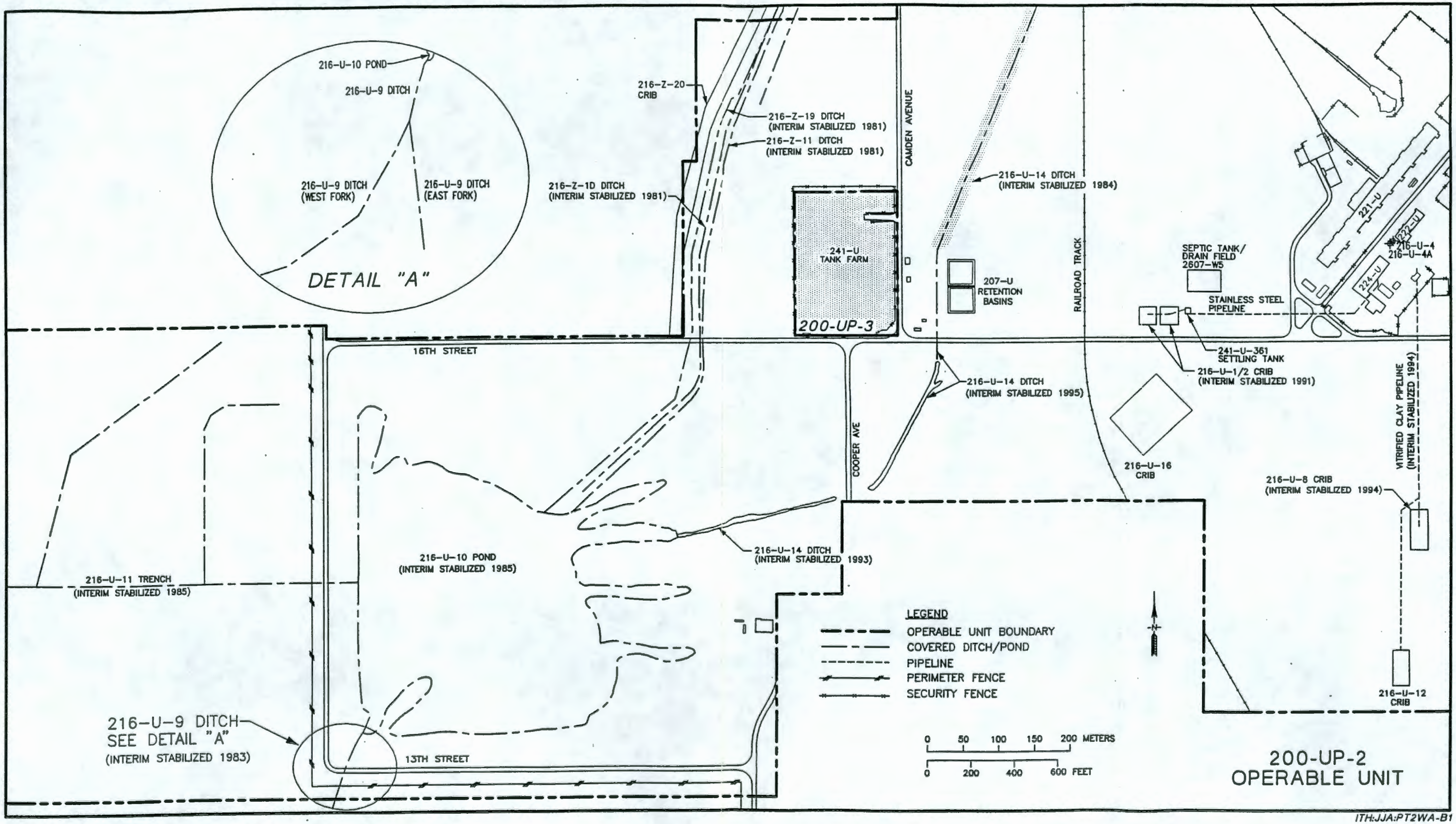


Figure 1-2 200-UP-2 Operable Unit Map

Hanford Past Practice RI/FS (RFI/CMS) Process

The process is defined as a combination of interim cleanup actions (involving concurrent characterization), field investigations for final remedy selection where interim actions are not clearly justified, and feasibility/treatability studies.

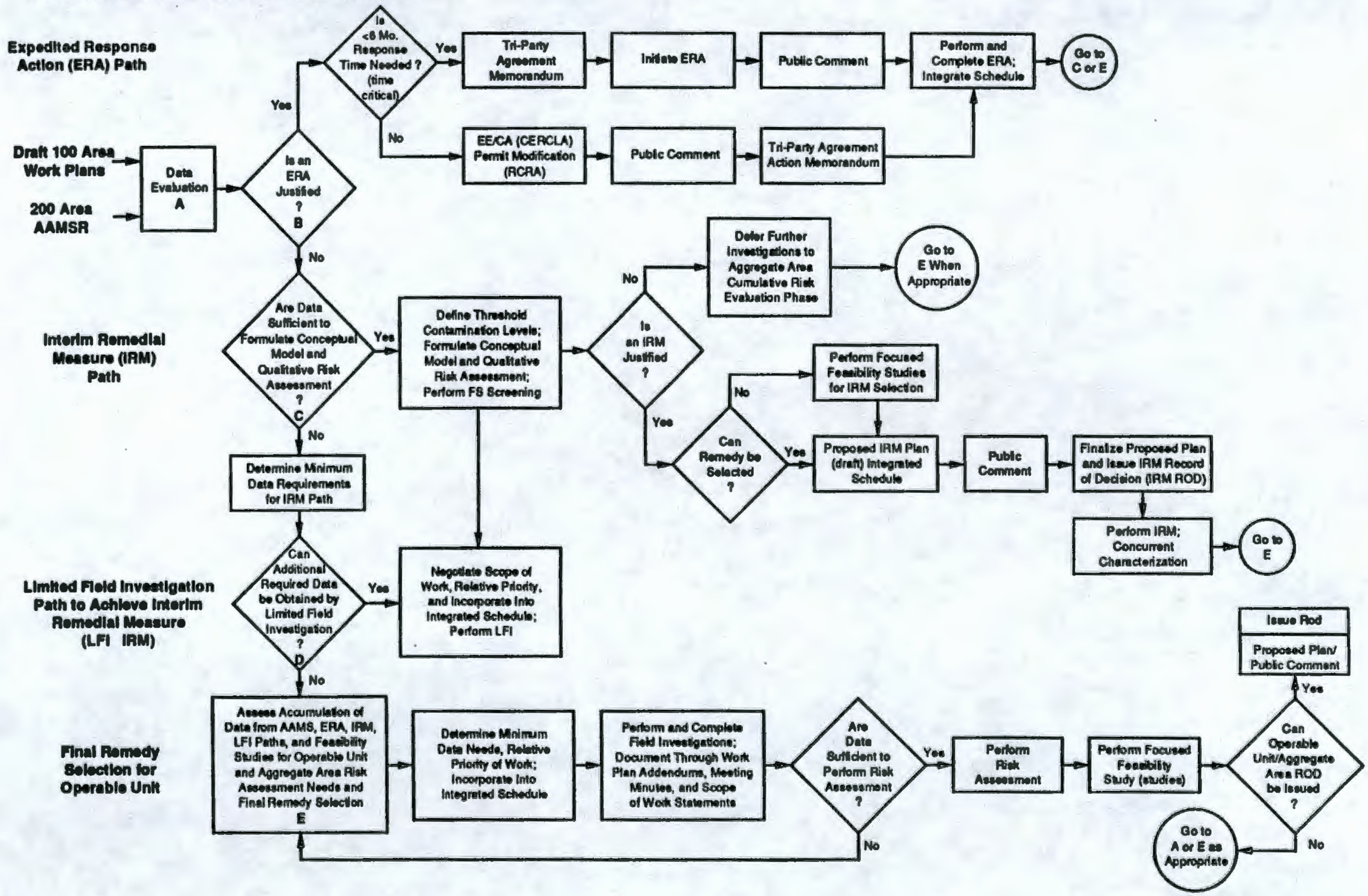


Figure 1-3 Hanford Past-Practice Strategy Flow Chart

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Table 1-2 Key Supporting Documents

Title	Document #	Release Date	Key Items Discussed
Work Plan Driven Documents Summarizing Field Investigation Activities			
Surface and Near Surface Field Investigation Data Summary Report for the 200-UP-2 Operable Unit	BHI-00033, Rev. 00	September 1994	Surface sampling of waste management units Inline camera surveys (VCP and Stainless Steel) Collection of subsurface samples - VCP
Borehole Summary Report for the 200-UP-2 Operable Unit, 200 West Area	BHI-00034, Rev. 01	March 1995	7 vadose zone boreholes 1 test pit (U-Pond) Cone penetrometer test (U-Pond)
200-UP-2 Ambient Air Monitoring Report	BHI-00035, Rev. 00	September 1994	200-UP-2 Operable Unit Ambient Air Monitoring Report
200-UP-2 Operable Unit Radiological Surveys	WHC-SD-EN-RPT-009	May 1994	Surface radiological survey summaries and graphical presentations. MSCM II - (U-Pond System) USRADS - (216-U-8 Crib, 216-U-1/2 Crib, 207-U Retention Basins) Manual - (216-U-9 Ditch, 216-U-4/4a)
Limited Field Investigation Report for the 200-UP-2 Operable Unit	DOE/RL-95-13	June 1995	Summary of site investigations Results of QRA Identification of sites warranting IRMs
Hanford Site Effluent Disposal Study Documents			
Groundwater Impact Assessment Report 216-U-14 Ditch	WHC-EP-0698	January 1994	Effluent disposal study at 216-U-14 ditch 6 test pits excavated 2 vadose zone boreholes drilled 3 groundwater monitoring wells installed
Groundwater Impact Assessment Report 216-Z-20 Crib, 200 West Area	WHC-EP-0674	October 1993	Effluent Disposal Study of Z-20 Crib Nonintrusive investigation of site, summary of existing historical data.
Miscellaneous Documents			
216-U-10 Pond and 216-Z-19 Ditch Characterization Report	WHC-EP-0707	February 1994	1980 investigation to support U-Pond decommissioning activities.
Ecological Sampling at Four Wastes in the 200 Areas	BHI-00032, REV 00	September 1994	Biotic Analogue Summary of 200 Area 216-U-11 Trench is included.

VCP = vitrified clay effluent pipeline MSCM II = Mobil Surface Contamination Monitor USRADS = ultrasonic ranging and data system

Table 1-1 200-UP-2 Operable Unit Waste Management Units (page 1 of 2)

All Units in OU	Units Evaluated in LFI	Units Evaluated in FFS*
241-U-361 Settling Tank/Stainless Steel Pipeline	X	X
216-U-1/2 Cribs	X	X
216-U-8 Crib/VCP	X	X
216-U-12 Crib/VCP	X	X
216-U-16 Crib/VCP	--	X
216-U-17 Crib	--	--
216-Z-20 Crib	--	X
216-U-3 French Drain	--	--
216-U-4a French Drain	X	X
216-U-4b French Drain	--	--
216-U-7 French Drain (UN-200-W-138)	--	--
216-U-4 Reverse Well	X	X
2607-W5 Septic Tank/Drain Field	X	X
2607-W7 Septic Tank/Drain Field	X	--
2607-W9 Septic Tank/Drain Field	X	--
216-U-10 Pond	X	X
200-W Powerhouse Pond	X	--
216-U-9 Ditch	X	X
216-Z-1D Ditch	X	X
216-Z-11 Ditch	X	X
216-Z-19 Ditch	X	X
216-U-14 Ditch	X	X
207-U Retention Basin	X	X
216-U-5 Trench	--	--
216-U-6 Trench	--	--
216-U-11 Trench	X	X
216-U-13 Trench	--	--
216-U-15 Trench (UN-200-W-125)	--	--
200-W Construction Surface Laydown Area	--	--
241-UX-154 Diversion Box	--	--
241-WR Vault	--	--
270-W Neutralization Tank	--	--
Burning Pit/Burial Ground	--	--

Table 1-1 200-UP-2 Operable Unit Waste Management Units (page 2 of 2)

All Units in OU	Units Evaluated in LFI	Units Evaluated in FFS*
UN-200-W-19	--	X
UN-200-W-33	--	--
UN-200-W-39	--	--
UN-200-W-46	--	--
UN-200-W-48	--	--
UN-200-W-55	--	--
UN-200-W-60	--	--
UN-200-W-68	--	--
UN-200-W-78	--	--
UN-200-W-86	--	--
UN-200-W-101	--	--
UN-200-W-111	X (as part of 207-U)	X
UN-200-W-112	X (as part of 207-U)	X
UN-200-W-117	--	--
UN-200-W-118	--	--
UN-200-W-161	--	--
UPR-200-W-104	X (as part of 216-U-10)	X
UPR-200-W-105	X (as part of 216-U-10)	X
UPR-200-W-106	X (as part of 216-U-10)	X
UPR-200-W-107	X (as part of 216-U-10)	X
UPR-200-W-110	X (as part of 216-Z-19)	X

* All units not addressed by this FFS will be addressed in the final remedial alternative selection for the operable unit

2.0 REMEDIAL ACTION OBJECTIVES

The RAO are medium-specific or operable unit-specific objectives to protect human health and the environment. The RAO are developed considering the land-use, COPC, ARAR, exposure pathways, and specify remediation goals so that an appropriate range of interim remedial options can be developed for evaluation. This section presents the steps taken in refining the initial RAO (defined in AAMSR) based on a more thorough evaluation of the 200-UP-2 Operable Unit data from the LFI and other supporting reports.

The RAO refinement process begins with the refinement of COPC for the operable unit. This information ensures that interim remedial alternatives being considered in this FFS can adequately address the types of contaminants and facilitates the refinement of ARAR. The RAO also provide the basis for developing the general response actions (GRA) that will satisfy the objectives of protecting human health and the environment. The RAO are defined as specifically as possible without limiting the range of GRA that can be applied.

The RAO specified for protecting human receptors express both a contaminant level and an exposure route. Interim remedial action objectives for protecting the environment are expressed in terms of the medium of interest (e.g., soil) and target remediation goals, because the intent of the remedial action is to minimize impact on human and ecological receptors from site contaminants.

2.1 LAND USE

The 200-UP-2 Operable Unit is contained within the Hanford Central Plateau as defined in *The Future for Hanford: Uses and Cleanup,* the final report of the Hanford Future Site Uses Working Group (HFSUWG) (DOE-RL 1992b). The Central Plateau encompasses the 200 East and 200 West Areas, as well as land to the north of 200 West. One hundred forty-nine single-shell and 28 double-shell waste tanks are located on the Central Plateau.

Following is a synopsis of the findings and recommendations for the Central Plateau by the HFSUWG:

- Some type of government presence or oversight of the area should be assumed for the foreseeable future due to the anticipated level of residual contamination.

- Waste management, storage, and disposal activities in the 200 Areas and immediate vicinity should be concentrated within the 200 Areas whenever feasible, to minimize the amount of land devoted to or contaminated by waste management activities.

- Waste and contaminants within the 200 Areas should be treated and managed to prevent migration from the 200 Areas to other areas and/or off site.

- A buffer zone around the borders of these contaminants and waste management activities should be established to minimize exposure.

With the above-listed findings and recommendations in mind, the HFSUWG listed six future use options for the Central Plateau as follows:

- *Option 1: Hanford onsite waste and existing obligations for disposal.* This future-use option would designate the interior portion of the Central Plateau (containing 200-UP-2) for waste management activities. Managed wastes would be DOE onsite and offsite waste for which there are existing obligations for disposal. Access to the waste management areas would be restricted to waste management personnel who were properly trained.

- *Option 2: Same as Option 1 with the addition of offsite DOE waste for treatment only.* This option allows future import of waste to the Central Plateau.

- *Option 3: Same as Option 2 with the addition of offsite commercial hazardous waste for treatment only.*

- *Option 4: Same as Option 3 with the addition of offsite DOE transuranic and high-level waste for long-term storage, and offsite DOE low-level waste for disposal.*

- *Option 5: Same as Option 4 with the addition of commercial spent reactor fuel for long-term, monitored retrievable storage.*

- *Option 6: Same as Options 1 through 5 with the addition of compatible commercial or industrial activity.* This future-use option would permit use of the waste management area for commercial or industrial activity that is compatible with the waste management operations.

Based on the six future-use options, the HFSUWG identified a single cleanup scenario for the Central Plateau. Future use of the surface, subsurface, and groundwater in and immediately surrounding the 200 East and 200 West Areas would be "exclusive," or contained within the sites. For the "exclusive" zone, the cleanup target is to reduce risk outside the "buffer" zone posed by contaminants coming from the 200 Areas. The cleanup target for the "buffer" zone is to remediate and restore the area (where contaminated) to be available ultimately for unrestricted use. The size of the "buffer" zone is to be based on conventional risk management practices, and presumably would shrink in size as 200 Area restoration activities proceed. The cleanup scenario assumes that efforts will be made to prevent the spread of groundwater contamination from the Central Plateau to other parts of the Hanford site.

The HFSUWG stated that ultimately, depending on technical capabilities, it is desirable that the Central Plateau would be clean enough for future uses other than waste management activities.

For purposes of this FFS, it is assumed the DOE will maintain control of the operable unit for the foreseeable future. This is a reasonable assumption given current waste management activities (e.g., operation and closure of Tank Farms and Environmental Restoration Disposal Facility [ERDF]) that will continue for several years. The remedial options for 200-UP-2 in this FFS will focus on interim actions to support waste management activities. Other more restrictive future-use scenarios, such as recreational or residential, will not be considered at this point.

2.2 CONTAMINANTS OF POTENTIAL CONCERN

In the context of this FFS, COPC are those constituents that must be addressed by remedial actions. The CERCLA requires that actions selected to remediate hazardous waste sites be protective of human health and the environment. Based on the QRA, the majority of the risk to the waste management worker unit in the short term is attributable to cesium-137 with some contribution from strontium-90 and other radionuclides. Initial COPC for the 200-UP-2 IRM candidate waste sites were defined using the results of the QRA. Constituents exhibiting an incremental cancer risk (ICR) of $>1 \times 10^{-6}$ or a hazard quotient (HQ) greater than one were identified as COPC to be addressed by an IRM. These contaminants represent the primary risk contributors at the waste sites, and are used to develop PRG and determining extent of contamination. The contaminants to be addressed by the remedial action will be further refined by comparing site-specific data to the PRG.

2.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121 of CERCLA requires that any remedial action selected for a Superfund site be protective of human health and the environment. A component of an action's protectiveness is its ability to comply with ARAR. An ARAR is a promulgated federal or state environmental cleanup standard, standard of control, substantive environmental protection requirement, criteria, or limitation. It must be either:

- "Applicable," (i.e., specifically addressing the substances, location, or action being considered).

- "Relevant and appropriate," (i.e., addressing a situation sufficiently similar to that encountered at the CERCLA site that its use is well suited to the particular site). A standard or criterion must be both relevant and appropriate to be an ARAR.

There are three categories of ARAR:

- <u>Chemical-specific ARAR</u> - numerical values or methodologies used to determine acceptable concentrations of a contaminant.

- <u>Location-specific ARAR</u> - requirements that dictate or restrict actions at or surrounding the CERCLA site because of sensitive or unique conditions.

- Action-specific ARAR - technology or activity-based requirements or limitations on actions taken with respect to hazardous waste.

In addition to ARAR, TBC guidance consists of nonpromulgated criteria, advisories, guidelines, or proposed regulations. Because TBC guidance is not legally binding, it does not have the status of ARAR; however, TBC are identified and considered if ARAR do not exist for the substances or situations of concern or the ARAR alone would not be sufficiently protective.

The ARAR and TBC used in the analysis of alternatives for the 200-UP-2 Operable Unit FFS are identified in Appendix A.

2.4 EXPOSURE PATHWAYS

For the 200-UP-2 Operable Unit, the QRA considered the following pathways for the industrial scenario:

- soil ingestion
- fugitive dust inhalation
- external radiation exposure from soil.

The risk scenario used in the QRA is based on a worker exposed to the waste at the maximum concentration within the top 4.5 m (15 ft) of soil for the entire work year. Because the operable unit is likely to be used for waste management, this exposure scenario is overly conservative. The HFSUWG definition of waste management assumes only properly trained and protected workers would be allowed on site. As part of this FFS, a more realistic exposure scenario was developed to estimate potential risk. Under this scenario, it is presumed that DOE access control to is maintained for at least 100 years following the closure of the tank farms. The Tri-Party Agreement Milestone M-45-00 requires the closure of the tank farms by 2028; therefore, DOE controls are assumed until the year 2128. This assumption is used only to bound the scope of the FFS and provide a basis to evaluate effectiveness of IRMs. The actual date for DOE release may not be defined until a later date. Because the operable unit is in close proximity to both ERDF and the 241-U Tank Farm, these same DOE controls are assumed for 200-UP-2.

The ecological risk was evaluated as part of the QRA. Ecological risk was rated low at the 216-U-1/2 Cribs and the 216-U-4 Reverse Well/216-U-4a French Drain system. For the 216-U-8 Crib and the 216-U-10 Pond systems, the ecological risk was estimated as medium to medium-high based on plant uptake of radionuclides and metals and the subsequent ingestion of plants by the pocket mouse. Because all of the sites evaluated in the LFI were retained on the IRM pathway because of potential unacceptable human health risk, ecological risk was not considered a driver for remedial action. In the detailed analysis of alternatives, the potential improvement of the ecological risk currently identified will be evaluated qualitatively along with the mitigation of ecological impacts from remedial activities.

2.5 PROTECTION OF GROUNDWATER

Protection of groundwater is considered when evaluating remedial alternatives for source operable units. The protection of groundwater was considered in the LFI through a unit gradient analysis. Remediation of the 200 West Area groundwater will be addressed through the 200-UP-1 and 200-ZP-1 Operable Units. The potential impacts to groundwater from 200-UP-2 source contamination are discussed in Appendix B. Future impacts are considered negligible because of the following reasons:

- Current contamination in the groundwater is mainly uranium, technetium-99, and carbon tetrachloride. Current groundwater contamination results from past operations that included significant discharge of effluent to the liquid waste disposal facilities. However, with this high effluent discharge, only the mobile constituents have significantly impacted the groundwater. The caliche layer can effectively delay the downward migration of contaminants; however, breaches in the caliche as a result of drilling activities and natural geologic features, have resulted in contamination reaching the groundwater.

- Current infiltration rates are significantly lower than during operations, resulting mainly from natural infiltration of precipitation. Infiltration from precipitation is estimated at 1.2 cm/yr (0.5 in./yr). This infiltration rate does not provide sufficient driving force to mobilize contaminants to the groundwater during the IRM period.

- Many of the contaminants have a high ion exchange capacity for the soils, especially because of the buffering capacity of the soils.

- The monitoring program for the groundwater operable unit, will be able to quickly identify potential future impacts to the groundwater that can then be evaluated and addressed as needed. The 216-U-12 Crib is being monitored in accordance with interim status groundwater assessment monitoring. Upon incorporation of the closure/post closure plan into the Hanford Site RCRA Permit, a final status compliance monitoring program will be initiated in accordance with WAC 173-303-645 controls.

- Characterization efforts during the LFI did not indicate residual moisture in the vadose zone as was previously anticipated, therefore, impact to groundwater is not the primary concern for the operable unit.

2.6 REMEDIAL ACTION OBJECTIVES

Based on the results of the QRA, the LFI, and the assumptions discussed above, the RAOs for the 200-UP-2 Operable Unit are as follows:

- Reduce human exposure to radionuclides to attain an estimated annual dose rate of ≤100 mrem. Reduce human exposure to nonradioactive contaminants consistent with *Model Toxics Control Act* (MTCA) industrial Method C cleanup levels.

- Satisfy closure requirements established in WAC 173-303-610 for the 216-U-12 Crib.

- Minimize any adverse ecological effects caused by site remediation. Because all of the sites evaluated in the LFI were retained on the IRM pathway because of potential unacceptable human health risk, ecological risk was not considered a driver for remedial action. In the evaluation of alternatives in this FFS, the potential improvement of the ecological risk currently identified will be evaluated qualitatively, along with the mitigation of ecological impacts from remedial activities.

2.7 PRELIMINARY REMEDIATION GOALS

Waste sites were initially recommended as IRM candidates based on the QRA and were recommended for further evaluation in this FFS. The FFS refines the assumptions related to land use, exposure scenarios, the applicable regulatory requirements and defines the PRGs. The waste sites and associated contaminants are further evaluated against the PRGs to refine the COPC, to determine the continued need for an IRM, and to develop associated extents of contamination. This evaluation is conducted in Section 3.0 and summarized in Section 3.5

For purposes of this FFS, a waste management land use assumption has been defined consistent with continued DOE control of the 200 Areas. The exposure scenario for this land use assumption is defined by waste management workers excavating to install an underground pipeline. The scenario is based on a 3 m (10 ft) by 3 m (10 ft) trench excavated through the waste site that leaves residual contamination on the surface after installing the pipeline and backfilling. The 3 m (10 ft) vertical limit is based on engineering judgement of the probable depth of excavation for pipeline installation applicable to 200-UP-2. This exposure scenario results in a less conservative estimate (relative to the QRA) of threats posed by the 200-UP-2 waste sites. This is considered appropriate given the continued DOE control of the 200 Areas for the foreseeable future.

Preliminary remediation goals for ecological receptors and protection of groundwater are not developed for this FFS. Ecological impacts are evaluated qualitatively in the analysis of alternatives, and any impacts/improvements subsequent to remedial action are noted. Potential impacts to groundwater are evaluated in Appendix B. The appendix discusses contaminant migration potential and supports qualitative evaluation of groundwater impacts.

2.7.1 Radiological Constituents

The PRGs for radionuclides are based on a 100 mrem/yr exposure limit as identified in 10 CFR 835.208 because DOE control of the site is assumed (continued waste management activities). The proposed 40 CFR 196 standard of 15 mrem/year above background for radionuclides in soil would apply to the general public, that is considered to reside off the Hanford Site during DOE control. The 15 mrem/yr standard may also be applicable for industrial uses onsite if and when DOE releases control of the 200 Areas.

Corresponding soil concentrations based on the 100 mrem/per year are identified in Table 2-1. Soil concentrations were develop for those constituents from the QRA that exhibited an ICR greater than 1 X 10^{-6} or an HQ greater than 1. Using RESRAD[1], soil concentrations equating to a dose of 15 mrem/yr were estimated (see Appendix F). An exposure scenario using realistic but conservative assumptions was developed for calculating the soil concentrations. The assumed worst-case scenario that is thought to be possible is a worker spending 1,500 hrs/yr in a building on a waste site and 500 hrs/yr outside a building on a waste site. This is consistent with the assumptions used for the 300-FF-1 Operable Unit FFS (DOE-RL 1995c).

The 15 mrem/yr concentrations were estimated to aid in the screening of contaminants (see Section 3.1), and to provide a benchmark from which the 100 mrem/yr concentrations could be extrapolated.

2.7.2 Nonradiological Constituents

The PRGs for nonradiological consistuents are based on MTCA Method C (industrial formula values) consistent with WAC 173-340-745. The MTCA C industrial values are applied to the first 3 m (10 ft) of soil consistent with the waste management exposure scenario developed for this FFS. The nonradiological PRG are identified in Table 2-1.

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[1]RESRAD is a pathway analysis computer code used to calculate radiation doses to individuals.

Table 2-1 Preliminary Remediation Goal*

Radionuclides	100 mrem/yr Exposure (pCi/g)
Americium-241	2200
Cobalt-60	100
Cesium-137	480
Europium-152	240
Europium-154	220
Neptunium-237	840
Plutonium-238	2600
Plutonium-239/240	2500
Radium-226	NA
Radium-228	NA
Strontium-90	50,000
Thorium-228	190
Uranium-234	10,000
Uranium-235	1800
Uranium-238	5400
Nonradioactive COPC	**MTCA C Industrial Limit (mg/kg)**
PCBs (Arochlor 1260)	17
Arsenic	188
Chromium	17,500

* Applies to the top 3 m (10 ft) of soil for radionuclides and top 4.5 m (15 ft) for nonradionuclides.

**These PRGs do not include those for 216-U-12 dangerous waste constituents. An analysis of cleanup levels for the purpose of RCRA closure of 216-U-12 are contained in Appendix C.

3.0 WASTE SITE DESCRIPTIONS

This section summarizes the conceptual models for the waste units based on existing information and data collected through operable unit investigations. Physical descriptions are summarized from the AAMSR (DOE-RL 1992a), the 200-UP-2 work plan (DOE-RL 1993a), and the 200-UP-2 LFI (DOE-RL 1995a). Additionally, Hanford Plant drawings were used to verify waste-site dimensions.

The physical descriptions provide original construction information such as site dimensions and associated structures. These descriptions help identify site-specific characteristics that may impact alternative development (e.g., underground voids). Actions taken at the waste sites as part of the Radiation Area Remedial Action (RARA) project to address contamination are summarized.

Historical and LFI data are summarized as well as associated COPC from the QRA and results of data screening against the PRG developed in Section 2.7. The screening against PRG identifies those contaminants to be addressed by the IRM. The extents of contamination for the contaminants exceeding PRG are then estimated based on site-specific data, data from analogous sites, or engineering assumptions. Details of the extent of contamination estimates are provided in Appendix D. Finally, any interferences (i.e., roads, utilities, structures) present at or near each waste site are identified to help select and develop appropriate IRMs.

3.1 DATA SCREENING AGAINST PRELIMINARY REMEDIATION GOALS

In order to identify those constituents to be addressed by an interim action, site-specific data (where available) are screened against the PRG developed in Section 2.7. Constituents exceeding the PRG require some degree of interim action in order to minimize unacceptable exposure to contaminants. Additionally, extent of contamination estimates and subsequent volume estimates presented in this section are based on the lateral and vertical extent of constituents which exceed PRG.

Analytical data for the waste sites have been gathered during historical investigations, and most currently in the LFI (Table 3-1). It is important to note that not all sites have analytical data and thus rely on data from analogue units. Also not all historical data is considered to be of adequate quality (i.e. hygrading of hot spots, mixing of samples, etc) for identification of contaminants and associated concentrations. Based on review of all available data, the sources identified in Table 3-2 were used for screening against applicable PRG. The following section discusses the process for screening the contaminants against the PRG. The results of the screening for each waste site are presented in each waste site-specific discussion.

3.1.1 Radiological Constituents

Radiological constituents with concentrations within the top 3 m (10 ft) of soil which exceed 15 mrem/yr are identified and the average vertical concentrations for the constituents are calculated. The average concentrations is considered appropriate because mixing can be expected to occur under the assumed exposure scenario (pipeline installation).

The average concentration is then compared to the 100 mrem/yr PRG to determine if contamination at the site represents and unacceptable exposure. If the average concentration is less than the 100 mrem/yr PRG, the site does not warrant an interim action and will not require analysis of remedial alternatives. Sites with average concentrations exceeding the 100 mrem/yr PRG will require interim action thus remedial alternatives will be developed and analyzed for those sites.

The average concentration is then used to estimate the dose associated with each waste site under the no action scenario.

3.1.2 Nonradiological Constituents

Maximum concentrations of nonradiological consistuents identified from 0 to 3 m (0 to 10 ft) bgs are compared to the MTCA C-industrial formula values to identify if any maximum concentrations exceed the PRG. If exceedences are identified, vertical averages are calculated and again compared to the PRG. Any constituent exceeding the PRG would warrant an interim action.

3.2 216-U-1/2 CRIB SYSTEM

As defined in the 200-UP-2 LFI (DOE-RL 1995a), the 216-U-1/2 Crib system consists of the following waste management units:

- 216-U-1 and 216-U-2 Crib structures (216-U-1/2)
- 241-U-361 Settling Tank and stainless steel pipeline
- 2607-W5 Septic Tank and Drain Field
- 216-U-16 Crib and Vitrified Clay Pipeline (VCP).

3.2.1 Physical Description and Process Knowledge

216-U-1 and 216-U-2 Cribs. The 216-U-1 and 216-U-2 Cribs are located 61 m (200 ft) north of 16th Street and 305 m (1,000 ft) east of the 207-U Retention Basin (Figure 3-1). Each crib is comprised of a 3.6 by 3.6 by 1.2 m (12 by 12 by 4 ft) deep wooden structure constructed of 15 by 15 cm (6 by 6 in.) timbers on undisturbed soil at the bottom of 6.1 m (20 ft) deep backfill excavations with 1:1 side slopes. The crib trench was backfilled with native soil. The cribs are 18 m (60 ft) apart and are connected by a 8.9 cm (3.5 in.) diameter stainless steel pipe.

Overflow from the 216-U-1 Crib flowed to the 216-U-2 Crib. Waste flowed from the 221-U Building, 224-U Building, Tank 5-2, and the solvent storage area to the cribs through the 241-U-361 Settling Tank. This was the sole source of effluent to these cribs. It is estimated that the cribs received 46,200,000 L (12,196,800 gal) of waste from 1951 until 1967.

241-U-361 Settling Tank. The 241-U-361 Settling Tank is located southwest of U Plant and 30 m (100 ft) east of the 216-U-1 Crib (Figure 3-1). The tank is a circular 6.1 m (20 ft) diameter by 6 m (19 ft) deep structure made of 15 cm (6 in.) steel reinforced, prestressed concrete. Its top is 2 m (6 ft) below grade. Vent and liquid-level measurement risers penetrate the surface. A stainless steel pipeline (8.9 cm [3.5 in.] diameter) connects the settling tank to the 224-U Building. The 241-U-361 Settling Tank served as a settling tank for liquid wastes enroute to the 216-U-1 and 216-U-2 Cribs from 1951 through 1967. It received waste from Tank 5-2 in the 221-U Building, waste from the 224-U Building, and waste from the 276-U Settling Tank solvent storage area.

Records indicate that 4,000 kg (8,900 lb) of uranium was discharged to the tank between 1957 and 1967. The bulk of this waste flowed out to the 216-U-1 and 216-U-2 Cribs. Most recent estimates indicate that the tank (136,000 L [36,000 gal] total capacity) contains 104,000 L (27,500 gal) of sludge of unknown plutonium content estimated at 2,125 Ci beta/gamma. A spill (Unplanned Release Number UN-200-W-19) occurred from the tank in 1953. Liquid overflowed by way of the tank vents and contaminated the ground above the tank and the 216-U-1 Crib. Contaminated soil was scraped and consolidated east of the tank area and covered with 46 to 61 cm (18 to 24 in.) of uncontaminated backfill.

2607-W5 Septic Tank and Drain Field. The 2607-W5 Septic Tank and Drain Field was installed in 1944 and is still an active waste management unit. The system lies about 122 m (400 ft) west of the southwest corner of the 222-U Laboratory (Figure 3-1) and receives sanitary sewage from the 221-U Building, the 222-U Laboratory, the 224-U Building, and the 271-U Plutonium Storage and Services Building. The unit is comprised of an underground concrete septic tank (9.1 by 4.0 by 3.4 m [30 by 13 by 11 ft] deep), two distribution boxes, and two drain fields. The current drain field dimensions are 41 by 30 m (136 by 100 ft). The drain field is backfilled to a depth of roughly 0.8 m (2.5 ft) below grade. An abandoned drain field is located to the west of the existing drain field. The daily rate of sanitary sewage discharge is 12,100 L (3,200 gal) per day (DOE-RL 1992a).

216-U-16 Crib. The 216-U-16 Crib is south of 16th Street and midway between Beloit Avenue and Cooper Avenue (Figure 3-1). It is a large, gravel-filled, drain field-type crib with no major internal structure. It is 80 m (262 ft) long, 58 m (191 ft) wide, and 4.6 to 5.2 m (15 to 17 ft) deep. Liquid waste, transported via a 45.7 cm (18 in.) diameter vitrified clay pipeline (274.3 m [900 ft] long), entered a 2 m (6.7 ft) square distribution box at a depth of approximately 2.4 m (8 ft) bgs and flowed into a pair of 20 cm (8 in.) diameter polyvinyl chloride header pipes that form the north, east, and west borders of the drain field. There is gravel to a depth of 1.5 m (5 ft) covered with 25 μm (1 mil) reinforced polyethylene liner. The trench is backfilled to grade with native soil.

The crib operated from 1984 until 1985. It received 224-U Laboratory process condensate, 271-U Compressor cooling water, 221-U Building chemical sewer waste, and for a period of several months, 224-U Building process condensate and chemical sewer waste. By 1985, enough waste had been discharged to the 216-U-16 Crib to create a perched groundwater zone on top of a relatively impermeable caliche layer. The perched water mounded high enough to effect the uranium contaminated vadose zone beneath the 216-U-1 and 216-U-2 Cribs. This water mobilized uranium present in the vadose zone from past discharges to the 216-U-1 and 216-U-2 Cribs and transported it to the groundwater. The uranium concentration in the groundwater rose from about 166 pCi/L to about 72,000 pCi/L in monitoring wells at the 216-U-1 and 216-U-2 Cribs. Discharge to the 216-U-16 Crib was stopped and between June and August 1985, about 685 kg (1,510 lb) of uranium was removed via a pump and treat system using ion exchange. This resulted in a decreased groundwater uranium activity to about 17,000 pCi/L.

3.2.2 Radiation Area Remedial Action Project

The 216-U-1 and 216-U-2 Cribs were interim stabilized in 1991 with 0.6 m (2 ft) of clean soil. The 241-U-361 Settling Tank and surrounding area was also stabilized during this time frame. Soil above the settling tank was stabilized using a herbicide impregnated geotextile covered with shotcrete to prevent growth of Russian thistle and other deep rooted vegetation. The surrounding area received a 46 to 60 cm (18 to 24 in.) soil cover over the contaminated surface soils.

Surface contamination problems persist at this site primarily because of vegetation uptake. The contaminated areas were recently restabilized with the addition of a clean soil cover. Ongoing activities conducted by the RARA Project include surveillance and monitoring of the cribs for subsidence, the ground surface for radiological contamination, the covers for natural deterioration, and annual applications of herbicides.

3.2.3 Summary of 216-U-1/2 System Site Investigation Data

Before the LFI, the 216-U-1/2 system had been monitored to determine crib performance and potential impact to groundwater. From 1958 through 1976, gross gamma ray logs were collected and groundwater was sampled from existing groundwater monitoring wells (Fecht et al. 1977). Additionally, characterization of the uranium plume under the 216-U-1/2 Cribs was conducted in 1988 (Baker et al. 1988).

During the LFI, the 216-U-1/2 system was characterized with the following:

- three vadose zone boreholes with sediment samples and radionuclide logging
- surface radiological survey
- five surface soil samples
- stainless steel pipeline camera survey.

A summary of results from the 216-U-1/2 system characterization conducted during the LFI are presented in Table 3-1. A vertical cross section of the site including geologic logging, radiological logging, and soil analytical data from the LFI boreholes, is presented in Appendix D.

3.2.4 Contaminants of Potential Concern

For the 216-U-1/2 Crib system, the following contaminants were determined to be COPC under an industrial scenario in the QRA (DOE-RL 1995a) performed on the LFI data:

- cesium-137
- strontium-90
- cobalt-60
- radium-228
- thorium-228.

After further screening of the analytical data against the PRG, the contaminants to be addressed by an IRM is reduced to cesium-137.

3.2.5 Extent of Contamination to be Addressed by an IRM

216-U-1 & -2 Cribs. Average concentrations of samples collected from borehole 299-W19-96 exceed the PRG of 100 mrem/yr (Table 3-3). Based on screening of the soil sample data from Borehole 299-W19-96 against the PRG, the vertical extent of contamination is assumed to be from the ground surface to a depth of 3.1 m (10 ft). The lateral extent of contamination is assumed to extend radially 7.6 m (25 ft) from the edge of the crib trenches forming a border that is 53 by 31.1 m (174 by 102 ft). This is based on the distance to the nearest monitoring well indicating contamination at depth (Borehole 299-W19-11). Appendix D provides the basis and assumptions estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

241-U-361 Settling Tank. Because there is no borehole directly associated with this unit, the extent of subsurface contamination will be assumed to be to the dimensions of the tank, from 1.8 to 7.6 m (6 to 25 ft) bgs. The lateral extent of contamination will be assumed to be the edges of the settling tank (6.1 m [20 ft] diameter). For the associated contamination from the tank overflow (Unplanned Release Number UN-200-W-19), the lateral dimensions are 76.2 by 61.0 m (250 by 200 ft) with a vertical depth of 0 to 1.8 m (0 to 6 ft) bgs. Appendix D provides the basis and assumptions to estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

Stainless Steel Pipeline. The investigation data showed no evidence of any soil contamination for the stainless steel pipeline. Therefore, the extent of contamination is defined as the entire length of the pipeline itself, 304.8 m (1,000 feet) long at a depth of approximately 3 m (10 ft) below grade. Additionally, free liquids were discovered in a 9.1 m (30 ft) section of the stainless steel pipeline during the LFI. The estimated volume of liquid waste is 75.6 L (20 gal).

2607-W5 Septic Tank and Drain Field. Because this site is still actively receiving discharge, no interim actions will be proposed and the extent of contamination has not been determined.

216-U-16 Crib and VCP. Because no investigation has been completed at the 216-U-16 Crib, the gravel fill is assumed to be contaminated. However, because the location of the gravel fill being below the zone of receptor intrusion (0 to 3 m [0 to 10 ft]), no contamination is assumed to warrant implementation of an IRM. The associated VCP is assumed to be analogous to the 216-U-8 VCP; therefore, the vertical extent of contamination is assumed to extend from 1.8 to 3.1 m (6 to 10 ft) bgs. The lateral extent of contamination is assumed to be 1.5 m (5 ft) to each side of the pipeline, or 3 m (10 ft) in total width by the length of the pipeline. The total length of pipeline is 274.3 m (900 ft). Appendix D provides the basis and assumptions to estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

3.2.6 Potential Interferences

Potential interferences in implementing of an IRM at the 216-U-1 and 216-U-2 Cribs and the 241-U-361 Settling Tank include the nearby 16th Street, utilities that are located along 16th Street, a main water line east of the cribs, the 224-U Building, and the neighboring active sites (2607-W5 Septic Tank and Drain Fields and associated influent pipeline) (Figure 3-2).

Potential interferences in implementating an IRM at the 216-U-16 VCP include the intersection of the VCP and 16th Street, utilities that are located along 16th Street, a nearby railroad track, and steamlines (Figure 3-2).

3.3 216-U-4 AND 216-U-4A SYSTEM

As defined in the 200-UP-2 LFI, the 216-U-4 and 216-U-4a system consists of the following waste management units:

- 216-U-4 Reverse Well
- 216-U-4a French Drain.

3.3.1 Physical Description and Process Knowledge

216-U-4 Reverse Well. The 216-U-4 Reverse Well is a registered underground injection well in Washington State. It is located just north of the west corner of the 222-U Laboratory (Figure 3-3). It consists of a 7.6 cm (3 in.) diameter steel pipe extending to a depth of 23 m (75 ft). The reverse well has a perforation for the bottom 2.4 m (8 ft) of the pipe. The well depth does not extend to the water table, which is located at a depth of roughly 61 m (200 ft) bgs.

The 216-U-4 Reverse Well operated from 1947 to 1955 and received 300,000 L (80,000 gal) of decontamination waste from the 222-U Laboratory hood sinks containing acidic plutonium and fission product waste. In 1955 the well began to plug and was deactivated.

216-U-4a French Drain. The 216-U-4a French Drain was installed to receive 222-U Laboratory hood sink waste when the 216-U-4 Reverse Well began to plug. The drain was installed 2.4 m (8 ft) north of the reverse well (Figure 3-3) and was connected by an overflow line. The 216-U-4a French Drain is a 130 cm (51 in.) diameter concrete pipe extending downward at least 1.2 m (4 ft); the upper surface is 1.5 m (5 ft) below grade. During its operation (1955 to 1970), it received 545,000 L (144,000 gal) of acidic plutonium and fission product decontamination waste.

3.3.2 Radiation Area Remedial Action Project

The 216-U-4 and 216-U-4a site has not been stabilized under the RARA project. The waste unit is not posted as a surface contamination area.

3.3.3 Summary of the 216-U-4 and 216-U-4a System Site Investigation

No previous records of characterization were found for the waste unit. During the LFI, the 216-U-4 and 216-U-4a system was characterized with a vadose zone borehole. The vadose zone borehole (299-W19-98) was located between the two units to characterize them concurrently.

A summary of results from the 216-U-4 and 216-U-4a system characterization conducted during the LFI are presented in Table 3-1. A vertical cross section of the site including geologic logging, radiological logging, and soil analytical data from the LFI boreholes, is presented in Appendix D.

3.3.4 Contaminants of Potential Concern

For the 216-U-4 and 216-U-4a system, the following were determined to be COPC under the industrial scenario in the QRA (DOE-RL 1995a) performed on the LFI data:

- americium-241
- cesium-137
- cobalt-60
- europium-152
- europium-154
- radium-228
- thorium-228.

After further screening of the analytical data against the PRG (Section 2.7), no contamination exists warranting an IRM.

3.3.5 Extent of Contamination to be Addressed by an IRM

Average concentrations of samples collected from Borehole 299-W19-98 do not exceed the PRG of 100 mrem/yr (Table 3-3). Therefore, no contamination is identified that warrants an IRM. Appendix D provides the basis for this determination.

3.3.6 Potential Interferences

Because no contamination exists at this site warranting an IRM, no potential interferences have been determined.

3.4 216-U-8 CRIB SYSTEM

As defined in the 200-UP-2 LFI, the 216-U-8 Crib system consists of the following waste management units:

- 216-U-8 Crib structure
- 216-U-12 Crib structure
- VCP.

3.4.1 Physical Description and Process Knowledge

216-U-8 Crib. The 216-U-8 Crib consists of three underground timber crib structures within a north-south oriented trench that is 49 by 15.2 m (160 by 50 ft). The trench has been backfilled with native soil. Each structure is a 4.9 by 4.9 by 3 m (16 by 16 by 10 ft) box constructed of 15 by 20 cm (6 by 8 in.) timbers that rest on top of a 0.9 m (3 ft) thick gravel bed, about 9.4 m (31 ft) below grade. The crib is located 137 m (450 ft) west of Beloit Avenue and 229 m (750 ft) south of 16th Street (Figure 3-4).

The 216-U-8 Crib operated from 1952 until 1960. Roughly 379,000,000 L (100,000,000 gal) of effluent from the 291-U Stack Drainage System, the acidic (pH <1) uranium oxide (UO_3) Process Condensate System, waste from the C-5 and C-7 Tanks, and storm drain waste from the 224-U Building were discharged to the crib via a 15.2 cm (6 in.) diameter VCP. In 1960, the surface above the 216-U-8 Crib began to subside. In response to this subsidence, the pipeline was blanked off near the crib and the waste diverted to the 216-U-12 Crib via a new section of VCP.

216-U-12 Crib. The 216-U-12 Crib is located 649.6 m (2,130 ft) south of the 221-U Building, almost directly south of the 216-U-8 Crib (Figure 3-4). It consists of a 46 m (150 ft) long, gravel-filled drain field. The crib was constructed in 1960 and measures 30 by 3 m (100 by 10 ft) at the base, has earthen sides with a 2:1 slope, and contains no internal structure. The bottom 2.1 m (7 ft) are filled with layers of sand and gravel that are covered with a polyethylene barrier. The crib is backfilled to grade with native soil.

The crib was constructed in 1960 when the 216-U-8 Crib began to subside. A 15.2 cm (6 in.) diameter VCP, connected to the 216-U-8 VCP, transported roughly 150,000,000 L (40,000,000 gal) of liquid waste to the crib during 28 years of use. Effluent received includes the 291-U Stack Drainage System effluent, the acidic (pH <1) UO_3 Process Condensate System, waste from the C-5 and C-7 Tanks, and storm drain waste from the 224-U Building. Approximately 3.1 kg (6.9 lb) of thorium were received from the 241-WR Vault in October 1965. The 216-U-12 Crib was taken out of service in January 1988, and the 216-U-17 Crib was placed into service. The 216-U-12 Crib is a RCRA TSD facility that is undergoing closure as part of the 200-UP-2 Operable Unit actions (Appendix C). The crib is listed as a RCRA TSD because it received waste with the characteristic of corrosivity (pH <2).

Vitrified Clay Pipeline. The VCP served the 216-U-8 and the 216-U-12 Cribs (Figure 3-4). The VCP is fed by a 7.6 cm (3 in.) diameter Schedule 40 stainless steel pipe, which is routed to a neutralization tank located beneath the 2715-UP Building. The 15.2 cm (6 in.) diameter VCP runs from the tank and extends roughly 304.8 m (1,000 ft) south underneath 16th Street and into the 216-U-8 Crib. Before to going under 16th Street (61 m [200 ft] south of the 207-U Building), the grade above the VCP consists primarily of backfilled gravel and soils. After the VCP runs under 16th Street, the surface grade above the VCP consists of a roughly 0.6 m (2 ft) thick soil cover resulting from surface stabilization activities (Section 3.4.2). The depth to the pipeline is from 3.1 to 3.7 m (10 to 12 ft) below grade. When the 216-U-8 Crib was deactivated in 1960 due to subsidence, the VCP was blanked north of the 216-U-8 Crib and routed around it to the location of the 216-U-12 Crib. The section of VCP that is associated solely with the 216-U-12 Crib is also approximately 3 m (10 ft) bgs and is approximately 121.9 m (400 ft) in length.

The VCP served as the effluent pipeline for the 216-U-8 and 216-U-12 Cribs. Roughly 529,000,000 L (140,000,000 gal) of effluent went through the section that fed both cribs, and roughly 150,000,000 L (40,000,000 gal) of effluent went through the lower section to the 216-U-12 Crib after the 216-U-8 Crib was deactivated.

3.4.2 Radiation Area Remedial Action Project

The surface contamination area (SCA) associated with the 216-U-8 Crib and VCP is maintained as part of the Hanford Site RARA project through annual radiological surface surveys. Following 200-UP-2 LFI activities, the 216-U-8 Crib and the VCP corridor south of 16th Street was reduced to an underground contamination zone due to RARA stabilization activities. This stabilization resulted in the radiological posting being removed from roughly 1.2 hectares (3 acres) of this site and the down posting of roughly 0.4 hectares (1 acre) to underground contamination.

Stabilization of this site took place in November 1994. Stabilization consisted of scraping the top 8 to 10 cm (3 to 4 in.) of soil in the northern section of the SCA, which encompassed the area surrounding the pipeline corridor. This soil was consolidated over the 216-U-8 Crib. As the soil over the pipeline was scraped, increasing levels of radioactive contamination were uncovered. Because of this, the area 2.1 m (7 ft) to either side of the pipeline was covered with 46 cm

(18 in.) of clean fill. The contaminated soil that was consolidated on the surface of the 216-U-8 Crib was covered with 46 to 61 cm (18 to 24 in) of clean fill.

The area that was scraped was seeded and fertilized. The areas with underground contamination (over the pipeline and over the crib) are monitored and are on a nonselective herbicide treatment schedule. Additional ongoing activities include maintaining the soil cover and monitoring for surface radiation and crib subsidence. However, a SCA currently exists above a portion of the VCP to the north of 16th Street. This section of VCP is also not within the RARA project.

No stabilization efforts were needed at the 216-U-12 Crib or that portion of the pipeline which led to it.

3.4.3 Summary of the 216-U-8 Crib System Site Investigation Data

Before completion of the LFI, the 216-U-8 system had been monitored through past Hanford Site practices. From 1958 through 1976, gross gamma ray logs were collected from existing groundwater monitoring wells (Fecht et al. 1977). Additionally, wells 299-W22-73 and 299-W22-75, located through the 216-U-12 Crib, were originally logged by Pacific Northwest Laboratory (PNL) in 1982.

During the LFI, the 216-U-8 system was characterized with the following:

- two vadose zone boreholes with sediment samples and radionuclide logging
- eight shallow soil boreholes (associated with the VCP)
- surface radiation survey
- four vegetation and three surface soil samples (associated with the VCP)
- four vegetation and six surface soil samples (associated with the 216-U-8 Crib)
- effluent pipeline camera survey.

A summary of results from the 216-U-8 system characterization conducted during the LFI are presented in Table 3-1. A vertical cross section of the site, including geologic logging, radiological logging, and soil analytical data from the LFI boreholes, is presented in Appendix D.

3.4.4 Contaminants of Potential Concern

For the 216-U-8 Crib system, the following contaminants were determined to be COPC under an industrial scenario in the QRA performed on the LFI data:

- arsenic
- chromium
- americium-241
- cesium-137
- cobalt-60
- europium-154

- europium-152
- neptunium-237
- plutonium-239
- radium-228
- radium-226
- strontium-90
- thorium-228
- uranium-234
- uranium-238.

After further screening of the data against the PRG, cesium-137 was identified as the only contaminant warranting consideration of an interim action. Additionally, due to its status as a RCRA TSD, the 216-U-12 Crib also possesses contaminants that are a concern for RCRA closure. These additional contaminants are addressed in Appendix C.

3.4.5 Extent of Contamination to be Addressed by an IRM

216-U-8 Crib. Based on screening of the investigation data against the PRG for this IRM site, the vertical extent of contamination is assumed to consist of the contaminated soil consolidated to a 0.9 m (3 ft) thick layer above the ground surface. The lateral extent of contamination is assumed to be the dimensions of the top of the crib, 67.7 m (222 ft) in length and 34.1 m (112 ft) in width. Appendix D provides the basis and assumptions for estimating the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

216-U-12 Crib. Data from a borehole (299-W22-78) drilled just outside the crib did not indicate subsurface contamination; therefore, the lateral extent of contamination is assumed to be the outer edge of the crib that measures 45.7 by 18.3 m (150 by 60 ft). Because there is no analytical data from within the crib, the vertical extent of contamination is assumed to be from the polyethylene liner (1.8 m [6 ft]) to 3 m (10 ft) bgs. Contamination is assumed to extend below 3 m (10 ft) based on contaminant distribution found at the 216-U-8 Crib (analogue unit), but will not be addressed because it is located below the zone of receptor intrusion (0 to 3 m [0 to 10 ft]). Appendix D provides the basis and assumptions to estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

Vitrified Clay Pipeline. Average concentrations of samples collected from boreholes along the VCP exceed the PRG of 100 mrem/yr (Table 3-2). For the part of the pipeline associated with the 216-U-8 and the 216-U-12 Cribs, borehole soil samples along the VCP are presented in Appendix D. Based on this data, the vertical contamination is assumed to extend from 1.8 to 3 m (6 to 10 ft) bgs. Based on investigation data that showed minimal lateral contamination, the lateral extent of contamination is assumed to be 1.5 m (5 ft) to each side of the pipeline, or 3 m (10 ft) in total width by the length of the pipe. The total length of pipeline to be addressed is 313.9 m (1,030 ft), as defined in Section 3.4.1. Appendix D provides the basis and assumptions to estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

For that part of the pipeline associated solely with the 216-U-12 Crib, a camera survey indicated that the pipeline is in fairly good condition and may not present the same contamination problems discovered at the 216-U-8 VCP. However, because only a small section of the pipeline was investigated, the VCP is conservatively assumed to be analogous to the 216-U-8 VCP. Therefore, the vertical extent of contamination is assumed to extend from 1.8 to 3 m (6 to 10 ft) bgs. The lateral extent of contamination is assumed to be 1.5 m (5 ft) to each side of the pipe, or 3 m (10 ft) in total width by the length of the pipe. The total length of pipeline is 121.9 m (400 ft). Appendix D provides the basis and assumptions to estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

3.4.6 Potential Interferences

Potential interferences in implementing an IRM at the 216-U-8 system include the intersection of the VCP and 16th Street, a transfer line running to 241-SX-151 (Figure 3-2), and an active liquid waste transport line associated with the Treated Effluent Disposal Facility (TEDF).

3.5 THE 216-U-10 POND SYSTEM

As defined in the 200-UP-2 LFI, the 216-U-10 Pond system consists of the following waste management units:

- 216-U-10 Pond
- 216-U-14 Ditch
- 207-U Retention Basin
- Z-Ditches consisting of the 216-Z-1D Ditch, -11 Ditch, -19 Ditch, and 216-Z-20 Crib
- 216-U-11 Trench
- 216-U-9 Ditch.

3.5.1 Physical Description and Process Knowledge

216-U-10 Pond. The 216-U-10 Pond and its associated ditches were constructed in 1944 to receive low-level liquid effluent from the plutonium processing facilities. The pond is located in the southwest corner of the 200 West Area (Figure 3-5). At its maximum extent, it covered roughly 12 hectares (30 acres).

The pond was active from 1944 until 1985 and received an estimated total volume of 1.65 x 10^{11} L (4.4 x 10^{10} gal) of effluent. The pond received the following effluents at various times:

- 284-W Powerhouse process cooling water
- 231-Z and 234-5Z Buildings steam condensate
- 2723-W Mask Cleaning Station and 2724-W laundry wastewater
- 221-U Building chemical sewer waste

- 224-U Building cooling water
- 231-Z Laboratory wastes and PNL operations waste
- 241-U-110 Condenser Tank water
- 242-S Evaporator steam condensate.

The large volumes of low-level waste water and occasional isolated releases of considerably higher, nonroutine discharges have resulted in the accumulation of transuranic (TRU) waste, fission product, and activation product inventories. It is estimated that, through 1992, a potential radionuclide inventory included 8.2 kg (18 lb) of plutonium, 1,500 kg (3,300 lb) of uranium, 15.3 Ci of cesium-137, and 22.6 Ci of strontium-90 that had been discharged to the system. During the LFI, TRU levels of contaminants were not detected. It is expected that most of the TRU waste inventory (plutonium and americium) is located in the 216-Z Ditches. The large number of disposal sources, operational dates of both sources, and each particular system component complicates any attempt to derive total inventories for each individual component of the 216-U-10 Pond system.

As part of deactivation of the pond in 1985, some peripheral areas were scraped to a depth of 0.3 m (1 ft) or greater to remove contaminated soil. This soil was placed near the middle of the pond. These peripheral areas were covered with a minimum of 0.6 m (2 ft) of clean soil and the central pond area was covered with a minimum of 1.2 m (4 ft) of clean soil and seeded.

216-U-14 Ditch. The 216-U-14 Ditch began operation as one of the original effluent ditches to the 216-U-10 Pond. It runs from northeast to southwest for about 1.6 km (1 mi) of the 200 West Area (Figure 3-5). It originates 500 m (1,600 ft) north of the U-Plant and terminates at the 216-U-10 Pond.

The 216-U-14 Ditch was originally known as the "laundry ditch" because it received waste water from the 2724-W Laundry Building. In addition, it has received the following effluents:

- 284-W Powerhouse waste water
- 2723-W Mask Cleaning Station waste water
- 221-U Building chemical sewer waste
- 224-U Building cooling water
- 271-U Building cooling water
- 241-U-110 Condenser Tank water
- 242-S Evaporator steam condensate
- 207-U Retention Basin waste water (this is the 221-U and 224-U waste waters).

Roughly 570,000 L (150,000 gal) of laundry waste water per day were discharged to this ditch. In 1986, about 3,000 L (800 gal) of 50 percent reprocessed nitric acid was released to the ditch. The total release, which included dilution water, was about 100,000 kg (225,00 lb) of corrosive solution (pH < 2.0) containing 45 kg (100 lb) of uranium.

The entire ditch has been surface stabilized to one extent or another over the years. The most recent stabilization activities occurred in the summer of 1995 when the remaining open sections of the ditch were backfilled. There is a section of the ditch that has not been backfilled, but rather has been stabilized by using gravel and cobbles. The remainder of the 216-U-14 ditch has been backfilled with native soils.

207-U Retention Basin. The 207-U Retention Basin consists of two concrete lined, open settling ponds where waste water was held before overflowing into the 216-U-14 Ditch. The basin is located roughly 91.4 m (300 ft) east of the 241-U Tank Farm (Figure 3-5). The two compartments to the basin are each about 2 m (6.5 ft) deep and have a holding capacity of 2,000,000 L (500,000 gal) each. The influent line is oriented east-west between the basins and 224-U Building.

The 207-U Retention Basin started operating in 1952 and ceased operation in 1994. Until 1972, the basin received steam condensate and cooling water from the 224-U Building and chemical sewer waste from the 221-U Building. Since then the basin only received cooling water from the 224-U Building. In the 1960's, sludge was scraped from the north basin and buried in a 12.2 by 3 by 2.4 m (40 by 10 by 8 ft) deep trench on the north side of the north basin (UN-200-W-111). A similar action was taken to clean out the south basin and a similar burial trench is located immediately south of the south basin (UN-200-W-112). No stabilization has occurred and the site is posted as a surface contamination area.

216-Z-1D Ditch. The 216-Z-1D Ditch operated from 1944 until 1959 as a liquid waste disposal site for the Plutonium Finishing Plant. It was deactivated in 1959 and replaced by the 216-Z-11 Ditch. The ditch begins at a point immediately east of the 231-Z Building and runs almost due south to the 216-U-10 Pond (Figure 3-5). It was 1,300 m (4,300 ft) long, 0.6 m (2 ft) deep, and 1.2 m (4 ft) wide at its bottom with side slopes of 2.5:1.

The 216-Z-1D Ditch received roughly 1,000,000 L (264,000 gal) of process cooling water, steam condensate, and vacuum pump sealant waters from the 231-Z, 234-5Z, and 291-Z Buildings. It is classified as a TRU-contaminated soil site. The ditch was interim stabilized in 1981.

216-Z-11 Ditch. The 216-Z-11 Ditch began operations in 1959 as the replacement ditch for the 216-Z-1D Ditch. It parallels the earlier ditch from a point immediately east of the 241-Z Building to the 216-U-10 Pond (Figure 3-5). It was 797 m (2,615 ft) long, 0.6 m (2 ft) deep, and 1.2 m (4 ft) wide at its bottom with side slopes of 2.5:1. The lower 203 m (665 ft) of the 216-Z-11 Ditch is the same as the 216-Z-1D Ditch. The first 36.6 m (120 ft) is also the same as the 216-Z-1D Ditch.

The 216-Z-11 Ditch received process cooling waste and steam condensate from the 234-5Z Building, cooling and sealant water from the 291-Z Building, and lab waste from the 231-Z Building. Total volumes of effluent are not known for this site. The ditch was interim stabilized in 1981.

216-Z-19 Ditch. The 216-Z-19 Ditch operated from 1971 until 1981 replacing the 216-Z-11 Ditch as a liquid waste disposal site for various Plutonium Finishing Plant facilities. It runs parallel to, and between, the 216-Z-1D Ditch and the 216-Z-20 Crib (Figure 3-5). It was 842.8 m (2,765 ft) long, 1.2 m (4 ft) deep, and 1.2 m (4 ft) wide at its bottom with side slopes of 2.5:1.

The first 36.6 m (120 ft) is the same as the 216-Z-1D and 216-Z-11 Ditches. The next 129.5 m (425 ft) to the south is also the same as the 216-Z-1D Ditch.

The 216-Z-19 Ditch received process cooling waste and steam condensate from the 234-5Z Building, vacuum pump sealant water from the 291-Z Building, and cooling water from the 231-Z Building. Total volumes of effluent disposed to this ditch are not known. The ditch was interim stabilized in 1981.

216-Z-20 Crib. The 216-Z-20 Crib was constructed in 1981 to replace the 216-Z-19 Ditch as a low-level liquid waste disposal site for various Plutonium Finishing Plant facilities. It lies west of, and runs parallel to, the other Z-Ditches (Figure 3-5). It is constructed of three parallel PVC distribution lines lying 1.1 m (3.5 ft) apart. These lines are perforated and run the entire 463 m (1,519 ft) of the crib. The depth below grade varies from 3.6 to 4.6 m (12 to 15 ft).

The 216-Z-20 Crib received 3,800,000,000 L (1,004,000,000 gal) of cooling water, steam condensate, storm sewer, building drain, and chemical drains from the 234-5Z Building; cooling water, steam condensate, and lab drain waste from the 231-Z Building; and miscellaneous drain waste from the 291-Z, 232-Z, 236-Z, and 2736-Z Buildings. Up until the middle of 1995, it also received potentially contaminated noncontact cooling water from the Plutonium Reclamation Facility and the Remote Mechanical C Line, miscellaneous waste water from laboratory activities, condensates from heating, ventilation and air conditioning systems, and storm sewer runoff. No stabilization efforts have occurred since the site remained active until July 1995.

216-U-11 Trench. The 216-U-11 Trench is located immediately west of the 216-U-10 Pond (Figure 3-5). It was active from 1944 to 1957 and received overflow from the 216-U-10 Pond. In its original configuration, the trench was 573 m (1,880 ft) long. A new trench was constructed in 1955 and was 1,048 m (3,440 ft) long and included 247 m (810 ft) of the original trench. The new trench was u-shaped and would sometimes form a pond when adequate overflow from the 216-U-10 Pond was available. The trench was interim stabilized in 1985.

216-U-9 Ditch. The 216-U-9 Ditch is located in the southwest corner of the 200 West Area (Figure 3-5). It served as an overflow for the 216-U-10 Pond from late 1952 until late 1953. In the spring of 1954, it was covered with 0.6 m (2 ft) of clean soil. It connects the 216-U-10 Pond with the 216-S-17 Pond. It is speculated that it may have at one time gone first to the 216-S-16 Pond.

3.5.2 Radiation Area Remedial Action Project

The 216-U-10 Pond system has undergone stabilization efforts on many of the associated waste management units. Each unit will be addressed separately below.

216-U-10 Pond. The 12 hectare (30 acre) 216-U-10 Pond site was originally deactivated and stabilized in 1984 and 1985. As part of this deactivation, some peripheral areas were scraped to a depth of 0.3 m (1 ft) or greater to remove contaminated soil. This soil was placed near the middle of the pond. These peripheral areas were covered with a minimum of 0.6 m (2 ft) of clean soil and the central pond area was covered with a minimum of 1.2 m (4 ft) of clean soil. Of the original 12 hectares (30 acres), 1.2 hectares (3 acres) have been restabilized along the original shoreline of the pond. During the LFI, it was determined that this area was indeed the greatest concern for surface contamination. The appearance of pieces of the organic material from the pond bottom were noticed on the surface and it was suspected that burrowing insects and animals were responsible for this. Another suspected problem area is a moisture wicking of contaminants from the contaminated pond bottom.

216-U-11 Trench. Clean soil has been placed over portions of this unit. These activities took place in 1984 and 1985 during the deactivation of the 216-U-10 Pond, and again in 1988 and 1989. Surface radiation surveys performed during the 200-UP-2 LFI identified surface contamination present along the southern trench of the unit. Contaminated tumbleweeds have also been found along the old trenches.

216-U-9 Ditch. There are no known reports of contamination associated with this unit during its use or after the deactivation of the 216-U-10 Pond (boring/cross trenches did not indicate contamination, therefore, the site was "down posted"). The latest surface survey performed as part of the 200-UP-2 LFI confirmed these results. Therefore, this site is not under the RARA project.

216-Z-1D Ditch, 216-Z-11 Ditch, 216-Z-19 Ditch, 216-Z-20 Crib. This series of parallel waste facilities have been inactive since stabilization in 1981 and 1982 except for the 216-Z-20 Crib which became inactive in 1995. These units are posted for subsurface contamination and have no history of surface contamination problems since stabilization. Surface radiation surveys performed as part of the 200-UP-2 LFI confirmed this finding.

216-U-14 Ditch. The 216-U-14 Ditch has been stabilized in three phases. The most northern section of the ditch, starting just north of the location of the 207-U Retention Basin, was stabilized in conjunction with the 216-U-10 Pond. This section is part of the RARA Project. The southern- or western-most section located between Cooper Avenue and the 216-U-10 Pond was stabilized in 1992 with a gravel and cobble combination to stabilize the surface and allow for continued use. The central- or eastern-most section was stabilized in 1995 by chemically killing all vegetation and consolidating contaminated soil into the center of the ditch. The consolidated material was then covered with clean backfill. No surface contamination problems are evident along any portions of the 216-U-14 Ditch at this time. These two sections are not part of the RARA project.

207-U Retention Basin. This unit is not part of the RARA project.

3.5.3 Summary of 216-U-10 Pond System Site Investigation

Before completion of the LFI report, the 216-U-10 system had extensively been monitored through past Hanford Site practices. In 1980 a comprehensive study was conducted on the 216-U-10 Pond and its associated trenches to prepare for their eventual closure (Last and Duncan 1980). Preexisting data were incorporated into the 1980 study and new samples were collected to fill in any data gaps that were identified. Also, data on plutonium and americium concentrations in sediments underlying the 216-U-10 Pond are published in Emery et al. (1974). Sediment and vegetation samples from the 216-Z-19 Ditch were analyzed in 1976 (Last and Duncan 1980). Maxfield (1979) documented analytical results for soil samples collected from the leach trenches and the flood plain south of the 216-U-10 Pond. An aerial gamma survey by Bruns (1974) indicated that the delta area was the most contaminated part of the 216-U-10 Pond. Additionally, elevated uranium concentrations have been noted in groundwater monitoring wells beneath the 216-U-10 Pond for several years (Schmidt et al. 1990). Finally, two samples were collected adjacent to the 207-U Retention Basin in 1991 (Schmidt et al. 1992).

During the LFI, the 216-U-10 system was characterized using the following:

- one vadose zone borehole with soil sampling and radionuclide logging
- one test pit with soil sampling
- 10 cone penetrometer holes, scintillator logged
- surface radiological survey
- surface soil and vegetation samples
  - 7 soil and 2 vegetation in 216-U-10 Pond
  - 2 soil in 216-U-11 Trench
  - 2 soil in Z-Ditches
  - 3 soil in 216-U-14 Ditch (includes 207-U Area).

A summary of results from the 216-U-10 system characterization conducted during the LFI are presented in Table 3-1. The vertical cross section of the site, including geologic logging, radiological logging, and soil analytical data from the LFI boreholes, is presented in Appendix D.

3.5.4 Contaminants of Potential Concern

For the 216-U-10 Pond system, the following contaminants were determined to be COPC under an industrial scenario in the QRA (DOE-RL 1995a) performed on the LFI data:

- americium-241
- arochlor-1260
- cesium-137
- chromium
- cobalt-60
- europium-154
- europium-152
- plutonium-239/240
- plutonium-238
- radium-226
- radium-228
- thorium-228
- uranium-234
- uranium-238.

After further screening of the data against the PRG, the only contaminant warranting action for the 216-U-10 Pond is cesium-137. Based on data from Last and Duncan (1980), historical investigation indicated high levels of plutonium-239/240 and americium-241 in the Z Ditches. These constituents are the only COPC for the Z-Ditches, cesium-137 was not found at levels of concern at Z-Ditches. This data was not considered as part of the 200-UP-2 QRA, since data collected from U Pond was sufficient to determine these sites as IRM candidates.

3.5.5 Extent of Contamination to be Addressed by an IRM

216-U-10 Pond. During the site investigation, it was apparent that there was contamination on the surface on the pond and also in the backfill material. Therefore, the backfill over the pond will be included in the estimate of the extent of contamination. It is assumed that the average depth of cover over the pond is 1.2 m (4 ft) of soil. The lateral extent is defined by the pond dimensions and covers roughly 12 hectares (30 acres). Average concentrations of samples collected from Borehole 299-W23-231 and Test Pit 216-U-10-TP exceed the PRG of 100 mrem/yr (Table 3-3). Based on site investigation data, the vertical extent of contamination is limited to just below the pond bottom located 1.8 m (6 ft) below grade in the deepest area of the pond. It is therefore assumed that 2.1 m (7 ft) bgs defines the vertical extent of contamination for the pond. It should be noted that Unplanned Release Numbers UPR-200-W-104, UPR-200-W-105, UPR-200-W-106, and UPR-200-W-107 are defined within this extent of contamination. Appendix D provides the basis and assumptions to estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

216-U-14 Ditch. It is assumed for ditches that the vertical contamination extends to a depth of 1.2 m (4 ft) below the bottom of the ditch. The 216-U-14 Ditch has been backfilled with clean soil except for that portion lying west of Cooper Avenue, which has roughly 0.6 m (2 ft) of gravel and cobble used for surface stabilization. The lateral extent of contamination is defined by the dimensions of the top of the ditch. The bottom of the ditch is 2.4 m (8 ft) wide. Assuming an average depth of 1.2 m (4 ft), with side slopes of 2.5:1, the average top width is 8.5 m (28 ft). The entire length of the ditch is 1,706.9 m (5,600 ft). Appendix D provides the basis and assumptions to estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

216-Z-1D Ditch. Under the analogous site approach, average concentrations for samples collected along the 216-Z-19 Ditch bottom are assumed the same. The average concentrations exceed the PRG of 100 mrem/yr (Table 3-3). The vertical extent of contamination is assumed to extend to a depth of 1.2 m (4 ft) below the bottom of the ditch. The 216-Z-1D Ditch has been backfilled with clean soil. The lateral extent of contamination is defined by the top dimensions of the ditch. The bottom of the ditch is 1.2 m (4 ft) wide. The ditch had an average depth of 0.6 m (2 ft) with side slopes of 2.5:1. The average top width is 4.3 m (14 ft). The entire length of the ditch is 1,310.6 m (4,300 ft). Appendix D provides the basis and assumptions to estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

216-Z-11 Ditch. Under the analogous site approach, average concentrations for samples collected along the 216-Z-19 Ditch bottom are assumed the same. The average concentrations exceed the PRG of 100 mrem/yr (Table 3-3). The vertical extent of contamination is assumed to extend to a depth of 1.2 m (4 ft) below the bottom of the ditch. The 216-Z-11 Ditch has been backfilled with clean soil. The lateral extent of contamination is defined by the top dimensions of the ditch. The bottom of the ditch is 1.2 m (4 ft) wide. The ditch had an average depth of 0.6 m (2 ft) with side slopes of 2.5:1. The average top width is 4.3 m (14 ft). The entire length of the ditch is 557.8 m (1,830 ft) (this does not include 239.3 m [785 ft] that is the same as the 216-Z-1D Ditch). Appendix D provides the basis and assumptions to estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

216-Z-19 Ditch. Average concentrations of samples collected along the 216-Z-19 Ditch bottom exceed the PRG of 100 mrem/yr (Table 3-3). The vertical extent of contamination is assumed to extend to a depth of 1.2 m (4 ft) below the bottom of the ditch (Figure 3-20). The 216-Z-19 Ditch has been backfilled with clean soil. The lateral extent of contamination is defined by the top dimensions of the ditch. The bottom of the ditch is 1.2 m (4 ft) wide. The ditch had an average depth of 1.2 m (4 ft) with side slopes of 2.5:1. The average top width is 7.3 m (24 ft). The entire length of the ditch is 677 m (2,220 ft) (this does not include 203 m (665 ft) that is the same as the 216-Z-1D Ditch). Appendix D provides the basis and assumptions to estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

216-Z-20 Crib. This waste management unit was still actively receiving effluent during field investigations. Because no investigation has been completed at the 216-Z-20 Crib, the gravel fill is assumed to be contaminated. However, due to the location of the gravel fill being below the zone of receptor intrusion (0 to 3 m [0 to 10 ft]), no contamination is assumed to warrant implementation of an IRM. Appendix D provides the basis for this assumption.

216-U-11 Trench. The vertical extent of contamination is assumed to extend to a depth 1.2 m (4 ft) below the bottom of the trench. The lateral extent of contamination is defined by the top dimensions of the ditch. The bottom of the trench is 1.5 m (5 ft) wide, an average depth of 1.2 m (4 ft) with assumed side slopes of 2.5:1. The average top width is 7.6 m (25 ft). The entire length of the trench is 1,375 m (4,510 ft).

Also associated with the 216-U-11 Trench is the flood plain in the south section of the facility that would occasionally flood when overflow volumes exceeded trench capacity. It is assumed that the depth of contamination in this area to be a total of 15.2 cm (6 in). The total surface area is assumed to be 244 by 183 m (800 by 600 ft). Appendix D provides the basis and assumptions to estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

216-U-9 Ditch. There was no evidence of any contamination based on historical investigations (borehole/cross trenches) of the area conducted after operation and confirmed by surface radiation surveys performed during the LFI. Therefore, an extent of contamination has not been estimated.

207-U Retention Basin. Based on site investigation data, surface contamination is present near the 216-U-14 Ditch. However, the lateral extent of contamination is conservatively assumed to be the total dimensions of the unit, 75.0 by 37.5 m (246 by 123 ft). The unit dimensions encompass both concrete lined basins and the surrounding area. The vertical extent of contamination is assumed from the ground surface to 0.6 m (2 ft) bgs to account for the surface contamination. Investigations have not determined that the concrete-lined basins have leaked; therefore, no contamination is assumed below the basins. Additionally, Unplanned Release Numbers UN-200-W-111 and UN-200-W-112 are defined within the lateral extent of contamination, however, the vertical extent for the uncontrolled releases is assumed from 0 to 2.4 m (0 to 8 ft) bgs. Appendix D provides the basis and assumptions to estimate the extent of contamination and presents the lateral and vertical extent of contamination with respect to this site.

3.5.6 Potential Interferences

216-U-10 Pond. Potential interferences in implementating an IRM include the nearby Dayton Avenue and 13th Street, the associated ditches/trenches, and various influent pipelines (Figure 3-2).

216-U-14 Ditch. Potential interferences in implementating an IRM include the intersection of the ditch and Cooper Avenue, 16th Street, and 19th Street, the nearby 241-U Tank Farm, the 207-U Retention Basin, and transfer facility lines to 241-SX-151 and 241-S-151.

216-Z Ditches. For all three ditches, the only potential interference in implementating an IRM is the intersection of the ditches and 16th Street. However, for the section where only the 216-Z-1D Ditch exists, various roads and fencelines may also pose as an interference.

216-U-11 Trench. A potential interference in implementating an IRM is the intersection of the trench and Dayton Avenue.

207-U Retention Basin. Potential interferences in implementating an IRM is the nearby 16th Street and the nearby 241-U Tank Farm.

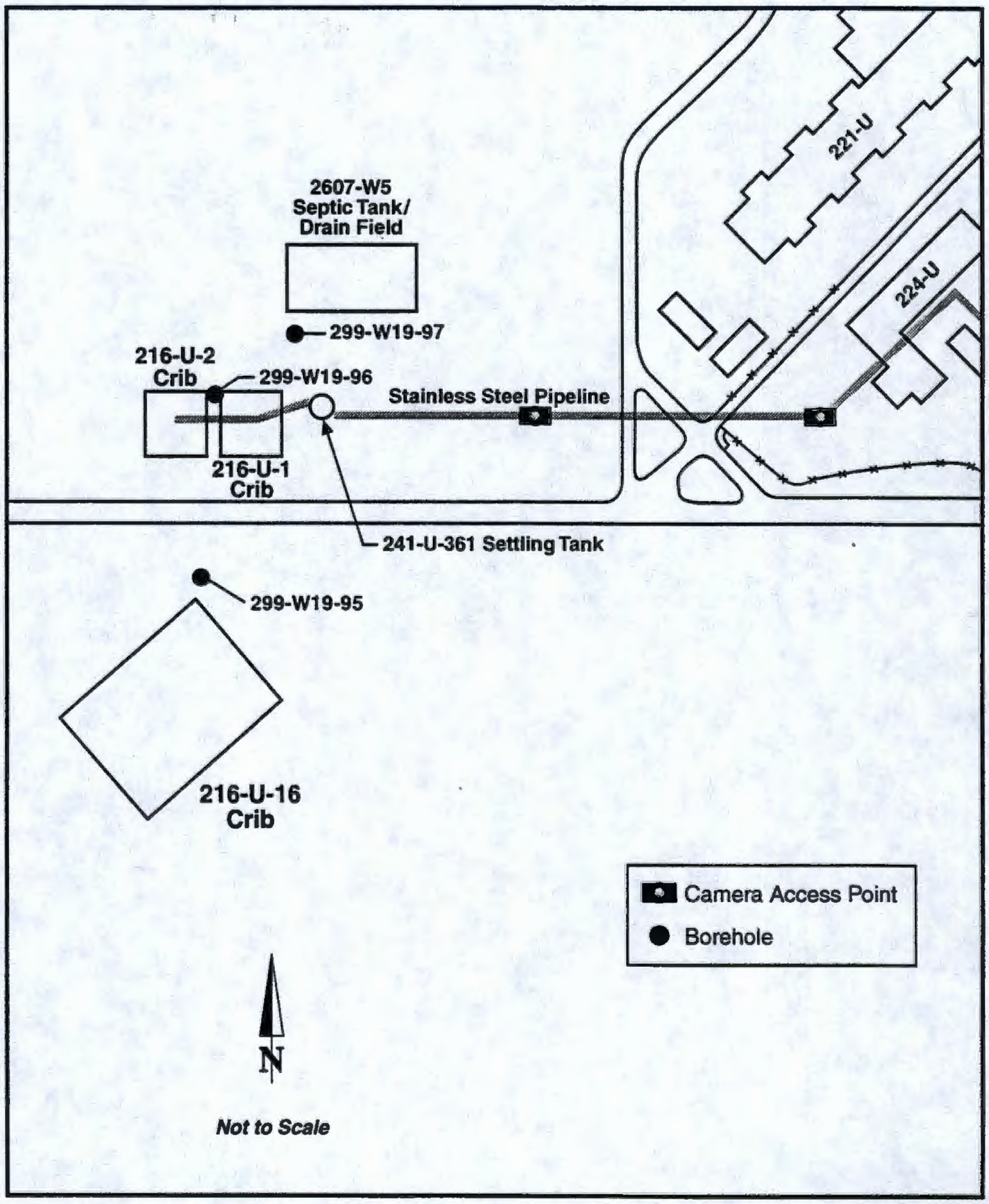
3.6 SUMMARY OF RESULTS

Table 3-3 presents a summary of the waste site evaluations discussed in previous sections. The table displays the results of the screening process described in Section 3.1. For each waste site, the refined COPC, average soil concentration and present dose are summarized. Each site was evaluated to determine if its dose rate exceeds the PRG of 100 mrem/yr. Additionally, each site exceeding 100 mrem/yr was examined to determine if the contamination is within the zone of receptor intrusion (0-3.1 m [0-10 ft]). Finally, for those sites determined to warrant an IRM, a contaminated material volume was estimated based on the extent of contamination defined in Appendix D.

For nearly all waste units evaluated in this FFS, the COPC were refined to only cesium-137. The exceptions are the 216-Z Ditches and the 216-Z-20 Crib, where plutonium-239/240 and americium-241 were the identified COPC. Of the waste sites evaluated, not all of the sites warrant an IRM. The 2607-W5 Septic Tank/Drain Field do not warrant an IRM due to their active status. The 216-U-4, -4a system does not warrant an IRM because contaminant levels are below the PRG of 100 mrem/yr and the 216-U-9 Ditch was determined not to warrant an IRM because no contamination has been identified at the site. Finally, at both the 216-U-16 Crib and the 216-Z-20 Crib, the extent of contamination is defined below the zone of receptor intrusion, therefore an IRM is not warranted.

For those waste sites determined to warrant action, IRM alternatives are developed in Section 4.

Figure 3-1 216-U-1/2 Cribs System



E9601023.15

9613401.2930

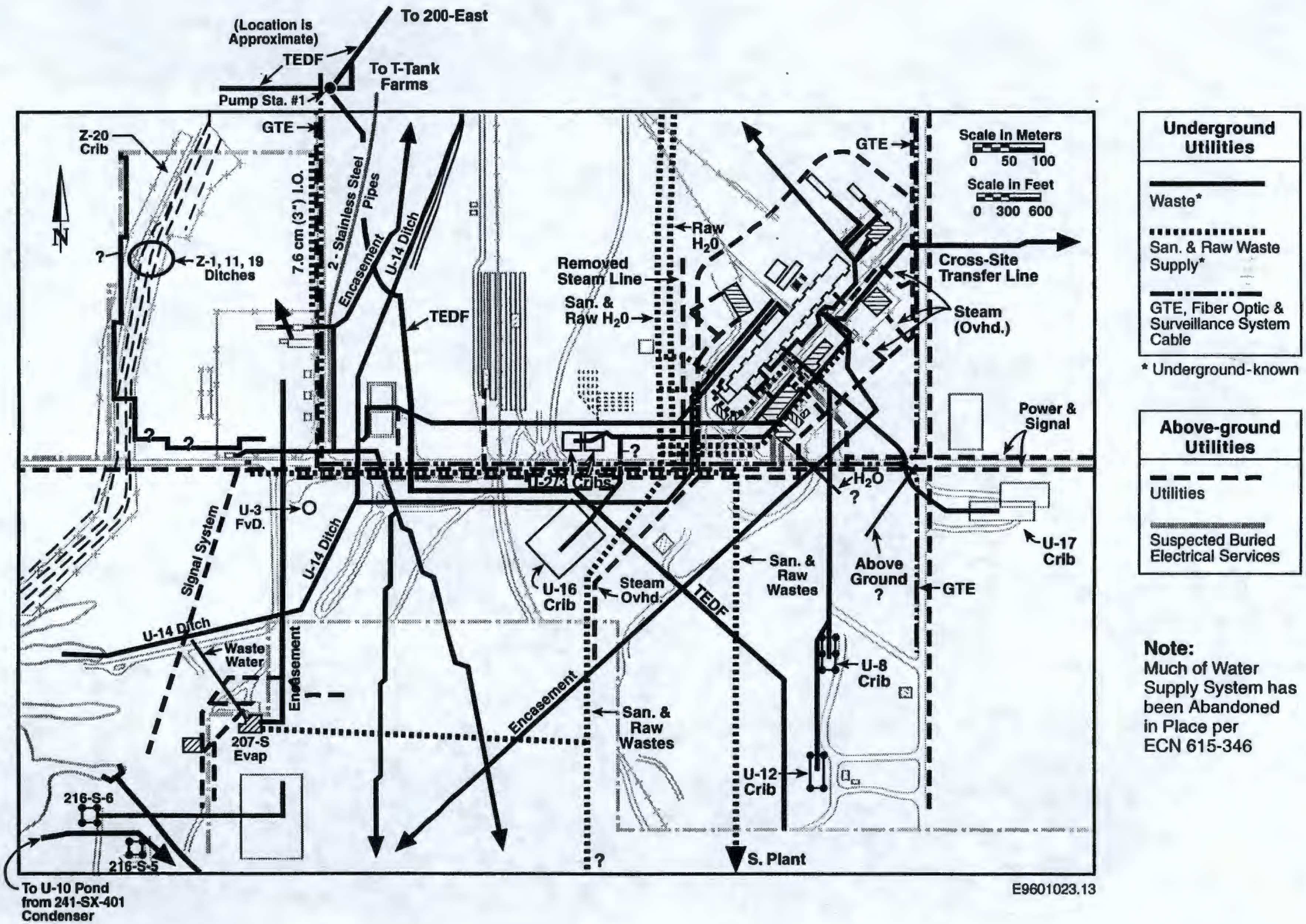
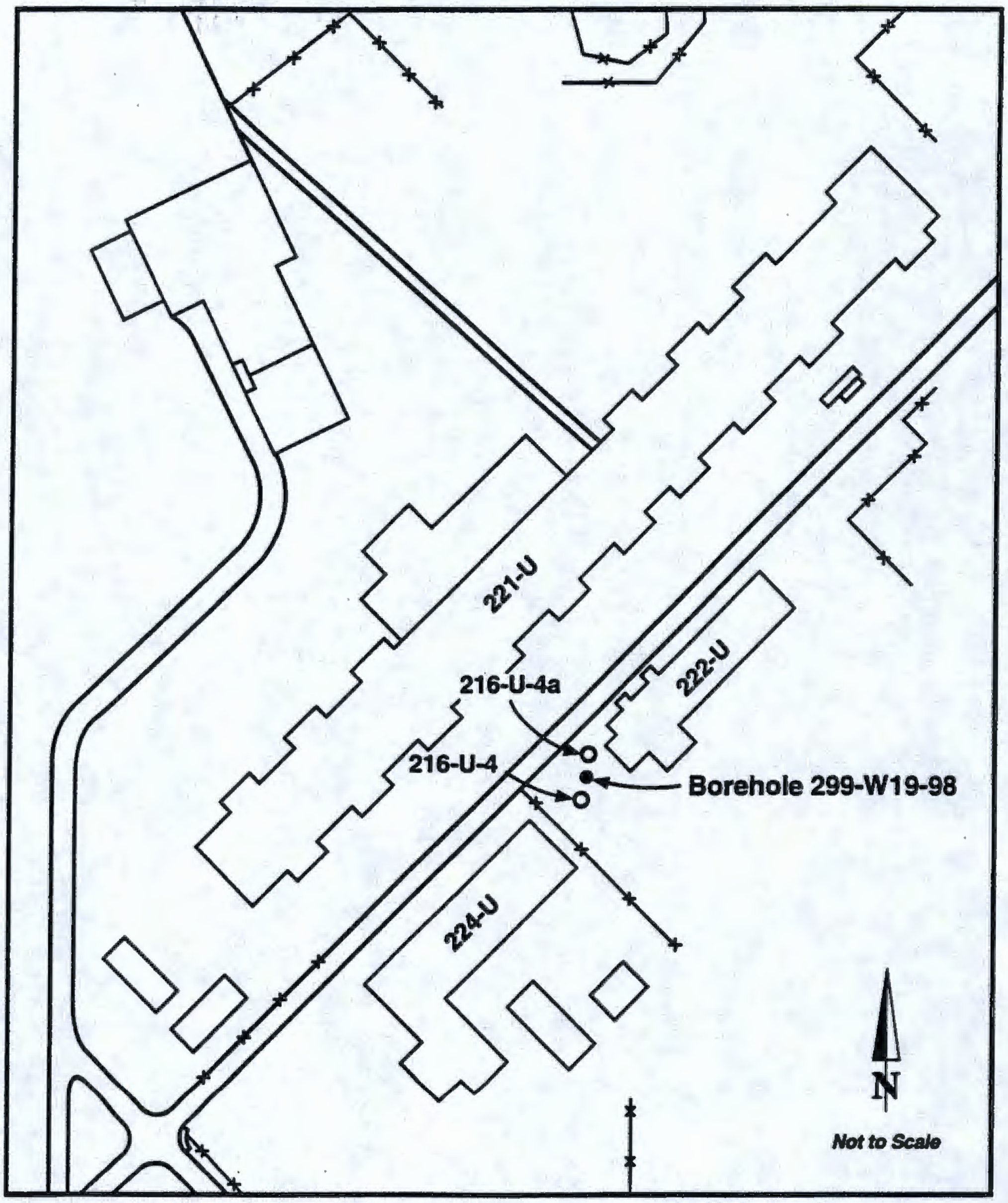


Figure 3-2 200-UP-2 IRM Potential Interferences

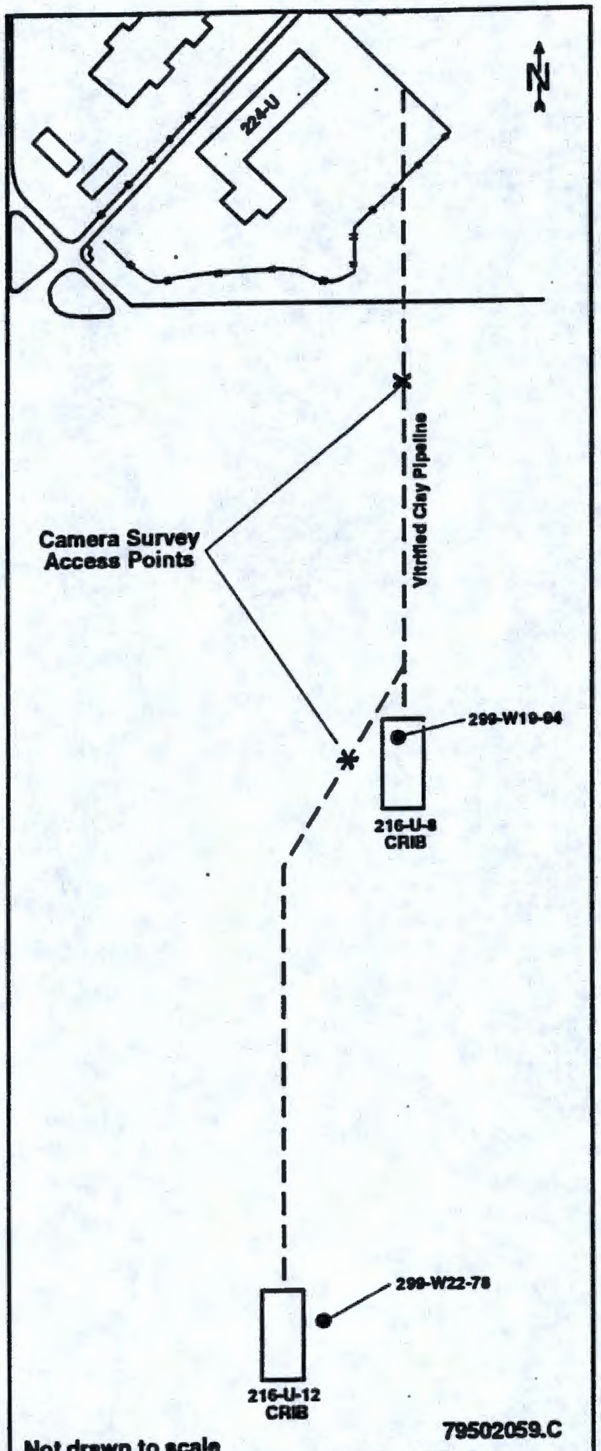
Figure 3-3 216-U-4 Reverse Well/216-U4a French Drain



Waste Site Dimensions	
216-U-4 Reverse Well	- 7.6 cm (3 in.) diameter - 22.9 m (75 ft.) deep
216-U-4a French Drain	- 129.5 cm (51 in.) diameter - 1.5 to 2.7 m (5 to 9 ft.) bgs.

E9601023.10

Figure 3-4 216-U-8 System



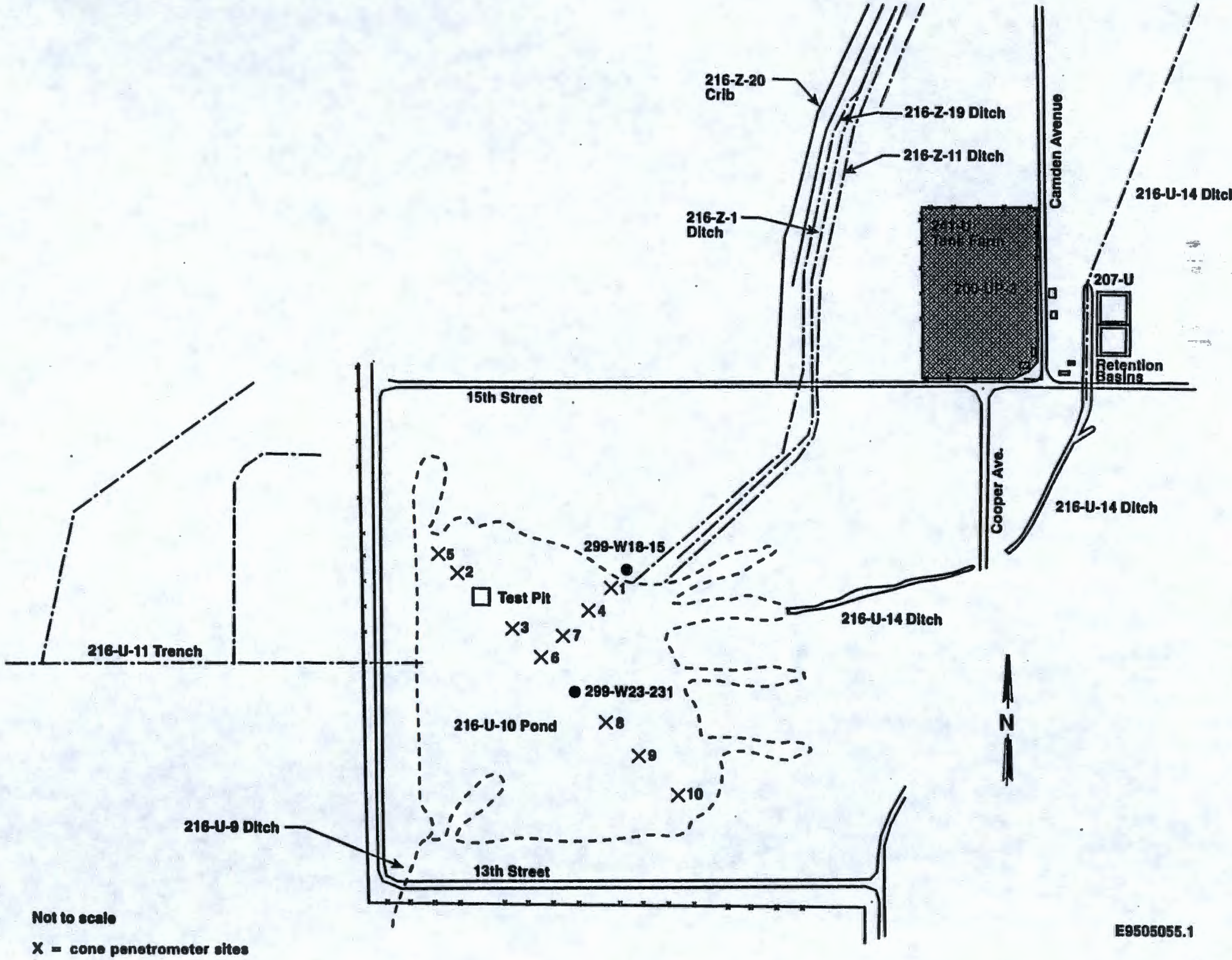


Figure 3-5 216-U-10 System

Table 3-1 Waste Site Investigations Summary (page 1 of 3)

Waste Unit	Investigations	
	Method	**Major Results**
216-U-1 and 216-U-2 Cribs	Record Search	4,000 kg (8,800 lb) disposed of to unit[a]
		Elevated uranium levels in groundwater (72,000 pCi/L)[a]
	Borehole 299-W19-96	
	Sediment Sampling	Majority of inventory is located immediately below the crib at a depth of 6.7 to 7.3 m (22 to 24 ft) Cs-137 (1.758E7 pCi/g) and Sr-90 (2.38E6 pCi/g) are major contaminants.[b]
	RLS	High levels of Cs-137 identified from surface to a depth of 10.8 m (35.5 ft). Other radionuclides (Co-60, Eu-152, -154, U-235, -238) identified between the 9 to 18 m (30 to 60 ft) depth.[b]
	Boreholes 299-W19-95 and -97	
	Sediment Sampling	Drilled north and south of site to evaluate lateral spreading of uranium. Uranium found at the top of the caliche layer in both boreholes.[b]
	RLS	Only radionuclide identified was Cs-137 in the upper 1.8 m (6 ft) of profile. Maximum concentrations are 10 and 20 pCi/g respectively.
	Surface Radiation Survey	Elevated readings detected east of 2607-W5 Drain Field and around 241-U-361 Settling Tank[c].
	Surface Soil Sampling	Highest concentrations were found for Cs-137 east of 2607-W5.[c]
	Stainless Steel Pipeline Integrity Test	Soils surrounding pipeline were clean. Final 6 to 9 m (20 to 30 ft) of pipeline were filled with liquid (roughly 20 gal) believed to be uranyl nitrate. Pipeline has remained intact.
216-U-10 Pond	Historic[d,e]	Pond sediments showed maximum concentrations of Cs-137 and Am-241 in the northern area of the pond. Both values are surface 0 to 10 cm (0 to 4 in.) of pond bottom with concentrations less than detection below this.
	Borehole 299-W23-231	Drilled to investigate potential contamination below pond bottom. No constituents showed elevated readings of concern. Pu-239/240 and U-233/234 were detected slightly above background levels at the caliche layer (41.2 to 41.8 m [135 to 137 ft]).
	Cone Penetrometer Test [d]	Showed elevated readings at the pond bottom (generally 1.8 to 2 m [6 to 6.5 ft] of depth). Two holes showed the potential for contamination at depth, resulting in the drilling of 299-W23-231.

Table 3-1 Waste Site Investigations Summary (page 2 of 3)

Waste Unit	Investigations	
	Method	Major Results
216-U-10 Pond	Test Pit [d]	Pond bottom found at 1.8 m (6 ft) of depth. A 15 cm (6 in.) thick organic rich silt layer indicated the old pond bottom. Radionuclide inventory in this interval was max for all constituents in pond sediments. The COPC values (Cs-137, 4,800pCi/g, Pu-238, 23 pCi/g, Pu-239/240, 36 pCi/g, Sr-90, 190 pCi/g, U-233/234, 85 pCi/g, U-238, 88 pCi/g).
	Surface Radiation Survey	Qualitatively, the perimeter of pond tends to show the greatest amount of radionuclide activity.
	Surface Soil and Vegetation Sampling	Concentrations for COPCs generally not high enough to present risk in surface soils. Sr-90 at 415 pCi/g found in a vegetation sample in SW corner of pond. Pu-239/240 at 74.9 pCi/g found in Z-Ditch delta region, in close proximity to the pond.
216-U-11 Trench	Historic	Periodic surface surveys indicated surface contamination. Soil samples collected in 1978 in SW quarter of pond showed elevated values for Sr-90 and Cs-137.
	Surface Radiation Survey	Qualitative data indicated that the majority of potential surface activity was located in the southern area of the unit.
	Surface Soil Sampling	Of COPCs, Cs-137 was the only contaminant discovered.
216-U-14 Ditch and 207-U Retention Basin	Historic	Roughly 45 Kg of uranium was released to the sites.[d]
		Sediment samples taken for effluent monitoring study[f] showed elevated COPC levels of: Cs-137 U-238 Sediment sample concentrations taken during the U-Pond system deactivation found[d]: Cs-137 in delta region of pond Cs-137 in middle section of ditch U-238 in middle section of ditch
	Surface Radiation Survey[c]	Survey showed, qualitatively, that greatest degree of surface contamination was located in proximity of the 207-U Retention Basins.
	Surface Soil Sampling[g]	Surface soil samples found elevated concentrations of: Cs-137 Pu-239/240 Sr-90 uranium
216-U-4 Reverse Well, 216-U-4a French Drain	Historic[h]	Both units are situated a minimum of 1.5 m (5 ft) below grade. Waste to units is believed to contain less than 1 Ci of beta activity.
	Surface Radiation Survey[g]	Survey showed activity of 100 disintegrations/minute (dpm) alpha to 15,000 dpm beta.
	Borehole 299-W19-98[b]	Two zones of contamination noted, one associated with the release point of each unit. Maximum Cs-137 value was 420 pCi/g at 1.5 m (5 ft) of depth.

Table 3-1 Waste Site Investigation Summary (page 3 of 3)

Waste Unit	Investigations	
	Method	**Major Results**
216-U-8 Crib and VCP	Surface Radiation Survey[i]	Qualitatively, majority of surface contamination is located over the vitrified clay effluent pipeline.
	Surface Soil and Vegetation Sampling[g]	Maximum value for Cs-137 was 525 pCi/g. Maximum value for Sr-90 was 523 pCi/g in vegetation. Field personnel noted that activity increased with depth while collecting samples.
	Pipeline Camera Survey[g]	Vitrified clay pipeline was in poor condition overall. Joints were separated and some were offset.
	Borehole 299-W19-94[b]	Maximum value for Cs-137 was 91,190 pCi/g located directly below the crib. Maximum value for U-238 was 150 pCi/g located at the caliche layer.
216-U-12 Crib and VCP	Pipeline Camera Survey[g]	Pipeline condition was noticeably different from that of the 216-U-8 section. Joints were still intact. Pipe condition looked like new.
	Borehole 299-W22-78	Borehole was drilled on the eastern edge of the crib. Sediment data showed no radiological or chemical contamination. Conclusion was drawn that there was little to no lateral spreading of contaminants.
219-U-9 Ditch	Historic	Contamination of the unit with an unspecified contaminant in 1953 led to deactivation of ditch and backfilling in 1954.[h]
	Surface Radiation Survey	Survey indicated no surface contamination of unit.[g]
Z-Ditch Complex	Historic	Contaminants found in the Z Ditches were Pu-239/240.
		216-Z-19 Ditch shows elevated concentrations at ditch bottom of: Pu-239/240 Am-241 Contamination in the Z-Ditches is concluded to be concentrated in the shallow soils directly beneath the ditches. Deep borings show no contamination below the near surface soils.[d]
	Surface Radiation Survey[c]	Qualitatively, surface contamination of the ditches is located at the southern end of the ditches near the 216-U-10 Pond.
	Surface Soil Sampling[g]	Surface soil samples for elevated concentrations of: Cs-137 Pu-239/240

[a] = U Plant AAMSR (DOE-RL 1992a)
[b] = Borehole Summary Report for the 200-UP-2 Operable Unit (Kelty et al. [1995])
[c] = Surface Radiation Survey Report for the 200-UP-2 Operable Unit
[d] = 216-U-10 Pond and 216-Z-19 Ditch Characterization Studies (WHC-EP-0707)
[e] = Characterization included air, surface water, vegetation, sediment, and groundwater sampling
[f] = Groundwater Impact Assessment Report for the 216-U-14 Ditch
[g] = Surface and Near Surface Field Investigation Data Summary Report for the 200-UP-2 Operable Unit (Wasemiller et al. [1994])
[h] = Environmental Sites Database General Summary Report
[i] = 200-UP-2 Operable Unit Radiological Surveys (Wendling [1994])

Table 3-2 Site Specific Data Sources

Waste Management Unit	Data Sources
216-U-10 Pond	Borehole 299-W23-231 Test Pit 216-U-10-TP Surface soil and vegetation samples
216-U-1 and 216-U-2 Cribs	Boreholes 299-W19-95, -96, -97 Surface soil samples
216-U-4 French Drain and 216-U-4a Reverse Well	Borehole 299-W19-98
216-U-8 Crib	Borehole 299-W19-94 Surface soil and vegetation samples associated with the crib and the vitrified clay effluent pipeline
216-U-12 Crib	Borehole 299-W22-78
Z-Ditches	Surface soil and vegetation samples from the LFI and from deactivation characterization study (Last et al. 1994)

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Table 3-3 200-UP-2 IRM Candidate Waste Sites Summary

Waste Site	Refined COPC	100 mrem/yr PRG, pCi/g	Present Conc.[a], pCi/g	Present Dose[b], mrem/yr	IRM	Notes	Contaminated Volume[c], CY
216-U-1/2 Cribs	Cs-137	480	3,552	740	Yes	Present contaminant levels indicate a need for an IRM	6,600
241-U-361 Settling Tank[g]	Cs-137	480	3,552	740	Yes	Present contaminant levels indicate a need for an IRM	11,300
2607-W5 Septic Tank	NA	NA	NA	NA	No	No need for an IRM due to active status of site	0
2607-W5 Drain Field	NA	NA	NA	NA	No	No need for an IRM due to active status of site	0
216-U-1/2 Stainless Steel Pipeline	Cs-137	480	NA	NA	Yes	No soil contamination warranting an IRM has occurred, but the pipeline will be addressed	0
216-U-16 Crib	Cs-137	480	NA	NA	No	No IRM warranted as defined by PRG because the site is below the zone of receptor intrusion	0
216-U-16 VCP	Cs-137	480	7,027 [d]	1,464	Yes	Present contaminant levels indicate a need for an IRM	1,300
216-U-4 Reverse Well, 4a French Drain	Cs-137	480	252	53	No	No IRM warranted because contaminant levels are below the PRG	0
216-U-8 Crib	Cs-137	480	7,027	1,464	Yes	Present contaminant levels indicate a need for an IRM	2,800
216-U-8 VCP	Cs-137	480	7,027	1,464	Yes	Present contaminant levels indicate a need for an IRM	1,500
216-U-12 Crib	Cs-137	480	7,027 [d]	1,464	Yes	Present contaminant levels indicate a need for an IRM	1,300
216-U-12 VCP	Cs-137	480	7,027 [d]	1,464	Yes	Present contaminant levels indicate a need for an IRM	600
216-U-10 Pond[g]	Cs-137	480	717	149	Yes	Present contaminant levels indicate a need for an IRM	338,900
216-U-11 Trench	Cs-137	480	717	149	Yes	Present contaminant levels indicate a need for an IRM	42,300
216-U-9 Ditch	NA	NA	NA	NA	No	Investigations indicate that no contamination has occurred warranting an IRM	0
216-U-14 Ditch	Cs-137	480	717 [e]	149	Yes	Present contaminant levels indicate a need for an IRM	34,800
207-U Retention Basins[g]	Cs-137	480	717 [e]	149	Yes	Present contaminant levels indicate a need for an IRM	820
216-Z-1D Ditch	Am-241	2,200	3,034 [f]	138	Yes	Present contaminant levels indicate a need for an IRM	13,400
	Pu-239/240	2,500	1,300,200 [f]	52,008			
216-Z-11 Ditch	Am-241	2,200	3,034 [f]	138	Yes	Present contaminant levels indicate a need for an IRM	8,100
	Pu-239/240	2,500	1,300,200 [f]	52,008			
216-Z-19 Ditch[g]	Am-241	2,200	3,034	138	Yes	Present contaminant levels indicate a need for an IRM	19,700
	Pu-239/240	2,500	1,300,200	52,008			
216-Z-20 Crib	Am-241	2,200	NA	NA	No	No IRM warranted as defined by PRG because the site is below the zone of receptor intrusion	0
	Pu-239/240	2,500	NA	NA			

[a] Vertical Average From 0 - 10 Feet Below Ground Surface
[b] Present Dose = (100/100 mrem/yr PRG)*Present Concentration
[c] See Appendix D for Description
[d] Assumed Analogous to 216-U-8 Crib and VCP
[e] Assumed Analogous to 216-U-10 Pond
[f] Assumed Analogous to 216-Z-19 Ditch
[g] Includes Unplanned Releases Defined in Table 1-1

4.0 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

This section develops a range of potential, interim remedial action alternatives that address the threats posed by contaminants present at the 200-UP-2 IRM candidate waste sites. Preliminary remedial action alternatives for these waste sites have been developed in the AAMSR (DOE-RL 1992a). However, since the publication of that document, additional investigations have occurred at the 200-UP-2 Operable Unit. The additional data, as reported in the *Limited Field Investigation for the 200-UP-2 Operable Unit* (DOE-RL 1995a), have been evaluated and incorporated in the refinement of the RAOs (Section 2.0) and extents of contamination (Section 3.0 and Appendix D) for each candidate waste site.

The AAMSR (DOE-RL 1992a) identified the following GRA for the U-Plant source operable unit waste sites:

- no action
- institutional controls
- waste removal and treatment or disposal
- waste containment
- in situ waste treatment
- combinations of the above.

Potential remedial technologies consistent with these GRA are presented in Section 4.1. Process options within each technology type are also presented. Section 4.2 begins with a revision of the AAMSR GRA, as appropriate, with consideration of the additional site-specific data and the refined RAOs. Following this revision, interim remedial action alternatives are then assembled consistent with the revised GRAs by combining selected technologies and process options.

The 216-U-12 Crib will undergo modified closure in accordance with WAC 173-303-610 and the Hanford Site RCRA Permit Condition II.K.3. Any discussions that follow regarding the 216-U-12 Crib are for the purpose of remediating radiological constituents of concern at that unit.

4.1 POTENTIAL REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

This section identifies potential remedial technologies and associated process options to be considered for addressing threats posed by contamination at the 200-UP-2 IRM candidate waste sites. Remedial technologies and process options were originally identified and screened for this operable unit during the AAMSR (DOE-RL 1992a). Since the preparation of that document, additional investigations have occurred at the 200-UP-2 Operable Unit. A review of the new data, however, does not suggest that technologies and process options eliminated during the AAMSR screening should be reinstated. Therefore, all technologies and process options retained during the AAMSR screening constitute the baseline of potential interim action components. Each technology and process option is discussed in the following sections. Treatability study results and other pertinent information are also included, as available.

4.1.1 Surveillance and Maintenance

Institutional control and multimedia surveillance monitoring technologies are discussed in the subsections below. Instructional controls consist mostly of access restrictions designed to minimize present and future exposure to contamination. Monitoring may also be performed to document any changes in the level or distribution of contaminants. The 200-UP-2 Operable Unit has been and will continue to be under DOE institutional controls. These controls include restricted access, fencing around the 200 Area, and environmental monitoring. The surveillance and maintenance technology utilizes these existing controls and embellishes them with active contamination control measures described in Section 4.1.1.4.

4.1.1.1 Deed Restrictions. Deed restrictions are legal specifications for land use. Typical deed restrictions include a ban on activities that may bring humans in contact with contaminants. Deed restrictions may include (1) provisions that prevent the use of groundwater, (2) requirements for approval of excavations beyond a specified depth, and (3) limitations on land use by prohibiting activities such as grazing and farming. Deed restrictions will not be included in the scope of the IRM as DOE will maintain site ownership.

4.1.1.2 Signs/Fencing. Warning signs may be used to notify workers and members of the public of potential threats posed by conditions at the site. Examples of such warning signs include "Underground Radioactive Material," "Entry by Authorized Personnel Only," and "Keep Out." Fencing is a physical barrier around a contaminated area that limits worker and public access.

4.1.1.3 Entry Control. Entry control may consist of physical combinations of controls such as fencing, security guards, perimeter detection sensors, surveillance cameras, and warning signs. The intent of entry controls is to minimize or eliminate access to the site.

4.1.1.4 Surveillance and Maintenance. Monitoring will be performed at sites where contamination is left in place above the PRGs. For example, if a surface barrier is constructed to eliminate exposure to contaminated media, groundwater monitoring may be conducted to monitor migration of leachate. Groundwater monitoring will be performed as part of the 200-UP-1 Operable Unit. Additionally, routine radiological and physical site surveillances would be conducted to monitor barrier integrity and contaminated migration. Monitoring is generally required to evaluate the long-term effectiveness of any action. Also, because any remedial action selected as a result of this FFS may be an interim action, performance assessment monitoring should provide additional data to evaluate the need for further final action. Activities performed as part of surveillance and maintenance included application of herbicide/pesticide (as needed), hot spot contamination removal as necessary, and surface radiological surveys.

4.1.2 Capping

A number of barrier types have been proposed for application at the Hanford Site. These barriers differ in terms of design from a relatively simple biointrusion barrier to complex multilayered systems intended to function for a minimum of 1,000 years. For the purpose of this FFS, it is assumed that all capping applications being evaluated will, to the extent possible, accommodate existing utilities and monitoring wells. If such accommodations cannot be made, appropriate replacement activities will be conducted.

The following sections describe the four distinct cap types that may be applied at the 200-UP-2 source areas.

4.1.2.1 The Hanford Barrier. The Hanford Barrier is the baseline designed for TRU-contaminated soil sites, sites with TRU or TRU-mixed waste in nonretrievable configuration, and sites with greater-than-class C low-level waste (LLW) or greater-than-class C mixed waste. This barrier is designed to remain functional for a performance period of 1,000 years and to provide the maximum degree of hydrologic protection from contaminated media.

The Hanford Barrier design consists of a fine-soil layer overlying layers of coarser materials (e.g., sands, gravels, and basalt riprap) and a composite asphalt layer.

- **Fine-Soil Layers.** The uppermost portion of the barrier consists of two, 1 m (40 in.)-thick layers of fine soil that have been engineered with a gradual slope. The difference between the two layers is that the upper meter of fine soil has been mixed with pea gravel. The pea gravel and vegetation growing on the barrier surface will significantly reduce wind and water erosion.

  The fine-soil layers act like a sponge to store any precipitation that does not run off the barrier. The textural difference between the fine soils and underlying sand layer creates a capillary barrier that inhibits the downward percolation of water into the sand layer and other coarser materials below. Keeping the water in the fine-soil layers provides time for the processes of evaporation and plant transpiration to remove the excess moisture.

- **Sand and Gravel Filter Layers.** A graded filter, consisting of a 15 cm (6 in.)-thick layer of sand and 30-cm (11-in.)-thick layer of gravel is placed under the fine-soil layers. This graded filter minimizes the sifting of overlying fine-textured soils into the pore spaces of the coarser materials below. To maintain the textural difference between the silt loam and sand layers during construction, a geotextile is installed on the sand layer before placement of the fine-soil layers.

- **Fractured Basalt Riprap Layer.** A 1.5 m (5 ft)-thick layer of fractured basalt is added to the barrier to create another effective deterrent to inadvertent human intruders, burrowing animals, and plant roots that may try to penetrate deeper into the barrier profile.

- **Drainage Gravel.** A 30-cm (11-in.)-thick layer of gravel is placed directly below the fractured basalt riprap and on top of the composite asphalt layer. These gravels serve as a cushion to protect the composite asphalt layer and as a drainage medium.

- **Composite Asphalt Layer.** The low-permeability asphalt layer is a composite of two layers of compacted asphaltic concrete, each 7.5 cm (3 in.)-thick, overlain by approximately 5 mm (0.20 in.) of polymer modified asphalt. If water reaches this depth, the composite asphalt layer will function like an umbrella, diverting the percolating water from the waste zone. The composite asphalt layer limits the exhalation of any noxious gases and also serves as an effective intrusion barrier.

- **Gravel Base Course.** A 10 cm (4 in.)-thick layer of gravel is placed directly below the composite asphalt layer to provide a structurally stable medium upon which the composite asphalt layer can be compacted.

- **Native Soil Foundation.** The native soil foundation, or subbase material, is graded and compacted as necessary to provide a 2 percent slope that is maintained throughout all of the overlying layers.

In 1994 a 2 hectare (5 acre) prototype Hanford Barrier was constructed over the 216-B-57 Crib in the 200-BP-1 Operable Unit. The prototype barrier is well instrumented and designed to assess the movement of moisture within the various layers. The fine-soil layers and other layers of the prototype barrier are equipped with instruments, such as water collection basins, pan lysimeters, neutron probe access tubes, thermometers, and transducers, to monitor the changes in soil water storage and the movement of water. The construction of the prototype barrier is summarized in *Constructability Report for the 200-BP-1 Prototype Surface Barrier* (DOE-RL 1994a).

The testing and monitoring of the performance of the prototype barrier will continue for at least 3 years (Gee et al. 1993 and DOE 1993). Because only a limited amount of time exists to test a prototype barrier that is intended to function for a minimum of 1,000 years, the testing program has been designed to "stress" the prototype so that barrier performance can be determined within a reasonable timeframe. Stressing the prototype will be accomplished by adding supplemental precipitation (rain and snow) at rates representative of anticipated future climatic changes.

Initial test results show that, for the Hanford Site's arid climate, a well-designed capillary barrier limits water drainage through the barrier to imperceptible amounts. A subsurface asphalt layer provides additional redundancy. The data collected under extreme event testing (excess precipitation) support projections that the barrier will meet its performance objectives during the 1,000-year minimum design life.

The Hanford Barrier is not considered applicable for IRMs at 200-UP-2 since there is no current need for a hydrologic barrier.

4.1.2.2 Modified RCRA Subtitle C Barrier. The modified RCRA Subtitle C Barrier is the baseline design for sites containing not only dangerous waste, but also Category 3 LLW, Category 3 low-level mixed waste (LLMW), and Category 1 LLMW. The barrier is designed to provide containment and hydrologic protection for a performance period of 500 years.

The term "modified" designates that this design varies in certain key respects from EPA's minimum technology requirements (MTR) for RCRA covers. The MTR cover is a 30-year design that employs a two-component barrier layer consisting of a 0.6 m (2 ft)-thick compacted clay with an overlain geosynthetic membrane material. Neither of these materials appear to be well suited for modified RCRA Subtitle C Barrier application at a semiarid site, such as Hanford, given their propensity to develop shrinkage cracks under very dry conditions.

The modified RCRA Subtitle C barrier is comprised of components similar to those in the Hanford Barrier with the following exceptions. First, the two fine-soil layers that represent the uppermost portion of the RCRA barrier are one-half the thickness of their Hanford Barrier counterparts. Secondly, no Fractured Basalt Riprap Layer is present in the Modified RCRA Subtitle C Barrier. Lastly, the lateral drainage layer is only 15 cm (6 in.) thick, as opposed to 30 cm (12 in.) in the Hanford Barrier.

The modified RCRA Subtitle C Barrier is not considered applicable for IRMs at 200-UP-2 since there is no current need for a hydrologic barrier.

4.1.2.3 Modified RCRA Subtitle D Barrier. The modified RCRA Subtitle D Barrier is the baseline design for potential applications at nonradiological and nonhazardous solid waste sites, as well as Category 1 LLW sites where no hazardous waste constituents are present. It is designed to provide limited biointrusion and limited hydrologic protection (compared to the Hanford and modified RCRA Subtitle C Barriers) for a performance period of 100 years.

The term "modified" indicates that this design varies in certain key respects from the minimum functional standards design for covers over solid waste sites. This barrier is composed of four layers having a combined thickness of 90 cm (36 in.) minimum. Layer 1 (top layer) consists of 20 cm (8 in.) of sandy silt to silt loam with 15 percent admixture of pea gravel. Layer 2 consists of 40 cm (16 in.) of the same topsoil material without pea gravel. Layer 3 consists of 30 cm (12 in.) of the same material in Layer 2, but placed in a relatively densified condition. Layer 4 consists of grading fill placed over the preexisting site grade to establish a smooth, planar base surface for construction of the overlying layers.

The modified RCRA Subtitle D Barrier is not considered applicable for IRMs at 200-UP-2 as it has a design life less than the IRM timeframe and provides limited biointrusion control.

4.1.2.4 Biointrusion Barrier. The biointrusion barrier is designed for use at sites that contain hazardous low-level and mixed waste constituents that do not indicate a need for a hydrologic barrier. The primary function of this cover design is to provide protection against plants, animals, and humans contacting the waste for a performance period of 500 years without maintenance. This cover was designed to be a lower cost alternative to using the more expensive RCRA Subtitle C cap.

The biointrusion barrier is composed of five layers having a total thickness of 92 cm (37 in.). A detailed description of the functions of each cover layer is provided in the following sections. The uppermost layer is described first followed by descriptions of each successively deeper layer. A cross section of the barrier is shown in Figure 4-1. It is recognized that sources of some of the materials identified for barrier construction may be culturally and/or ecologically sensitive.

Alternative materials and sources have been considered and further evaluation of materials may be warranted.

Layer 1: Pea Gravel. This layer is designed to provide protection against wind erosion of the underlying layer of filter sand. Pea gravel is applied as a thin 15 cm (6 in. minimum) layer over the filter sand. It is intended that the pea gravel will naturally mix with the filter sand to yield a pea gravel-sand mixture similar to layer 1 of the Hanford Barrier. The pea gravel has been demonstrated to reduce wind erosion of soil when included as a 15 percent by weight admixture.

Layers 2 and 3: Filter Sand and Filter Gravel. These layers are designed to prevent the piping of soil fines into the crushed basalt (layer 4). The accumulation of soil fines in the interstitial spaces of the crushed basalt could act as a routing medium for plants, facilitating biointrusion into the contaminated subgrade.

Layer 4: Crushed Basalt. The purpose of this layer is to form a biointrusion layer to isolate the underlying waste from contact with plant roots and/or burrowing animals and insects. Plant root intrusion into the waste could potentially result in uptake of radionuclides, such as strontium with subsequent transport to the surface. Animal intrusion into the buried waste could provide a direct path for the movement of contaminated material to the soil surface.

Layer 5: Grading Fill. Grading fill will be used to establish a smooth base for the construction of the overlying cover layers. The subbase will be graded to match existing topography, but will not exceed a 2 percent slope that could cause soil erosion problems. Construction of a level or near-level subbase will also facilitate the construction process by allowing for more accurate placement of lifts of cover materials.

4.1.3 Vertical Barrier

Vertical barriers are a remedial control technology primarily used to contain or divert the flow of groundwater. Vertical barriers should be keyed into a continuous low-permeability stratum or an artificial horizontal barrier to prevent groundwater migration underneath the vertical barrier. Impacts to groundwater from the 200-UP-2 IRM candidate waste sites are not anticipated; therefore, these technologies are not being considered further.

4.1.4 Dust and Vapor Suppression

Effective dust control is needed during remedial action construction, particularly during excavation, as operations may generate fugitive dust. Dust control measures are provided to reduce the spread of contamination by entrainment of fugitive dust, to minimize the impacts on local air quality, and to minimize the exposure to onsite personnel. Water sprays are the primary means for controlling fugitive dust. Water is applied to an active excavation face by water trucks or local hydrants at the amount of approximately 1 gal/yd^2 (EPA 1985). Crusting agents may be applied to active excavations before short-term work breaks. Access ramps and haul roads also require dust suppression. Haul roads will be constructed and maintained using soil cementing agents. Dust and vapor suppression technologies will be implemented with any alternative which may introduce contamination migration (e.g., excavate, barrier placement).

4.1.5 Excavation

Excavation will be performed using conventional equipment and methods, including excavators (backhoes), bulldozers, and wheeled loaders. Excavators with grappling attachments will be used to remove and process concrete, steel structures, and pipelines, if necessary. The excavation of contaminated soils may also require other secondary/peripheral components, such as demolition of contaminated structures, realtime analytical field screening, dust control, and processing of materials to allow for proper treatment and/or disposal. Removal technologies have previously been explored for use in the 200 Areas on a large scale (WHC 1991a). High-activity waste, if encountered, would be remotely handled, shielded, and transported to a secure area. The high-activity waste would then be disposed of according to the *Hanford Site Solid Waste Acceptance Criteria* (WHC 1993).

The contaminated waste removal process involves the following steps:

- Remove and stockpile topsoil (if possible) and clean overburden, where present, to expose the contaminated material.
- Excavate soils with contaminant concentrations exceeding PRGs.
- Demolish contaminated structures as part of or concurrent with the excavation, if necessary.
- Implement dust control measures and realtime analytical field screening during excavation.
- Support nearby structures affected by excavation (where necessary).
- Process/treat materials removed (processing with equipment other than excavation equipment is discussed as a separate technology).
- Reclaim the site with vegetation and soil to control erosions and increase site aesthetics.

For the purpose of this FFS, it is assumed that all excavation activities evaluated for application will, to the extent possible, accommodate existing utilities, associated structures, and monitoring wells. If such accommodations cannot be made, appropriate demolition/replacement activities will be conducted.

4.1.6 Thermal Treatment

The processes described herein use ex situ thermal technologies to convert hazardous waste to nonhazardous forms.

4.1.6.1 Ex Situ Vitrification. Vitrification is a treatment process for immobilizing metals, including radionuclides and other inorganic contaminants in a glass or ceramic matrix. For contaminated soil, the glassy matrix is derived from the soil itself, although glass frit or ceramic admix may also be used.

When used ex situ, vitrification is typically performed in a ceramic melter, rotary kiln, or similar equipment. Organic compounds, if present, are destroyed via oxidation or pyrolysis.

Because very low leaching rates are possible, vitrification is a component of most high-level nuclear waste treatment programs. Vitrification plants have been successfully operated in Europe and numerous test programs have also been successfully completed in the United States. As a result, vitrification facilities are either under construction or in the planning stages at several DOE facilities, including the Hanford Site (Wicks et al. 1991). These facilities typically employ ceramic melters and are highly automated to minimize personnel exposure.

Vitrification processes using rotary kiln incinerators and similar industrial equipment have been developed for hazardous waste remediation, and could be effective for remediating low-level radioactive soil contamination. Rotary kiln vitrification of low level radioactive soils could be more cost-effective than the vitrification processes developed for high-level nuclear waste because higher processing rates should be achievable.

Vitrification is generally not the preferred technology for low-level radioactive waste because other treatments, such as mixing with cement, are much less expensive and the high degree of protection afforded by vitrification is not required. However, conditions present at 200-UP-2 do not indicate a need for ex situ fixation of contaminants; therefore, ex situ vitrification is not considered applicable for IRMs at 200-UP-2.

4.1.6.2 Thermal Desorption. Thermal desorption is a process that uses relatively low temperatures to thermally remove volatile organic compounds (VOC) and some semivolatile organic compounds (SVOC) from contaminated soils, sediments, solids, or sludges. Because VOCs and SVOCs area not COPC for the operable unit, thermal desorption is eliminated from further consideration.

4.1.7 Physical Treatment

Separation of hazardous constituents may be achieved via physical treatment. The following subsections describe applicable physical treatment process options.

4.1.7.1 Soil Washing. Soil washing is a remedial technology that may remove organic compounds, inorganic compounds, and radionuclides from soils. Soil washing can consist of (1) size separation of highly contaminated soil fractions (usually fines) from minimally contaminated soil fractions (typically course gravels and sands), (2) mechanical abrasion (such as trommels, ball mills, or autogenous grinding) to remove surface contamination (followed by separation), and (3) solvent extraction to leach the contaminants from the soil particles. Each technique can be used independently or in combination with each other.

Soil washing using physical separation is performed when contaminants are concentrated in one soil size fraction. This method works best when the contaminants are in the finer soil fractions (because of the larger surface area per unit mass and the higher adsorption tendencies). Physical soil separation segregates the contaminated fractions from the relatively clean soil and thereby reduces the volume of contaminated soil requiring disposal. Physical separation can involve wet or dry sieving alone, or it can be combined with gravity separation, classification, attrition scrubbing, or autogenous grinding, followed by some form of wastewater treatment involving suspended solids recovery. Attrition scrubbing (wearing away by friction) physically removes contaminants that exist as coatings or precipitates on soil particles. Attrition scrubbing is used if the contaminants are found primarily in the sand-sized material at the site. Autogenous grinding serves the same purpose for coarse (cobbles and boulders) material. In this case the cobbles and boulders themselves provide the mechanical abrasion to remove the surface-deposited contaminants.

Soil washing by solvent extraction involves the selective removal of contaminants from soil particles by contact with a liquid. This process has been used extensively in the mining and metallurgy industries, and the same basic principles apply to the extraction of contaminants from soil. The success of this technique generally depends on the proper selection of extractants (chemicals) and in understanding the kinetics of the reactions of concern (DOE-RL 1993b). Typical extractants include aqueous acids, alkalis, organic solvents, and surfactants. Extraction solvents are not currently available for all contaminants, and extraction efficiencies may vary for different types of soils, concentrations of contaminants, and site-specific parameters (Freeman 1989).

Soil washing has met limited success for soils contaminated with cesium-137. Because cesium-137 is prevalent in the 200-UP-2 waste sites, soil washing is not considered applicable for IRMs at 200-UP-2.

4.1.7.2 Fixation/Solidification/Stabilization. Fixation/solidification/stabilization involves mixing contaminated material with cement to reduce leachability and bioavailability. The fixation mixture typically consists of pozzolanic agents such as fly ash or kiln dust and cement. Plasticizers, hardening agents, and other additives are available to adjust the required physical properties of the final product. Treated waste exists as a solidified mass similar to concrete with significant unconfined compressive strength.

Fixation is an established technology for treatment of waste and soils contaminated with inorganic compounds and radionuclides. A typical fixation process involves the following steps:

- contaminated materials are screened to remove oversized material

- contaminated materials are introduced to a batch mixer and mixed with water, chemical reagents and additives, and cement

- after the material is thoroughly mixed, it is discharged into molds and allowed to solidify

- the solidified unit is then disposed.

A cement solidification/stabilization treatability study was recently completed for Operable Unit 1 of the Fernald Environmental Management Project (DOE 1993). Cement solidification testing was performed on waste from six waste pits. The waste treated was derived from Waste Pits 1, 2, 3, 4, 5, and 6. The waste composition was as follows:

Waste Pit 1: Filter cakes, vacuum-filtered sludges, magnesium fluoride slag, scrap graphite, and contaminated brick. Contained 1,075 metric tons (MT) of uranium.

Waste Pit 2: Same as Waste Pit 1. Also received raffinate residues. Contained 175 MT of uranium.

Waste Pit 3: Lime-neutralized raffinate slurries, contaminated storm water, vacuum-filtered production sludge, neutralized liquid from process systems, neutralized refinery sludges, and cooling water from heat-treatment operations. Contained 846 MT of uranium and 97 MT of thorium.

Waste Pit 4: Solid waste, including process residues, scrap uranium metal, off-specification intermediated uranium products and residues, thorium metal and residues, barium chloride, and contaminated ceramics. Also received noncombustible trash, including cans, concrete, asbestos, and construction rubble. Lime was occasionally added for uranium precipitation. Contained 2,203 MT of uranium and 74 MT of thorium.

Waste Pit 5: Slurries, including neutralized raffinates, acid leachate, filtrate from sump slurries, lime sludge, thorium in barium carbonate sludge, thorium in aluminum sulfate sludge, and uranium in calcium oxide sludge. Contained 527 MT of uranium and 72 MT of thorium.

Waste Pit 6: Magnesium fluoride slag, process residues, filter cakes, extrusion residue, and heat treatment quench water. Contained 1,432 MT of uranium.

Portland cement (Type I/II) and blast furnace slag were used as binders. Additives to the cement included Type F fly ash, site fly ash, absorbents, and sodium silicate. Solidified samples were tested for strength, leach resistance, permeability, and durability. The following results were obtained.

- All formulations passed toxicity characteristic regulatory criteria.

- Leachability of uranium was controlled except when present in high concentrations (Waste Pit 4).

- No significant temperature increases or offgassing occurred during mixing.

- Formulations developed could be applied on a large scale.

- Formulations with >43 percent Portland cement Type II were effective in meeting the 500 psi strength requirement set for an onsite retrievable waste form. This composition also effectively controlled leaching of uranium and gross alpha and beta.

- A significant increase in volume resulted from the cement stabilization process.

- Raffinate residues or lesser amounts of uranium (90 percent less than in Pit 1) in Pit 2 caused the percentage of organics in the waste to be at a much higher level.

- Permeabilities of all the solidified samples were low.

- Solidified samples passed criteria set for durability (wet/dry and freeze/thaw). Addition of blast furnace slag reduced durability.

Because 200-UP-2 waste site characteristics do not indicate the need for fixation/solidification/ stabilization (i.e., presence of land disposal restricted waste), this technology is not considered applicable to IRMs at 200-UP-2.

4.1.8 Disposal

Disposal (both within and outside the boundary of the Hanford Site) is being considered as an applicable technology. Disposal options are ultimately dependent upon waste acceptance criteria and the availability of a disposal facility. The following subsections provide a range of disposal options.

4.1.8.1 Trench Disposal. For purposes of the FFS, two trench disposal facilities exist (or will soon exist) which will provide the required disposal capacity for remediation of the 200-UP-2 waste sites. These two facilities include the W-025 Radioactive Mixed Waste Land Disposal Facility and ERDF. The major design components of each facility are discussed in the following paragraphs.

The major components of the W-025 facility are the disposal trench, a contaminated water temporary storage facility, utility systems such as electrical and communications, a security system, a stormwater management system, and a control building. The facility is located within the existing Low-Level Burial Area No. 5 between trenches 39 and 47 in the 200 West Area. The disposal trench is a rectangular landfill with a RCRA compliant liner. The trench will provide a burial capacity of approximately 21,000 m^3 (28,000 yd^3). The landfill is being constructed with a primary leachate collection system, a secondary leachate collection system, and a RCRA compliant cover. Waste will be transported to the facility by truck from the source areas. The design and operations of the facility are presented in the design report (WHC 1990). The facility will accept solid waste in accordance with the *Hanford Site Solid Waste Acceptance Criteria* (WHC 1993), which meet the requirements of RCRA and DOE (DOE Order 5400.5).

The major components of ERDF are as follows: waste disposal trench; leachate collection and storage; surface water runon/runoff control system; real-time air monitors and samplers; groundwater monitoring; use of existing Hanford Site transportation system; security/institutional controls; and fuel and chemical storage and dispensing areas and other infrastructure facilities.

The ERDF site will cover a maximum of 4.1 km^2 (1.6 mi^2) on the Central Plateau, southeast of the 200 West Area and southwest of the 200 East Area. The ERDF will be constructed in phases, with the first phase expected to provide a waste disposal capacity of over 900,000 m^3 (approximately 1.2 million yd^3). Waste acceptance criteria for this facility have been developed by DOE (BHI 1995a). The ERDF is designed to accept waste generated during the remediation of the 100, 200, and 300 Areas at the Hanford Site. Waste entering ERDF will be controlled on the basis of source, classification, and contaminant levels. The facility will accept low-level radioactive, dangerous/hazardous waste, hazardous substances, and low-level mixed waste. To coordinate the ERDF and waste source site remedial action operations, all incoming waste to ERDF will be handled in a uniform, consistent, and predictable manner. Given the estimated volumes of contaminated materials requiring disposal in this FFS, it has been assumed that the ERDF site is the only viable trench disposal alternative.

4.1.8.2 Geologic Repository. A geologic repository is an underground disposal facility constructed in a stable geologic setting. The design goal is to prevent exposure of biological receptors to radioactive waste or radioactive constituents for at least 10,000 years. However, no geologic repository for radioactive waste is currently available.

A geologic repository for high-level nuclear waste (spent nuclear fuel and byproduct waste) is proposed for construction at Yucca Mountain, Nevada. Another repository for TRU, the Waste Isolation Pilot Plant (WIPP), is presently under construction near Carlsbad, New Mexico and may be operational within a few years. Because space at any geological repository will be limited--and there is a backlog of high-level nuclear waste--disposal of all soil contaminated with low concentrations of radionuclides from sites such as 200-UP-2 at Yucca Mountain or WIPP would not be feasible.

Use of a geologic repository is not envisioned as a primary element of remediation for this operable unit. However, it is possible that contaminated soil encountered during soil remediation especially for the Z-Ditches where plutonium-239 and americium-241 have been detected at or near TRU levels, or waste generated from soil treatment (e.g., waste water sludge), could meet regulatory or DOE policy definitions that require disposal in a geologic repository. Therefore, a geologic repository is retained as an alternative to landfill disposal, if required.

4.1.8.3 Liquids Disposal. Given the small quantity of liquids present in the 216-U-1/2 Stainless Steel Pipeline (i.e., less than 50 gal), rigorous development of liquid treatment technologies is not warranted. Accordingly, liquids in the below-grade stainless steel pipe will be pumped to a 55-gallon drum and stored/disposed in accordance with typical Hanford waste handling protocols.

4.1.9 In Situ Thermal Treatment

In situ vitrification was the only in situ thermal treatment technology retained in the *U-Plant AAMS Report* (DOE-RL 1992a). This technology is presented in the following subsection.

4.1.9.1 In Situ Vitrification. In situ vitrification is a thermal treatment process that converts soil and other materials into stable glass or glass-like crystalline substances. In situ vitrification uses joule heating to transmit electric energy to the soil, heating it, and producing a molten glass zone that stabilizes the contaminants in place. In situ vitrification produces a durable product that is capable of long-term immobilization of many metals and radioactive waste.

The in situ vitrification treatment system consists of the electrical power supply, the offgas hood, and offgas equipment (Freeman 1989). The offgas system consists of a gas cooler, two quench towers, hydrosonic tandem nozzle scrubbers, two heat exchangers, three vane-separated mist eliminators, two scrub solution tanks, two pumps, a condenser, and high-efficiency particulate air filters (PNL 1992). Except for the offgas hood, all process components are contained in three transportable trailers.

In the in situ vitrification process, electrodes are inserted into the soil and a conductive mixture of flaked graphite and glass frit is usually placed between the electrodes to act as the starter path for the electrical circuit. The current of electricity passing through the electrodes heats the soils and graphite to temperatures of approximately 2,000°C (3,632°F) and melts the soil. The graphite starter path is eventually consumed by oxidation and the current is transferred to the molten soil (now electrically conductive). As the vitrified zone grows downward and outward, metals and radionuclides are incorporated into the melt. Organics are vaporized and then pyrolyzed as they pass upward through the melt. When the electrical current ceases, the molten volume cools and solidifies. A hood placed over the processing area provides confinement for the evolved gases, drawing the gases into an offgas treatment system.

In situ vitrification has proven to be an effective remedial technology for the immobilization of organics, metals, and radionuclides. However, specific site characteristics must be considered to determine the implementability of in situ vitrification. The presence of excessive moisture or groundwater can limit the economic practicality of in situ vitrification because of the time and energy required to eliminate the water. Soils with low alkaline content may be unable to effectively carry a charge and thereby diminish the applicability of in situ vitrification (EPA 1992). Large quantities of combustible liquids or solids may increase the gas production rate beyond the capacity of the offgas system. In addition, the presence of metals in the soil can result in a conductive path that would lead to electrical shorting between electrodes. However, this problem can be avoided by innovative electrode feeding techniques. In situ vitrification is currently limited to a maximum depth of 5.8 m (19 ft) (EPA 1992).

Before using in situ vitrification, the site is prepared by clearing vegetation, grading, and removing uncontaminated overburden by excavation (the cost to excavate uncontaminated material is much lower than the cost to vitrify). The waste area is divided into vitrification settings based on an electrode spacing of 43.5 m (14.8 ft). Four electrodes are used at a time at a width of 7.8 m (25.6 ft) per setting. Therefore, approximately one setting will be needed for each 56 m^2 (602 ft^2) of waste area. After the system is prepared, the four electrodes are simultaneously fed into the soil initiating the melt. The electrodes are continually fed until the desired vitrification depth is achieved and the melt is completed. An in situ vitrification processing rate of approximately 4 to 5 tons/hour is anticipated (EPA 1992). Once solidified, the sunken vitrified area is backfilled to a minimum of 1 m (3 ft) above the block. A crane is used to transport the electrode frame and hood to the next setting.

Two in situ vitrification treatability studies were conducted at the Hanford Site between 1987 and 1989 to evaluate in situ vitrification under site-specific conditions. Two waste cribs (216-Z-12 and 116-B-6A) were vitrified to depths of 4.9 and 4.3 m (16 and 14 ft), respectively. The depth limitation at the 116-B-6A crib area was believed to be the result of a cobble layer present at 4.3 m (14 ft). This resulted in preferential lateral growth rather than downward growth. When a large particle size layer is encountered, a high equilibrium temperature is necessary to achieve the same downward progression rate (PNL 1992). However, typically, heterogenous power distributions occur within the melt; half of the delivered power is held in the upper third of the melt, and power decreases as the depth increases. This results in a slower melt advance as the melt reaches an equilibrium, and finally melt advance stops (EPA 1992). Thus, the melt at the 116-B-6A Crib may not have extended much deeper, regardless of the cobble layer.

Although treatability studies have demonstrated possible effectiveness problems because of depth limitations, the Hanford Site 200 Areas include locations where in situ vitrification may be used. In situ vitrification stabilizes radionuclide and metal contaminated soils if the contaminant material type, concentrations, and depth are within process parameter limitations. In situ vitrification is considered incompatible with potential future final actions since long term future site uses are not defined. Therefore, in situ vitrification is not considered applicable to IRMs at 200-UP-2.

4.1.10 In Situ Physical Treatment

The processes described herein effect a separation or stabilization of constituents from/in their natural environment, without the need for excavation and ex situ waste handling. The following subsections provide details regarding applicable in situ physical treatment options.

4.1.10.1 Soil Vapor Extraction. Soil vapor extraction systems involve the extraction of air containing volatile contaminants from unsaturated soils. Clean air is injected into the contaminated soils, and a vacuum apparatus is used to extract the vapor-filled air from recovery or extraction wells. The operation uses an air blower and the inducted air flows come into equilibrium with extracted air. The established air flows are a function of the equipment used and soil characteristics, including soil air permeability.

The pore space of unsaturated soils is composed of liquid and vapor phases in equilibrium. Contaminants with high vapor pressures partition into the vapor phase in the air-filled pore spaces. With vapor extraction systems, these partitioning characteristics of volatile contaminants are used to facilitate their extraction when a vacuum is applied to the soil. This results in the liquid-phase contaminants being volatilized to maintain the liquid-vapor phase equilibrium present in the soil strata.

The use of vapor extraction systems is typically limited to permeable unsaturated soils, such as sands, gravels, and coarse silts. High clay soils usually lack the conductivity necessary for effective vapor extraction, unless they are first fractured. Hydraulic fracturing, a method used to increase fluid flow within the subsurface, may increase the effectiveness of vapor extraction.

Vapor extraction systems provide flexibility in operational parameters, including air extraction rates, extraction-well spacing and configuration, control of water infiltration, and pumping deviations. Higher flow rates increase vapor removal, as more air is forced through the permeable soil layers. Temporarily stopping the flow of air from the air-forcing blowers allows time for chemicals to diffuse into the vapor phase, and venting will subsequently remove higher concentrations of volatile contaminants. Because volatile contaminants are not present at the 200-UP-2 IRM candidate waste sites, this technology is not considered applicable for IRMs at 200-UP-2.

4.1.10.2 In Situ Grouting. In situ grouting techniques can be applied to fill void spaces, such as those associated with cribs, septic tanks, and pipelines. In situ grouting involves injecting a sand-cement based grout directly into a void. The grout is placed using conventional long stroke slush pumps with large valve openings.

4.1.10.3 In Situ Fixation. Details regarding fixation techniques have been presented during discussions of ex situ fixation in Section 4.1.7.2. The difference, of course, is that in situ fixation/encapsulation involves mixing contaminated materials inplace to create a monolith that is not susceptible to leaching.

Techniques for applying in situ fixation technologies include those used during installation of slurry walls (Section 4.1.3.1) and/or specialized mix-in-place equipment, such as very large diameter auger bits. In situ fixation is not considered applicable for IRMs at 200-UP-2 since contaminant leaching is not a primary concern.

4.2 REMEDIAL ACTION ALTERNATIVES

Based on CERCLA guidance and the National Contingency Plan (NCP) (40 CFR 300), remediation alternatives are developed to achieve the following goals (EPA 1988):

- protect human health and the environment
- attain ARARs to the maximum extent feasible
- be cost-effective
- use permanent solutions and alternate treatment or resource recovery technologies to the maximum extent practical
- satisfy the statutory preference for treatment
- minimize the need for long-term maintenance and monitoring.

General response actions and preliminary remedial alternatives have previously been developed and analyzed in the *U-Plant AAMSR* (DOE-RL 1992a). Additional site data gathering during the LFI has been used to further refine the potential remedial actions, such that IRM could be developed commensurate with site characteristics. All GRA developed during the AAMSR remain viable to some degree, however, not all technologies are considered applicable for IRMs at the 200-UP-2 waste sites. The range of applicable alternatives is focused on technologies which will not limit potential future final actions. Additionally, only those technologies which address the principle threats posed by the site (e.g., surface exposure to waste management worker) and are proven effective at addressing site contaminants are considered in the development of remedial alternative. The following subsections of this chapter detail the assembly of the most promising technologies retained in Section 4.1 into focused remedial alternatives for potential application of each 200-UP-2 IRM candidate waste site.

4.2.1 Description of Alternatives

Given the nature and extent of contamination defined in Section 3.0, as well as the physical characteristics of the 200-UP-2 IRM candidate waste sites, remedial alternatives have been formulated by assembling technologies and process options identified in Section 4.1.

Remedial alternatives are developed for the following waste sites.

- 216-U-8 Crib/VCP
- 216-U-10 Pond/216-U-11 Trench (216-U-9 Ditch does not possess contaminants warranting action; see Section 3.4.5)
- 216-U-14 Ditch/207-U Retention Basins
- 216-Z-1D Ditch/216-Z-11 Ditch/216-Z-19 Ditch (216-Z-20 Crib does not require an IRM as defined by the PRG; see Section 3.4.5)

- 216-U-1 Crib/216-U-2 Crib/216-U-361 Settling Tank/Stainless Steel and VCP/216-U-16 VCP (216-U-16 does not require an IRM as defined by PRG)
- 216-U-12 Crib/VCP.

The 216-U-4 Reverse Well and the 216-U-4a French Drain system is not evaluated for each remedial alternative because it does not exceed the PRG of 100 mrem/yr (Section 3.2.5). Therefore, the system does not represent an unacceptable exposure.

Consistent with the GRA developed in the AAMSR (DOE-RL 1992a) and summarized in the introduction of Section 4.0, the following alternatives are evaluated as potential IRMs for the 200-UP-2 IRM candidate sites identified above:

- no action
- surveillance and maintenance
- void grout (where applicable)/biointrusion barrier/surveillance and maintenance
- void grout (where applicable)/excavation/disposal.

Each alternative is described in the following sections. Site-specific considerations for each alternative are identified as appropriate.

4.2.1.1 No Action. The NCP requires that a "no action" alternative be evaluated. The No Action alternative represents a situation where no restrictions, controls, or active measures are applied to the site. In accordance with this alternative, none of the currently active institutional controls would be continued. Additionally, the existing contaminants are allowed to dissipate through natural attenuation processes.

<u>216-U-8</u>

Contamination control measures have been implemented at the 216-U-8 Crib and VCP under the RARA project. Contaminated surface soil was consolidated above the crib to a height of 0.9 m (3 ft) above grade and an additional 0.6 m (2 ft) of clean soil was placed on top of the crib and pipeline. The soil cover would receive no maintenance and would be allowed to deteriorate naturally, resulting in the migration of contaminants to the ground surface through biointrusion.

<u>216-U-10</u>

Contamination control measures have been implemented at the 216-U-10 Pond and the 216-U-11 Trench. The 216-U-10 Pond has been covered with an average of 1.2 m (4 ft) of clean soil and the 216-U-11 Trench has been backfilled to grade (DOE-RL 1992a). Should the covers remain intact, direct human contact with the contaminated soils and exposure to radionuclides would be prevented. However, these covers would receive no maintenance and would be allowed to deteriorate naturally, resulting in the migration of contaminants to the ground surface through biointrusion.

216-U-14

Contamination control measures have been implemented at the 216-U-14 Ditch. The 216-U-14 Ditch has been backfilled to grade with clean soil. Should the cover remain intact, direct human contact with the contaminated soils and exposure to radionuclides would be prevented. However, this cover would receive no maintenance and would be allowed to deteriorate naturally, resulting in the migration of contaminants to the ground surface through biointrusion. Additionally, the 207-U Retention Basins are currently posted as a surface contaminated area. Under this alternative, no controls would be in place, resulting in the potential intrusion of human receptors.

216-Z Ditch System

Contamination control measures have been implemented at the 216-Z Ditches. All three of the 216-Z Ditches have been backfilled to grade. Should the covers remain intact, direct human contact with the contaminated soils and exposure to radionuclides would be prevented. However, this cover would receive no maintenance and would be allowed to deteriorate naturally, resulting in the migration of contaminants to the ground surface through biointrusion.

216-U-1/2 System

Contamination control measures have been implemented at the 216-U-1/2 Cribs and the 241-U-361 Settling Tank under the RARA Project. Both cribs have been covered with approximately 0.9 m (3 ft) of clean soil. The ground surface above the 216-U-361 Settling Tank has been covered with a herbicide bonded geotextile and covered with 0.10 m (4 in.) of shotcrete on top. These covers would receive no maintenance and would be allowed to deteriorate naturally, resulting in the migration of contaminants to the ground surface through biointrusion.

216-U-12 System

Access restrictions in the form of warning markers have been installed. These warning markers would receive no maintenance and would be allowed to deteriorate naturally. Additionally, subsurface contamination would be transported to the ground surface through biointrusion.

4.2.1.2 Surveillance and Maintenance. The surveillance and maintenance alternative involves the continuance of current access restrictions (Section 4.1.1.3), surveillance and maintenance, and groundwater surveillance monitoring (Section 4.1.1.4). Maintenance activities would also be included as a continued institutional control.

Access restrictions currently in place include use of site security personnel, facility fencing, and warning signs. Site security and facility fencing reduces the potential for human exposure. Additionally, warning markers around waste sites discourages trespass and excavation.

Because waste would be left on site, groundwater monitoring would be required to track potential changes in groundwater quality. The existing monitoring program would continue to monitor concentrations of contaminants in groundwater beneath the operable unit. As a result of long-term monitoring, the effectiveness of the alternative may be assessed and additional actions taken if contaminant levels threaten to exceed groundwater quality criteria. Surface monitoring for radionuclides would also continue to track contaminant migration to the ground surface.

Maintenance activities include inspection and repair of the clean soil cover and the groundwater monitoring system. To account for potential future maintenance costs of soil covers, the following assumptions were made. Based on past experience, it is estimated that the clean soil cover will require complete replacement every 20 years for the 216-U-11 Trench, and the 216-U-1/2 Cribs. Additionally, the 216-U-10 Pond is estimated to require replacement of the soil cover every 20 years over one-half of its areal extent. The existing clean soil cover would also be maintained by controlling growth of deep-rooted plants and inhabitation of burrowing animals and nesting insects. By controlling such biological intrusions, transport of contaminants would be minimized.

In addition to current controls, an additional activity would include observing the 216-U-8 and 216-U-1/2 Cribs and the 241-U-361 Settling Tank for collapse of the void structures. If subsidence at the site is discovered, corrective actions would be taken.

4.2.1.3 Void Grout (Where Applicable)/Biointrusion Barrier/Surveillance and Maintenance. The type of biointrusion barrier selected for the waste sites is described in Section 4.1.2.4. This barrier was selected as a viable alternative over other barriers because it would provide cost-effective protection from human and ecological exposure to the radionuclides at the waste sites which that no longer need for hydrologic barrier. The barrier is designed to prevent biointrusion and to shield radiation from site contaminants. Barrier materials native to the site would be provided by an onsite borrow area, while other materials would be provided by offsite suppliers.

The biointrusion barrier would be constructed using standard earthmoving and construction equipment and would extend approximately 3 m (10 ft) beyond the lateral extent of contamination at each site. Dust control measures would be implemented during construction to minimize fugitive dust emissions. Because the barrier construction would be nonintrusive, the potential for contaminant migration would be minimal during construction. The barrier would extend 3 m (10 ft) beyond the edge of contamination (as defined in Section 3.1) at the ground surface to cover any lateral contamination.

To eliminate concern for collapse of the timber structures and contaminant migration in the pipelines, both would be filled with a standard grout, as described in Section 4.1.10.2. The timber structures and the pipelines would be void grouted using a sand-cement based grout. The grout would be placed using conventional long stroke slush pumps with large valve openings.

Surveillance and maintenance would be implemented to monitor the effectiveness of the barrier. Due to the design of this barrier, no significant physical maintenance (e.g., layer replacement seeding or herbicide application) is anticipated to be required during its performance life of 500 years. Warning markers would be implemented, in addition to the barrier, to prevent site access and inappropriate site use. Continued site security personnel would also prevent site access.

216-U-8

This alternative involves void grouting the 216-U-8 Crib and VCP, covering both with a biointrusion barrier, and implementing and maintaining institutional controls.

Approximately 225 m^3 (7,900 ft^3) of grout would be required to fill the timber structures and the VCP. The areal extent of the barrier for both the 216-U-8 Crib and the VCP would encompass approximately 5,900 m^2 (63,400 ft^2).

216-U-10

This alternative involves covering the 216-U-10 Pond and the 216-U-11 Trench with a biointrusion barrier and implementing and maintaining institutional controls.

Potential interferences to the construction of the barrier include the location where the 216-U-11 Trench crosses Dayton Avenue and the nearby 13th Street. The areal extent of the barrier for the 216-U-10 Pond and the 216-U-11 Trench and overflow area would encompass approximately 193,400 m^2 (2,081,200 ft^2).

216-U-14

This alternative involves backfilling the 207-U Retention Basins, covering both the 216-U-14 Ditch and 207-U Retention Basins with a biointrusion barrier, and implementing and maintaining institutional controls.

Before construction of the biointrusion barrier, the 207-U Retention Basins would be backfilled with clean soil using standard earthmoving equipment. The volume of clean soil required to backfill retention basins is estimated at 3,790 m^3 (133,700 ft^3).

Potential interferences to the construction of the barrier include the locations where the 216-U-14 Ditch crosses Cooper Avenue, 16th Street, and 19th Street, in addition to the nearby 241-U Tank Farm. The overall areal extent of the barrier for the 216-U-14 Ditch and the 207-U Retention Basins would encompass approximately 28,600 m^2 (307,800 ft^2).

216-Z Ditch System

This alternative involves covering the 216-Z-1D Ditch, the 216-Z-11 Ditch, and the 216-Z-19 Ditch with a biointrusion barrier and implementing and maintaining institutional controls.

Potential interferences to the construction of the barrier include the location where the ditches cross 16th Street. Because of the proximity of the three ditches, one soil barrier approximately 30 m (100 ft) wide by the length of the ditches would be constructed. The overall areal extent of the barrier would encompass approximately 39,950 m^2 (430,000 ft^2).

216-U-1/2 System

This alternative involves removing liquid from the pipelines, void grouting, covering with a biointrusion barrier, and implementing and maintaining institutional controls at the 216-U-1/2 Cribs and pipeline, the 241-U-361 Settling Tank, and the 216-U-16 VCP.

Because liquid waste was discovered in the stainless steel pipeline during field investigations, liquid would be pumped out of the vitrified clay (if present) and stainless steel pipelines and drummed for disposal at a facility capable of handling liquid waste (Section 4.1.8.3). Additionally, to eliminate concern for collapse of the timber structures and the 241-U-361 Settling Tank, along with contaminant migration in the pipelines, all would be filled with a standard grout. Approximately 110 m^3 (3,900 ft^3) of grout would be required to fill both timber structures, the settling tank, the stainless steel pipeline, and the VCP.

Potential interferences to the construction of the barrier include the nearby 16th Street and the neighboring active sites (2607-W-5 Septic Tank and Drain Fields). The areal extent of the barrier for the entire system would encompass approximately 9,430 m^2 (101,500 ft^2).

216-U-12 System

This alternative involves void grouting the VCP, covering the 216-U-12 Crib and pipeline with a biointrusion barrier, and implementing and maintaining institutional controls.

To eliminate concern for contaminant migration in the VCP, the VCP would be filled with a standard grout. Approximately 3 m^3 (80 ft^3) of grout would be required to fill the vitrified clay pipeline.

Potential interferences to the construction of the barrier include the neighboring active Investigation Derived Waste (IDW) Storage Area. The areal extent of the barrier at the 216-U-12 Crib and VCP would encompass approximately 2,050 m^2 (22,000 ft^2).

4.2.1.4 Void Grout (Where Applicable)/Excavate/Dispose. Under this alternative, timber structures to be left in place would be void grouted and contaminated soil would be excavated (Section 4.1.5) using standard earthmoving equipment and disposed (Section 4.1.8) at ERDF.

To eliminate concern for collapse of the timber structures to be left in place, the structures would be filled with a standard grout, as described in Section 4.1.10.2. The timber structures would be void grouted using a sand-cement based grout. The grout would be placed using conventional long stroke slush pumps with large valve openings.

During excavation, soils would be monitored for contamination. Clean soil would be stockpiled for backfill use while contaminated soils would be transported to the disposal facility. Additionally, dust control measures would be implemented during excavation and transported to minimize fugitive dust emissions. Although not anticipated, a geologic repository would be used in place of ERDF for contaminated soil where regulations or DOE policy require use of a geologic repository (e.g., TRU waste), if necessary. To minimize the potential for exposure, excavation would not begin until construction of the disposal facility (or geologic repository, if applicable) is completed, thus avoiding above-ground storage of contaminated soils. Confirmatory samples would be collected at the end of excavation to ensure that RAO have been achieved.

After all contaminated material exceeding PRG is removed, the excavation would be filled to grade with clean soil, compacted, graded for proper drainage, and revegetated with native vegetation. The clean soil would be provided by an onsite borrow area. Continued groundwater monitoring using the existing monitoring network would be required to ensure protection of groundwater quality.

216-U-8

During interim stabilization activities conducted under the RARA project, contaminated surface soils were consolidated at the 216-U-8 Crib and covered with clean soil. This stabilization activity effectively created a mound that extends above the original grade approximately 1.5 m (5 ft) at its apex. Excavation equipment would be used to remove the mound in accordance with standard excavation practices. Also, the 216-U-8 Crib timber structures would be void grouted. Contaminated soils surrounding the VCP and the VCP itself would also be removed to approximately 3 m (10 ft) below grade. Potential interferences to the excavation include the location where the VCP crosses 16th Street and a transfer line running to 241-SX-151. Approximately 217.5 m^3 (7,680 ft^3) of grout would be required to fill the timber structures. The total volume of soil that would be excavated and backfilled is approximately 12,790 m^3 (451,500 ft^3). Of this total volume, approximately 3,280 m^3 (115,800 ft^3) is contaminated and would require disposal at ERDF.

216-U-10

Under this alternative, contaminated soil at the 216-U-10 Pond and the 216-U-11 Trench would be excavated and disposed at ERDF. Potential interferences to the excavation include the location where the 216-U-11 Trench crosses Dayton Avenue, the nearby 13th Street, and various influent pipelines to the 216-U-10 Pond. Based on the extent of contamination data, it is anticipated that soils would be excavated to approximately 2.1 m (7 ft) below grade at the 216-U-10 Pond. At the 216-U-11 Trench, soils would require excavation to approximately 2.4 m (8 ft) below grade within the trench dimensions. Additionally, 0.15 m (6 in.) of surface soils would be excavated from the overflow area associated with the 216-U-11 Trench, as defined in the extent of contamination estimates (Section 3.0 and Appendix D). The total volume of soil that would be excavated and backfilled at the 216-U-10 Pond, 216-U-11 Trench, and overflow area would be 309,300 m^3 (10,922,900 ft^3). Of this total volume, approximately 291,410 m^3 (10,291,000 ft^3) is contaminated and would require disposal at ERDF.

216-U-14

Under this alternative, contaminated soil and concrete at the 216-U-14 Ditch and the 207-U Retention Basins would be excavated and disposed at ERDF. Potential interferences to the excavation include the locations where the 216-U-14 Ditch crosses Cooper Avenue, 16th Street, 19th Street, and the transfer facility lines to 241-SX-151 and 241-S-151, along with the nearby 241-U Tank Farm. Based on the extent of contamination, it is anticipated that soils would be excavated to approximately 2.4 m (8 ft) below grade at the 216-U-14 Ditch. At the 207-U Retention Basins, the surface contaminated soils, concrete liners, and uncontrolled releases UN-200-W-111 and UN-200-W-112 would require excavation, as defined by the extent of contamination described in Section 3.4.5. It is anticipated that the concrete liners will require some specialized concrete demolition equipment to facilitate removal. The total volume of soil and concrete that would be excavated and backfilled with clean soil is approximately 52,100 m^3 (1,839,700 ft^3). Of this volume, approximately 27,260 m^3 (962,770 ft^3) is contaminated material requiring disposal at ERDF.

216-Z Ditch System

Under this alternative, contaminated soil at the 216-Z Ditch System would be excavated and disposed at ERDF. Potential interferences to the excavation include the location where the ditches cross 16th Street. Based on the extent of contamination data, it is anticipated that soils would be excavated to approximately 1.8 m (6 ft) below grade at the 216-Z-1D Ditch and the 216-Z-11 Ditch. At the 216-Z-19 Ditch, soil would be excavated to approximately 2.4 m (8 ft) below grade. The total volume of soil that would be excavated and backfilled with clean soil would be 41,100 m^3 (1,450,600 ft^3). Of this total volume, approximately 31,480 m^3 (1,111,700 ft^3) is contaminated and would require disposal at ERDF. Because of the levels of plutonium-239 and americium-241 at or near the TRU level of 100 nCi/g, this waste may require disposal in a geologic repository. For purposes of this FFS, ERDF disposal is assumed; however, the application of this alternative at the Z-Ditches would be hindered if TRU disposal is required.

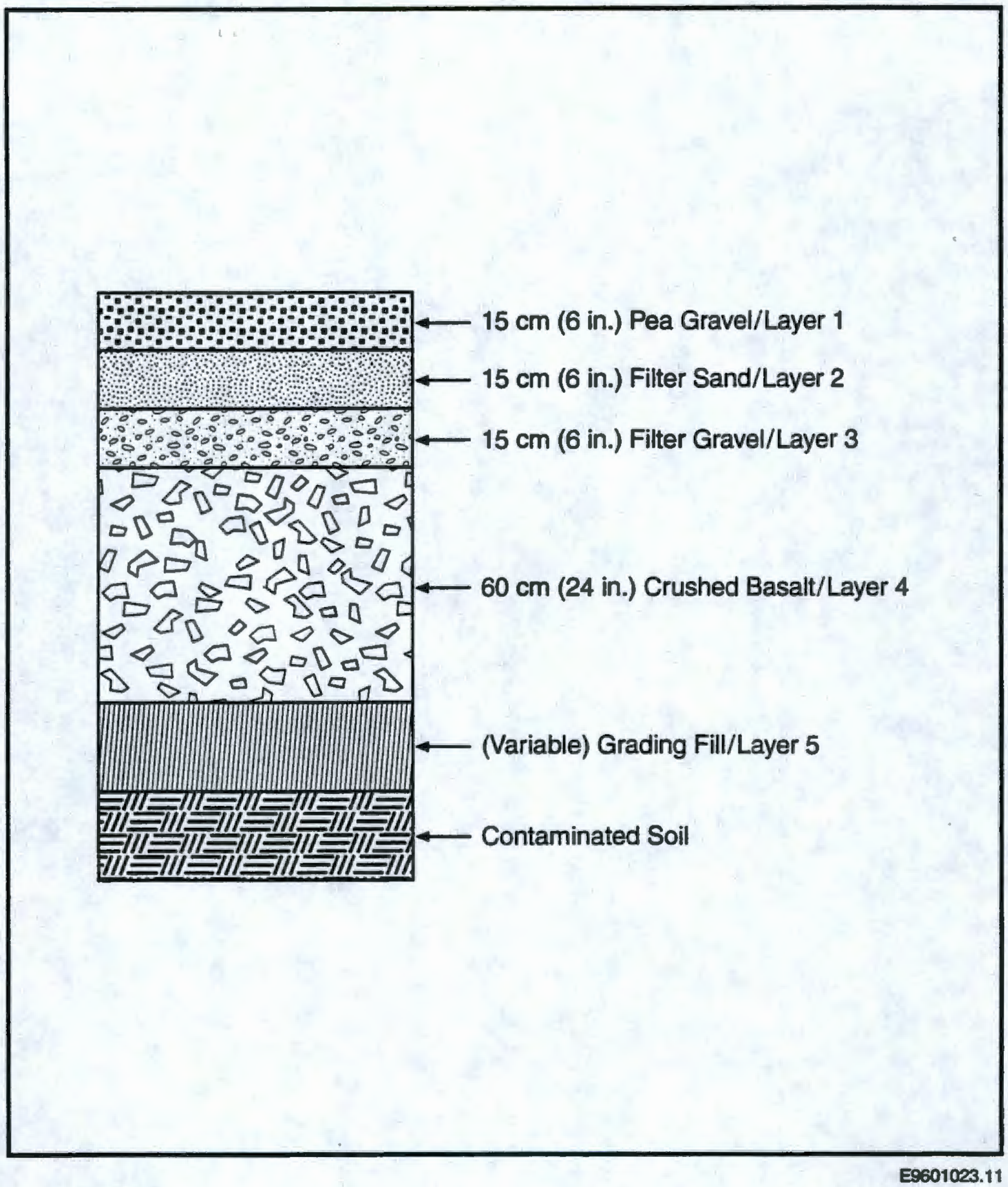
216-U-1/2 System

Under this alternative, timber structures to be left in place would be grout filled, and contaminated soil/sludge and associated structures at the 216-U-1/2 Cribs and pipeline, the 241-U-361 Settling Tank, and the 216-U-16 Pipeline would be excavated and disposed at ERDF. Due to the depth of the 216-U-1/2 Cribs, the associated timber structures would be void grouted. Potential interferences to the excavation include the nearby 16th Street and the neighboring active sites (2607-W-5 Septic Tank and Drain Fields). Additionally, the settling tank is a steel reinforced concrete structure and will require some specialized concrete demolition equipment to facilitate its removal. Approximately 32.6 m^3 (1,150 ft^3) of grout would be required to fill the timber structures. Based on the extent of contamination data, it is anticipated that soils would be excavated to approximately 3 m (10 ft) below grade for the 216-U-1/2 Cribs, 3 m (10 ft) below grade for the stainless steel pipeline, 1.8 m (6 ft) below grade for the 241-U-361 Settling Tank area (followed by demolition and removal of the Settling Tank itself), and 3.1 m (10 ft) below grade for the VCP. The total volume of soil and grout that would be excavated and backfilled with clean soil for the waste system would be 26,320 m^3 (929,400 ft^3). Of this total volume, approximately 14,710 m^3 (519,500 ft^3) is contaminated material requiring disposal at ERDF.

216-U-12 System

In this alternative, contaminated soil at the 216-U-12 Crib and VCP would be excavated and disposed at ERDF. Potential interferences to the excavation include the neighboring active IDW Storage Area and the locations where the VCP crosses an active liquid waste transport line associated with the TEDF. Based on the extent of contamination data, it is anticipated that soils would be excavated to approximately 3 m (10 ft) below grade for both the 216-U-12 Crib and the VCP. The total volume of material that would be excavated and backfilled with clean soil would be 6,300 m^3 (222,500 ft^3). Of this total volume, approximately 1,400 m^3 (52,000 ft^3) is contaminated and would require disposal at ERDF.

Figure 4-1 Biointrusion Barrier



5.0 DETAILED ANALYSIS

This section evaluates the expected performance of each interim remedial alternative (Section 4.2) in terms of the evaluation criteria defined in EPAs *Guidance for Conducting Feasibility Studies Under CERCLA Sites* (EPA 1988). These CERCLA criteria are described in Section 5.1.

In addition to the CERCLA criteria, the potential influence that each remedial action may have on natural, cultural, and physical resources is also evaluated to address NEPA issues. Detailed information regarding key NEPA issues (i.e., natural and cultural resources, socioeconomics, etc.) is presented in Appendix E. Appendix E also discusses issues such as irreversible and irretrievable commitment of resources and cumulative impacts of remedial actions implemented at the 200-UP-2 IRM candidate sites. Finally, the detailed analyses of each remedial alternative against the CERCLA and NEPA criteria are presented in Appendix H. Furthermore, this section does not analyze alternatives for 216-U-12 relative to RCRA closure; those are addressed in Appendix C. The analysis included in this section is concerned only with CERCLA contaminants.

5.1 EVALUATION CRITERIA DESCRIPTION

Nine CERCLA evaluation criteria have been developed by the EPA to address the statutory requirements and the technical and policy considerations important for selection of remedial alternatives. These evaluation criteria serve as the basis for conducting the detailed analysis during the FFS and for the subsequent selection of an appropriate interim remedial action.

The nine CERCLA evaluation criteria are as follows:

- overall protection of human health and the environment
- compliance with ARARs
- long-term effectiveness and permanence
- reduction of toxicity, mobility, or volume
- short-term effectiveness
- implementability
- cost
- state acceptance
- community acceptance.

The first two criteria, overall protection of human health and the environment and compliance with ARARs, are termed *threshold criteria*. Alternatives that do not protect human health and the environment or that do not comply with ARARs (or justify a waiver) do not meet statutory requirements for selection of a remedy; therefore, they are eliminated from further consideration. The next five criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; and cost) are *balancing criteria* upon which the remedy selection is based. The final two criteria, state and community acceptance, are evaluated following regulatory and public comment on this FFS. The CERCLA guidance for conducting feasibility studies lists appropriate questions to be answered when evaluating an alternative against the CERCLA criteria (EPA 1988). These questions are addressed during the detailed analysis process in Section 5.2 to provide a consistent basis for the evaluation of each alternative.

The CERCLA evaluation criteria are described as follows:

1. Overall Protection of Human Health and the Environment: This evaluation criterion determines whether each alternative provides adequate protection of human health and the environment. Protection includes reduction of risk to acceptable levels (either by reducing concentrations or eliminating potential routes for exposure) and minimization of exposure threats (introduced by actions during remediation). As indicated in EPA guidance, there is overlap between this protection evaluation criterion and the criteria for compliance with ARARs, long-term effectiveness and permanence, and short-term effectiveness (EPA 1988). This first criterion is a threshold requirement and the primary objective of the remedial program.

2. Compliance with ARARs: Each alternative is assessed for compliance with federal and state ARARs. When an ARAR cannot be met, justification for a waiver must be presented. Federal and state ARARs are grouped as follows:

   - chemical-specific ARARs, such as promulgated cleanup levels
   - location-specific ARARs, such as wetland regulations
   - action-specific ARARs, such as air emissions.

3. Long-term Effectiveness and Permanence: This criterion addresses the results of a remedial action concerning risks remaining at the site after remedial action objectives are met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated waste. The following components of the criterion are addressed for each alternative:

   - Magnitude of Residual Risk: This factor assesses the residual risk remaining from untreated waste or treatment residuals after remedial activities are completed. The characteristics of the residual waste are considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

   - Adequacy and Reliability of Controls: This factor assesses the adequacy and suitability of controls that are used to manage treatment residuals or untreated waste that remain at the site. It also assesses the long-term reliability of management controls for providing continued protection from residuals and includes an assessment of potential needs for replacement of technical components of the alternative.

4. Reduction of Toxicity, Mobility, or Volume: This criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element. Permanent and significant reduction can be achieved through destruction of toxic contaminants, reduction of total mass, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media. This criterion focuses on the following specific factors for each alternative:

   - the treatment processes used and the materials they treat
   - the amount of hazardous materials destroyed or treated, including how the principal threat(s) are addressed
   - the degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction
   - the degree to which the treatment is irreversible
   - the type and quantity of treatment residuals that remain following treatment
   - whether the alternative satisfies the statutory preference for treatment as a principal element.

5. Short-term Effectiveness: Under this criterion, alternatives are evaluated regarding their potential effects on human health and the environment during the construction and implementation phases of the remedial action. The following factors are addressed for each alternative:

   - protection of the community during remedial actions, specifically, to address any risk that results from implementation, such as fugitive dust, transportation of hazardous materials, or air quality impacts
   - health and safety of remediation workers and reliability of protective measures taken
   - environmental impacts that may result from the construction and implementation of the remedial action
   - the amount of time until the remedial action objectives are met.

   Human health short-term impacts are closely related to exposure duration, specifically, the amount of time a person may be exposed to hazards associated with the waste itself or the removal of the waste. The greater the exposure time, the greater the potential risk.

   Short-term environmental impacts are related primarily to the extent of physical disturbance of habitat. Risks may also be associated with the potential disturbance of sensitive species (such as the bald eagles) because of increased human activity in the area.

6. Implementability: The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of the

required services and materials. The following factors are considered during the implementability analysis:

- Technical Feasibility:

    - technical difficulties in constructing and operating the alternative
    - likelihood of technical problems associated with implementation of the technology leading to schedule delays
    - ease of implementing and interfacing additional remedial actions, if necessary
    - ability to monitor the effectiveness of the remedy.

- Administrative Feasibility:

    - ability to coordinate activities with other offices and agencies
    - potential for regulatory constraints to develop (for example, uncovering buried cultural resources or encountering endangered species).

- Availability of Services and Materials:

    - availability of adequate offsite treatment, storage capacity, and disposal services, if necessary
    - availability of necessary equipment and specialists and provisions to ensure any necessary additional resources
    - availability of services and materials
    - availability of prospective technologies.

7. Cost: The cost analysis estimates the expenditures required to complete each alternative in terms of capital and operation and maintenance costs. Once these values have been identified and a present worth calculated for each alternative (5 percent discount rate), a comparative evaluation can be made.

8. State Acceptance: This assessment evaluates the technical and administrative issues and concerns Washington State may have regarding each alternative. This criterion will be addressed following the agency review of this document.

9. Community Acceptance: This assessment evaluates the issues and concerns the public may have regarding each alternative. This criterion will be addressed following public review of the proposed plan.

Once the alternatives have been described and individually assessed against the CERCLA evaluation criteria, a comparative analysis is conducted to evaluate the relative performance of each alternative in relation to each specific evaluation criterion. The comparative analysis is presented in Section 6.0.

5.2 DETAILED ANALYSIS OF ALTERNATIVES

This section provides the detailed analysis of remedial alternatives for the IRM candidate sites. The evaluation is an independent assessment for each specific alternative. Comparative evaluation of relative performance will be presented in Section 6.0 to help identify tradeoffs between the alternatives. The alternatives considered for each waste site system have been presented in Section 4.2 and include the following:

- no action
- surveillance and maintenance
- void grout (where applicable)/biointrusion barrier/surveillance and maintenance
- void grout (where applicable)/excavation/disposal.

The detailed analysis of each alternative is presented in Appendix H. Sections 5.2.1 and 5.2.2 summarize the detailed analysis. Detailed cost sheets associated with each alternative are presented in Appendix G. The cost estimates are developed to provide capital, operations and maintenance, and present worth values for each alternative at each waste site.

Basic unit costs (e.g., disposal in $/cubic yard) for excavation/disposal rely on estimates presented in the 300-FF-1 FS (DOE-RL 1995c). These basic unit costs are considered appropriate for the 200-UP-2 cost estimating because they were developed for alternatives with similar components. Costs for the biointrusion barrier have been prepared based on estimates made in the development of the barrier FFS. Surveillance and maintenance costs are estimated from current RARA project costs. No costs have been developed for the no action alternative, as it does not involve any action requiring capital or operation and maintenance (O&M) expenditures.

All costs are presented in 1996 dollars and the present worth calculations incorporate an annual discount rate of 5 percent. The costs represent an accuracy of +50/-30 percent consistent with EPA guidance (EPA 1988) and should be used only as a comparison tool. Costs for the selected alternative will be further developed during the various phases of remedial design, as appropriate. The cost estimates for the 200-UP-2 IRM candidate sites are summarized in Table 5-1.

Based on waste site contaminant characteristics, the 200-UP-2 IRM candidate waste sites have been grouped into sites with short-lived radionuclides and sites with long-lived radionuclides. This is done since sites with contaminants that will decay in a relatively short period of time (e.g., cesium-137) may be effectively addressed by an interim action, given proposed DOE control of the 200 Areas for the foreseeable future. Other sites with long-lived radionuclides will most likely require more permanent long-term solutions at a later date once long-term land use of the 200 Areas is defined. For these sites interim actions may only be protective in the near-term. Note that 216-U-4, 216-U-4a, 216-U-9, 216-U-16, and 216-Z-20 are not included in the evaluation of alternatives, as they do not pose a threat to the waste management worker (Section 3.0). The 200-UP-2 sites follow:

Sites with short-lived radionuclides:

- 216-U-8/VCP
- 216-U-10/216-U-11
- 216-U-14/207-U
- 216-U-1/2/241-U-361/pipeline/216-U-16 VCP
- 216-U-12/VCP.

Sites with long-lived radionuclides:

- 216-Z-1D Ditch
- 216-Z-11 Ditch
- 216-Z-19 Ditch.

5.2.1 Sites With Short-Lived Radionuclides

5.2.1.1 No Action. As discussed in Section 4.2.1.1, the No Action alternative represents a situation where no restrictions, controls, or active measures are applied at a site. With this alternative, access to the waste site is not controlled, biointrusion is not inhibited, and existing soil covers are allowed to deteriorate.

Overall Protection of Human Health and the Environment

This alternative does not provide protection of human health or the environment; there is unacceptable exposure to contaminants. Appendix H presents the results of the RESRAD modeling for each waste system. Even though current levels of contamination are unacceptable, radioactive contaminants will naturally decay. Appendix H presents the timeframe for contaminants to decay to acceptable levels. The alternative results in additional impacts to ecological receptors as no controls are implemented that inhibit biological intrusion and uptake of contaminants.

Compliance with ARAR

The no action alternative does not comply with ARARs identified in Appendix H since contaminants above acceptable levels are left in place. There is no basis for ARAR waivers.

Long-Term Effectiveness and Permanence

The no action alternative is not effective at addressing site contaminants and does not provide a permanent solution. Unacceptable levels of contamination remain at the site. The dose from these contaminants are presented in Appendix H. The dose levels are based on exposure to industrial workers as calculated by RESRAD. Long-term protection of natural resources and environmental enhancements are not elements of this alternative; therefore, environmental quality will not be improved by the no action alternative.

Reduction of Toxicity, Mobility, or Volume

No treatment is proposed; however, contaminants will naturally decay.

Short-Term Effectiveness

The alternative will not result in risks to the community given the isolated location of the sites and waste management designation. Because no action is taken, unacceptable risks to workers will not be present. There will be no environmental impacts as a result of implementation.

Implementability

Because no action is taken, the alternative presents no issues concerning implementability. However, this alternative is completely compatible with any potential future final action.

5.2.1.2 Surveillance and Maintenance. As discussed in Section 4.2.1.2, this alternative includes continuation of access restrictions, surveillance, and monitoring that are currently active at the waste sites. Additionally, stabilization activities (e.g., soil covers) would be replaced/maintained, as required. Based on past experience, sites presenting chronic contaminant migration problems are 216-U-1/2, 216-U-10, and 216-U-11.

Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment. This alternative would minimize exposure to unacceptable levels of contamination through the use of access restrictions and surveillance/maintenance activities. Because exposure pathways are minimized, risk from the waste sites will be at acceptable levels upon implementation of this alternative. No unacceptable short-term or cross-media impacts are anticipated and natural resources will remain in their current condition.

Compliance with ARAR

The potential ARARs identified in Appendix H will be met by implementing this alternative. Exposure to contaminants left in place will be minimized and no action will be taken that adversely impacts natural resources.

Long-Term Effectiveness and Permanence

This alternative is effective at addressing threats posed by the site. As long as controls are maintained, this alternative represents a permanent solution. Although contamination is left in place, this alternative minimizes exposure pathways until contaminants naturally decay to acceptable levels. Underground voids present at some of the sites introduce risk of collapse; however, surveillance and maintenance activities would monitor collapse potential. Institutional controls and stabilization activities are proven technologies currently implemented at the Hanford Site. Long-term maintenance and monitoring are required until contaminants naturally decay or until an alternate final action is selected (if necessary). Periodic repair and/or replacement of fencing, signs, soil covers, and monitoring equipment may be necessary. Overall environmental quality will not be impacted as conditions will not change.

Reduction of Toxicity, Mobility, or Volume

No treatment is proposed; however, radioactive contaminants will naturally decay to acceptable levels.

Short-Term Effectiveness

This alternative addresses short-term risk to workers, as exposure to contaminants can be effectively addressed by appropriate health and safety procedures during surveillance and maintenance activities. No risks to the community exist given the sites' isolated location and waste management designation.

Implementability

This alternative is easy to implement as components of the alternative are established technologies currently implemented at the Hanford Site. Long-term deed restriction and DOE waste management activities will require coordination with state groundwater agencies and local zoning authorities.

5.2.1.3 Void Grout (where applicable)/Biointrusion Barrier/Surveillance and Maintenance. As described in Section 4.2.1.3, this alternative includes grouting of underground voids (cribs/pipelines) and placement of a biointrusion barrier. Void grouting eliminates collapse potential; the biointrusion barrier prevents biointrusion into the contaminated soil and provides shielding from external radiation.

Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment, as it controls biological intrusion and shields external radiation. Additionally, the barrier prevents exposure to contaminants via ingestion and inhalation as it isolates waste below ground surface. Risk of collapse of underground voids is also prevented by void grouting of cribs and pipelines.

Exposure to contaminants will be minimized immediately upon implementating the alternative, and the barrier has a life expectancy beyond the time that contaminants decay to acceptable levels. Construction of the barrier and grouting will not pose unacceptable short-term risks or crossmedia impacts. Natural resources will not be enhanced, as the barrier is not revegetated. No impact to groundwater is anticipated (Appendix B).

Compliance with ARAR

The potential ARARs identified in Appendix H will be met by implementing this alternative and no waivers are anticipated.

Long-Term Effectiveness and Permanence

This alternative is effective over the long-term as the barrier has a design life of 500 years, which exceeds the time for contaminants to naturally decay to acceptable levels. Void grouting permanently eliminates collapse potential of the underground voids. Long-term surveillance and maintenance will ensure that the barrier adequately minimizes exposure to contaminants. The barrier is not vegetated; therefore, no environmental enhancements are anticipated beyond control of biointrusion into the waste by the barrier.

Reduction of Toxicity, Mobility, or Volume

No treatment is proposed. However, exposure to the industrial worker and biological receptors are addressed by limiting potential direct exposure pathways. No impact to groundwater is anticipated and radioactive contaminants will naturally decay.

Short-Term Effectiveness

No unacceptable short-term risks to workers will occur by implementing this alternative. Potential impacts from fugitive dust, etc., will be minimized through appropriate contamination control measures during barrier construction. No risks to the community exist given the sites isolated location and waste management designation.

Implementability

This alternative can be readily implemented; however, lateral extent of contamination may have to be better delineated at some sites. Alternative components are established technologies and the barrier is constructed of local natural resources. The alternative is compatible with potential final actions; however, the barrier and grouted structures may have to be removed if leaving waste in place is not considered acceptable for a future final action.

5.2.1.4 Void Grout (where applicable)/Excavate and Dispose. As described in Section 4.2.1.4, this alternative includes excavation of contaminated material exceeding PRG. Additionally, any underground voids (cribs/pipelines) left in place would be void grouted to eliminate collapse potential. All excavated material exceeding PRG would be transported to ERDF for disposal.

Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment, as all waste exceeding PRG removed and disposed of in an engineered disposal facility. Additionally, underground voids are grouted to eliminate collapse potential. No short-term or crossmedia impacts are anticipated, as appropriated health and safety and contamination control measures will be implemented during excavation and transportation. After excavation, the waste site will be regraded and revegetated to enhance the local environment.

Compliance with ARAR

This alternative complies with ARARs presented in Appendix H through removal of contaminated material exceeding PRG. Additionally, the action will be implemented consistent with appropriate dust control/contamination control requirements.

Long-Term Effectiveness and Permanence

This alternative permanently addresses contamination at the site and provides protection against unacceptable levels of contamination over the long-term. Because contamination exceeding PRG is removed from the site, and underground voids are grouted, no additional risks to the waste management worker remain at the site. Appendix B establishes that contaminants left in place do not impact groundwater. No long-term O&M functions are needed at the site and no restrictions on surface activities (e.g., intrusive activities such as digging between 0 to 3 m [0 to 10 ft]) are required. Regrading and revegetation of the site will improve the environmental quality.

Reduction of Toxicity, Mobility, or Volume

No treatment is proposed; however, contaminants disposed of at ERDF will naturally decay to acceptable levels. Contaminant mobility will be reduced by placement in an engineered disposal facility.

Short-Term Effectiveness

This alternative is effective in the short-term, as risks (i.e., exposure to contaminants) to workers are controlled through implementation of appropriate health and safety/contamination control procedures. No risks to the community exist, given the isolated location of the sites and waste management designation. Backfill soils would be obtained from an onsite borrow area, limiting offsite impacts on natural resources.

Implementability

This alternative is readily implemented, as it uses standard earth-moving equipment and technologies. Site interferences (i.e., buildings, utilities, roadways, active waste sites) have significant impacts at many waste sites (Section 3.0). Excavations near these interferences would require coordination with ongoing site activities.

5.2.2 Sites With Long-Lived Radionuclides

5.2.2.1 No Action. As discussed in Section 4.2.1.1, the No Action alternative represents a situation where no restrictions, controls, or active measures are applied at the sites. With this alternative, access to the waste site is not controlled, biointrusion is not inhibited, and existing soil covers are allowed to deteriorate.

Overall Protection of Human Health and the Environment

This alternative does not provide protection of human health or the environment. Under the no action alternative, there is unacceptable exposure to contaminants. Current levels of contamination are unacceptable, and radioactive contaminants will not naturally decay for thousands of years. The alternative results in additional impact to ecological receptors as no controls are implemented that inhibit biological intrusion and uptake of contaminants.

Compliance with ARAR

The No Action alternative does not comply with ARAR, since contaminants above acceptable levels are left in place. There is no basis for ARAR waivers.

Long-Term Effectiveness and Permanence

The no action alternative is not effective at addressing site contaminants and does not provide a permanent solution. Unacceptable levels of contamination remain at the site. The dose from these contaminants is presented in Appendix H. The dose levels are based on exposure to industrial workers, as calculated by RESRAD. Long-term protection of natural resources and environmental enhancements are not elements of this alternative; therefore, environmental quality will not be improved by the no action alternative.

Reduction of Toxicity, Mobility, or Volume

No treatment is proposed.

Short-Term Effectiveness

The alternative will not result in risks to the community given the isolated location of the sites and waste management designation. Because no action is taken, unacceptable risks to workers will not be present. There will be no environmental impacts as a result of implementation.

Implementability

Because no action is taken, the alternative presents no issues concerning implementability. However, this alternative is completely compatible with any potential future final action.

5.2.2.2 Surveillance and Maintenance. As discussed in Section 4.2.1.2, this alternative includes continuation of access restrictions, surveillance, and monitoring that are currently active at the waste sites.

Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment. This alternative would minimize exposure to unacceptable levels of contamination by using access restrictions and surveillance/maintenance activities. Because exposure pathways are minimized, risk from the waste sites will be at acceptable levels upon implementating this alternative. No unacceptable short-term or crossmedia impacts are anticipated and natural resources will remain in their current condition.

Compliance with ARAR

The potential ARARs will be met by implementating of this alternative. Exposure to contaminants left in place will be minimized and no action will be taken that adversely impacts natural resources.

Long-Term Effectiveness and Permanence

This alternative is effective at addressing threats posed by the site in the near term (during DOE control). Even though this alternative would be protective in the near term, future final actions must be identified if/when DOE releases control of the 200 Areas due to the presence of long-lived radionuclides. Although contamination is left in place, this alternative minimizes exposure pathways. Institutional controls and stabilization activities are proven technologies currently implemented at the Hanford Site. Periodic repair and/or replacement of fencing, signs, soil covers and monitoring equipment may be necessary. Overall environmental quality will not be impacted, as conditions will not change from current conditions.

Reduction of Toxicity, Mobility, or Volume

No treatment is proposed.

Short-Term Effectiveness

This alternative addresses short-term risk to workers as exposure to contaminants can be effectively addressed by appropriate health and safety procedures during surveillance and maintenance activities. No risks to the community exist given the isolated location of the sites and waste management designation.

Implementability

This alternative is easy to implement as components of the alternative are established technologies currently implemented at the Hanford Site. Long-term deed restrictions and DOE waste management activities will require coordination with state groundwater agencies and local zoning authorities.

5.2.2.3 Biointrusion Barrier/Surveillance and Maintenance. As described in Section 4.2.1.3, this alternative includes placement of a biointrusion barrier that prevents biointrusion into the contaminated soil and provides shielding from external radiation.

Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment, as it controls biological intrusion and shields external radiation. Additionally, the barrier prevents exposure to contaminants via ingestion and inhalation as it isolates waste below ground surface.

Exposure to contaminants will be minimized immediately upon implemention of the alternative; the barrier has a life expectancy beyond the timeframe required for an interim action. The barrier life of 500 years will not be protective until contaminants decay due to the presence of long-lived radionuclides. Construction of the barrier will not pose unacceptable short-term risks or crossmedia impacts. Natural resources will not be enhanced, as the barrier is not vegetated. No impact to groundwater is anticipated (Appendix B).

Compliance with ARAR

The potential ARARs will be met by implementation of this alternative, and no waivers are anticipated.

Long-Term Effectiveness and Permanence

This alternative is effective over the long-term as the barrier has a design life of 500 years, which exceeds the time required for an interim action. Even though this alternative would be protective in the near-term, future final actions must be identified at the end of DOE control of the 200 Areas due to the presence of long-lived radionuclides, which will be present beyond the 500 year life expectancy of the barrier. Long-term surveillance and maintenance will ensure that the barrier adequately minimizes exposure to contaminants. The barrier is not vegetated; therefore, no environmental enhancements are anticipated beyond control of biointrusion into the waste.

Reduction of Toxicity, Mobility, or Volume

No treatment is proposed. However, exposure to the industrial worker and biological receptors are addressed by limiting potential direct exposure pathways. No impact to groundwater is anticipated.

Short-Term Effectiveness

No unacceptable short-term risks to workers will occur by implementing of this alternative. Potential impact from fugitive dust, etc., will be minimized through appropriate contamination control measures. No risks to the community exist given the isolated location of the sites and waste management designation.

Implementability

This alternative can be readily implemented; however, lateral extent of contamination may have to be better delineated at some sites. Alternative components are established technologies and the barrier is constructed of local natural resources. The alternative is compatible with potential final actions; however, the barrier may have to be removed if leaving waste in place is not considered acceptable for a future final action.

5.2.2.4 Excavate and Dispose. As described in Section 4.2.1.4, this alternative includes excavation of contaminated material exceeding PRG. All excavated material exceeding PRG would be transported to ERDF for disposal. Presence of TRU waste would require disposal in a geologic repository.

Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment, as all waste exceeding PRG removed and disposed of in an engineered disposal facility. No short-term or crossmedia impacts are anticipated, as appropriate health, safety, and contamination control measures will be implemented. Potential for TRU waste may require special waste handling techniques and identification of a geologic repository. After excavation, the waste site will be regraded and revegetated to restore the local environment.

Compliance with ARAR

This alternative complies with ARARs through removal of contaminated material exceeding PRG. Additionally, the action will be implemented consistent with appropriate dust control/ contamination control requirements.

Long-Term Effectiveness and Permanence

This alternative permanently addresses contamination at the site and provides protection against unacceptable levels of contamination over the long-term. Because contamination exceeding PRG is removed from the site, no additional risks remain at the sites. Appendix B establishes that contaminants left in place do not impact groundwater. No long-term O&M functions are needed at the site and no restrictions on surface activities (e.g., intrusive activities such as digging between 0 to 3 m [0 to 10 ft]) are required. Regrading and revegetation of the site will improve the environmental quality.

Reduction of Toxicity, Mobility, or Volume

No treatment is proposed. Contaminant mobility will be reduced by placement in an engineered disposal facility.

Short-Term Effectiveness

This alternative is effective in the short-term as risks (i.e., exposure to contaminants) to workers are controlled by implementing appropriate health and safety/contamination control procedures. Special requirements may be necessary if TRU waste is encountered. No risks to the community exist given the isolated location of the sites and waste management designation. Backfill soils would be obtained from an onsite borrow area, limiting offsite impacts on natural resources.

Implementability

This alternative is readily implemented, as it uses standard earth-moving equipment and technologies. Should TRU waste be encountered, additional implementation difficulties will be realized. Special handling procedures and the identification of a geologic repository will be necessary. Currently no repository exists. Site interferences (i.e., buildings, utilities, roadways, active waste sites, etc.) have significant impacts at many waste sites (Section 3.0). Excavations near these interferences would require coordination with ongoing site activities.

Table 5-1 Alternative Costs

Waste Sites		No Action	Surveillance and Maintenance	Void Grout/ Biointrusion Barrier/ Surveillance and Maintenance	Excavation and Disposal
216-U-8 Crib/VCP	Capital	No Cost	$ 0	$ 1,650,000	$ 2,409,000
	O&M	No Cost	$ 63,000	$ 32,000	$ 0
	Total Cost*	No Cost	$ 0	$ 1,682,000	$ 2,409,000
216-U-10 Pond/216-U-11 Trench	Capital	No Cost	$ 0	$20,284,000	$65,387,000
	O&M	No Cost	$ 2,727,000	$ 1,039,000	$ 0
	Total Cost*	No Cost	$ 2,727,000	$ 21,323,000	$ 65,387,000
216-U-14 Ditch/207-U Retention Basins	Capital	No Cost	$ 0	$ 3,841,000	$ 8,577,000
	O&M	No Cost	$ 307,000	$ 154,000	$ 0
	Total Cost*	No Cost	$ 307,000	$ 3,995,000	$ 8,577,000
216-Z-1D Ditch/ 216-Z-11 Ditch/ 216-Z-19 Ditch	Capital	No Cost	$ 0	$ 4,889,000	$ 8,367,000
	O&M	No Cost	$ 429,000	$ 215,000	$ 0
	Total Cost*	No Cost	$ 429,000	$ 5,104,000	$ 8,367,000
216-U-1 Crib/216-U-2 Crib/ 216-U-361 Settling Tank/ 216-U-16 VCP	Capital	No Cost	$ 0	$ 1,947,000	$ 4,924,000
	O&M	No Cost	$ 153,000	$ 51,000	$ 0
	Total Cost*	No Cost	$ 153,000	$ 1,998,000	$ 4,924,000
216-U-12 Crib/VCP	Capital	No Cost	$ 0	$ 1,088,000	$ 1,524,000
	O&M	No Cost	$ 22,000	$ 11,000	$ 0
	Total Cost*	No Cost	$ 22,000	$ 1,099,000	$ 1,524,000

No Cost = No action taken; therefore, no cost developed.

* Net present value

6.0 COMPARATIVE ANALYSIS

In accordance with applicable CERCLA guidance (EPA 1988), a comparative analysis of the interim action alternatives described in Section 4.2 and individually evaluated in Section 5.2, is subsequently presented. The comparative analysis facilitates evaluation of the relative performance of each alternative in terms of the CERCLA evaluation criteria.

Of the nine CERCLA evaluation criteria, the five *balancing criteria* are the primary basis of the comparative analysis. These criteria are as follows:

- long-term effectiveness
- reduction of toxicity, mobility, or volume
- short-term effectiveness
- implementability
- cost.

The *threshold criteria* (overall protection of human health and the environment and compliance with ARAR) are not primary elements of the comparative analysis because they must be met for an alternative to be considered. The modifying criteria (state and community acceptance) are also not primary elements of the comparative analysis, as they are considered after agency and public review of this FFS and subsequent proposed plan. The elements of each evaluation criteria are defined in Section 5.1. The following sections provide the comparative analysis of alternatives for the waste site groups considered in this FFS.

6.1 SITES WITH SHORT-LIVED RADIONUCLIDES

These sites are contaminated with radionuclides that are expected to decay within a few hundred years. It is likely that contaminants will decay to acceptable levels within the timeframe of DOE control of the 200 Area. The sites included in this group are as follows:

- 216-U-8 Crib/VCP
- 216-U-10 Pond/216-U-11 Trench
- 216-U-14 Ditch/207-U Retention Basin
- 216-U-1 Crib/216-U-2 Crib/241-U-361 Settling Tank/pipeline/216-U-16 VCP
- 216-U-12 Crib/VCP.

6.1.1 Overall Protection of Human Health and the Environment

All alternatives except No Action protect human health and the environment upon implementation by minimizing exposure to contaminants. The soil covers (including backfill) currently in place are reliant upon periodic surveillance and maintenance, which is not an element of the No Action alternative. Because existing soil covers would deteriorate, the No Action alternative will not be protective of human health and the environment.

6.1.2 Compliance with ARAR

All of the alternatives except No Action also comply with corresponding ARARs. No Action does not comply with chemical-specific ARAR, as it leaves waste in place above acceptable levels.

6.1.3 Long-Term Effectiveness and Permanence

The No Action alternative does not address the threats posed by the waste sites.

Surveillance and Maintenance and the Biointrusion Barrier alternatives both leave waste in place but minimize exposure to contaminants. The Biointrusion Barrier alternative is more effective over the long-term, as it would require less periodic maintenance and provide better protection against contaminant migration due to the design of the barrier. The Biointrusion Barrier alternative also provides additional protection by eliminating collapse potential through void grouting.

The Excavation/Disposal alternative is most effective over the long-term, as it permanently removes contaminants from the site for disposal at an engineered facility. This alternative also eliminates collapse potential through void grouting. Additionally, the Excavation/Disposal alternative is the only alternative that provides for environmental enhancement due to regrading and revegetation of the waste sites after removal.

Based on the discussion presented above, the alternatives are ranked as follows for this criterion (best to worst):

1. Void Grout (where applicable)/Excavation/Disposal
2. Void Grout (where applicable)Biointrusion Barrier/Surveillance and Maintenance
3. Surveillance and Maintenance
4. No Action.

6.1.4 Reduction of Toxicity, Mobility, or Volume

Although natural attenuation (through decay) is an implicit component of all the alternatives, no alternative provides for reduction of toxicity or volume of the waste through real treatment. However, the containment components (e.g., basalt gravel) of the Biointrusion Barrier and Excavation and Disposal alternatives and the vegetation control of the Surveillance and Maintenance alternative are expected to preclude contaminant mobility by minimizing uptake by potential ecological receptors and/or placement of contaminants in an engineered disposal facility.

Based on the discussion presented above, the alternatives are ranked as follows for this criterion (best to worst):

1. Void Grout (where applicable)/Excavation/Disposal, and Void Grout (where applicable)Biointrusion Barrier/Surveillance and Maintenance (Equal Rank)
2. No Action.

6.1.5 Short-Term Effectiveness

None of the remedial alternatives pose significant short-term risks (i.e., during remedial action) to site workers, offsite humans, or ecological receptors. Appropriate health and safety/ contamination control measures will be implemented to minimize potential risks.

The No Action alternative poses no risk at all, as no action will be taken. The Surveillance and Maintenance alternative poses very little risk as no heavy equipment is used, and there is no intrusion into the waste. The Biointrusion Barrier alternative poses minor short-term risks due to use of heavy equipment; however, intrusion into the waste is limited to drilling for void grouting. Additionally, material for the barrier will be taken from a local borrow source, which may impact natural resources.

The Excavation/Disposal alternative poses the most short-term risks, as it uses heavy equipment and requires handling and transportation of contaminated material. Local borrow material is also required to be used as backfill.

Based on the discussion presented above, the alternatives are ranked as follows for this criterion (best to worst):

1. No Action
2. Surveillance and Maintenance
3. Void Grout (where applicable)Biointrusion Barrier/Surveillance and Maintenance
4. Void Grout (where applicable)/Excavation/Disposal.

6.1.6 Implementability

All the alternatives are technically and administratively feasible and are therefore implementable. The components of all alternatives are available, reliable, and possess demonstrated technology status.

The No Action alternative is the easiest to implement, as no remedial action is taken. Under the No Action and Institutional Controls alternatives, no interferences are anticipated to impede implementation. Implementation of the Biointrusion Barrier may be hampered by above ground interferences such as roads, buildings, and utilities. The Excavation/Disposal alternative would be the most difficult to implement because of the number of aboveground and belowground utilities proximate to the waste sites.

Based on the discussion presented above, the alternatives are ranked as follows for this criterion (best to worst):

1. No Action
2. Surveillance and Maintenance
3. Void Grout (where applicable)Biointrusion Barrier/Surveillance and Maintenance
4. Void Grout (where applicable)/Excavation/Disposal.

6.1.7 Cost

A comparison of costs for each alternative at each 200-UP-2 IRM candidate waste site is presented in Table 5-1.

6.2 SITES WITH LONG-LIVED RADIONUCLIDES

These sites are contaminated with radionuclides that are not expected to decay within a few hundred years. It is likely that contaminants will remain above acceptable levels for thousands of years beyond DOE control of the 200 Areas. The sites included in this group are as follows:

- 216-Z-1D Ditch
- 216-Z-11 Ditch
- 216-Z-19 Ditch.

6.2.1 Overall Protection of Human Health and the Environment

All alternatives except No Action protect human health and the environment upon implementation by minimizing exposure to contaminants. The soil covers (including backfill) currently in place are reliant upon periodic surveillance and maintenance which is not an element of the No Action alternative. Because existing soil covers would deteriorate, the No Action alternative would not be protective of human health and the environment.

6.2.2 Compliance with ARAR

All of the alternatives except No Action also comply with corresponding ARARs. No Action does not comply with chemical-specific ARAR as it leaves waste in place above acceptable levels.

6.2.3 Long-Term Effectiveness and Permanence

The No Action alternative does not address the threats posed by the waste sites.

The Surveillance and Maintenance and Biointrusion Barrier alternatives both leave waste in place, but minimize exposure to contaminants. The Biointrusion Barrier alternative is more effective over the long-term, as it would require less periodic maintenance and provide better protection against contaminant migration due to the design of the barrier. Neither alternative would provide adequate protection until contaminants naturally decay due to the presence of long-lived radionuclides. Additional future final actions would be anticipated, and should be evaluated before to DOE releasing control of the 200 Areas.

The Excavation/Disposal alternative is most effective over the long-term, as it permanently removes contaminants from the site for disposal at an engineered facility. The potential to encounter TRU waste in concentrations above 100 nCi/g is likely. Presence of TRU waste would require disposal in a geologic repository that currently is not available. Handling techniques for TRU waste would also need to be tested before implementation to ensure that methods could address potential problems. Additionally, the Excavation/Disposal alternative is the only alternative that provides environmental enhancement due to regrading and revegetation of the waste sites after removal.

Based on the discussion presented above, the alternatives are ranked as follows for this criterion (best to worst):

1. Void Grout (where applicable)/Excavation/Disposal
2. Void Grout (where applicable)Biointrusion Barrier/Surveillance and Maintenance
3. Surveillance and Maintenance
4. No Action.

6.2.4 Reduction of Toxicity, Mobility, or Volume

Due to the presence of long-lived radionuclides, natural attenuation (through decay) is not considered a contaminant reduction component of the alternatives. Additionally, no alternative provides for reduction of toxicity or volume of the waste through real treatment. However, the containment components (e.g., basalt gravel) of the Biointrusion Barrier and Excavation and Disposal alternatives are expected to preclude contaminant mobility by minimizing uptake by potential ecological receptors and/or placement of contaminants in an engineered disposal facility.

Based on the discussion presented above, the alternatives are ranked as follows for this criterion (best to worst):

1. Void Grout (where applicable)/Excavation/Disposal, and Void Grout (where applicable)Biointrusion Barrier/Surveillance and Maintenance (Equal Rank)
2. Surveillance and Maintenance
3. No Action.

6.2.5 Short-Term Effectiveness

Only the Excavation/Disposal alternatives has the potential to pose significant short-term risks (i.e., during remedial action) to site workers, offsite humans, or ecological receptors because of the potential for TRU waste. Appropriate health and safety/ contamination control measures will be implemented to minimize potential risks.

The No Action alternative poses no risk at all as no action will be taken. The Surveillance and Maintenance alternative poses very little risk as no heavy equipment is used and there is no intrusion into the waste. The Biointrusion Barrier alternative poses minor short-term risks due to use of heavy equipment; however, intrusion into the waste is not anticipated. Additionally, material for the barrier will be taken from a local borrow source, which may impact natural resources.

The Excavation/Disposal alternative poses the most short-term risks, as it uses heavy equipment and requires handling and transportation of contaminated material. Special consideration must be given to the handling, transportation, and disposal of TRU waste because of the high exposure potential. Remote-handling techniques will most likely be employed and significant shielding during transportation may be necessary. Local borrow material is also required to be used as backfill.

Based on the discussion presented above, the alternatives are ranked as follows for this criterion (best to worst):

1. No Action
2. Surveillance and Maintenance
3. Void Grout (where applicable)Biointrusion Barrier/Surveillance and Maintenance
4. Void Grout (where applicable)/Excavation/Disposal.

6.2.6 Implementability

All the alternatives are technically and administratively feasible and are therefore implementable. The components of all alternatives, except Excavation/Disposal (due to potential for TRU waste), are available, reliable, and possess demonstrated technology status.

The No Action alternative is the easiest to implement, as no remedial action is taken. Under the No Action and Surveillance and Maintenance alternatives, no interferences are anticipated to impede implementation. Implementation of the Biointrusion Barrier may be hampered by aboveground interferences such as roads, buildings, and utilities.

The Excavation/Disposal alternative would be the most difficult to implement because of the number of aboveground and belowground utilities proximate to the waste sites. The most significant consideration, however, is the potential for TRU waste. Because TRU waste requires disposal in a geologic repository, the lack of an available disposal facility adds difficulty to implementation. Additionally, handling and transportation techniques may need to be tested before implementation to ensure that short-term risks from exposure can be minimized.

Based on the discussion presented above, the alternatives are ranked as follows for this criterion (best to worst):

1. No Action
2. Surveillance and Maintenance
3. Void Grout (where applicable)Biointrusion Barrier/Surveillance and Maintenance
4. Void Grout (where applicable)/Excavation/Disposal.

6.2.7 Cost

A comparison of costs for each alternative at each 200-UP-2 IRM candidate waste site is presented in Table 5-1. Note that the estimated costs for the Excavate/Dispose alternative do not account for the presence of TRU waste.

6.3 CONSISTENCY WITH FINAL ACTION

An important consideration for the selection of interim actions is consistency with potential future final actions. None of the alternatives evaluated in this FFS would preclude the implementation of an alternative action in the future. However, some of the alternatives have more impact on implementation of a future action. For instance, if the Biointrusion Barrier is selected as an interim action, it may need to be removed during a final action that called for waste removal. Conversely, should it be preferable in the future to leave waste in place, the Excavation/Disposal alternative may not be considered favorable. The No Action alternative is most consistent with potential final actions, as no remedial action is taken. However, the No Action alternative is not protective of human health and the environment. The Surveillance and Maintenance alternative is also completely consistent with final action, as no significant physical activities are implemented at the site.

Perhaps the most important issue with the 200-UP-2 sites is whether or not interim actions achieve potential final cleanup goals. This is important considering DOE will maintain control of the 200 Areas for many years into the future to address tank farms and manage ERDF (which is very near the 200-UP-2 Operable Unit). For purposes of bounding the scope of interim actions, the period of DOE control assumed for this FFS was until 2128 (100 years past proposed closure of tank farms). The use of this date in this FFS is not meant to represent an absolute, but rather provide a basis for evaluation of the effectiveness of interim actions. By employing the date of 2128 waste sites can be identified that naturally decay to acceptable levels before the potential release of the site by DOE; therefore, making natural decay of short-lived radionuclides a favorable consideration during evaluation of alternatives.

The evaluation of the site-specific data in Section 3.0 and Table 6-1 provide the anticipated decay durations for the 200-UP-2 IRM candidate waste sites. The evaluation considered current and future threats posed by a waste site assuming no controls. The evaluation concluded the following:

Sites that pose no current threat (<100 mrem/yr) or future threat (<15 mrem/yr by 2128) :

- 216-U-4 Reverse Well
- 216-U-4a French Drain
- 216-U-9 Ditch
- 216-Z-20 Crib
- 216-U-16 Crib.

Alternatives were not evaluated for the sites identified above, as no threats are present that warrant interim action.

Sites that pose a current threat (>100 mrem/yr), but no future threat (e.g., decay to <15 mrem/yr by 2128):

- 216-U-10 Crib (decay to <15 mrem/yr by 2096)
- 216-U-11 Trench (decay to <15 mrem/yr by 2096)
- 216-U-14 Ditch (decay to <15 mrem/yr by 2096)
- 207-U Retention Basin (decay to <15 mrem/yr by 2096).

Sites that pose a current threat (>100 mrem/yr) and a future threat (>15 mrem/yr) beyond 2128:

- 216-U-8 Crib/VCP (decay to <15 mrem/yr by 2196)
- 216-U-12 Crib/VCP (decay to <15 mrem/yr by 2196)
- 216-U-16 Crib/VCP (decay to <15 mrem/yr by 2196)
- 216-U-1/2 Crib and pipeline (decay to <15 mrem/yr by 2166)
- 241-U-361 Settling Tank (decay to <15 mrem/yr by 2166)
- 216-Z-1D Ditch (will not decay to <15 mrem/yr for thousands of years)
- 216-Z-11 Ditch (will not decay to <15 mrem/yr for thousands of years)
- 216-Z-19 Ditch (will not decay to <15 mrem/yr for thousands of years).

Except for the sites that will not decay for thousands of years (216-Z-1D, -11, and -19), it is conceivable that DOE control will be in place until contaminants naturally decay. This being the case, the interim actions implemented to prevent unacceptable exposures may in fact achieve final cleanup goals. The sites with long-lived radionuclides, however, will have to be addressed in the future by a more permanent, long-term solution.

Inadvertent intruders will have to be protected for the long-term (after DOE control) as well. The scope of the interim actions is primarily concerned with protection of the waste management worker at the ground surface; therefore, radiological contaminants are only addressed to 3 m (10 ft) bgs. As a result, contaminants with higher activity remain at depth in the vadose zone at most sites. While these contaminants at depth do not pose a threat to the waste management worker, and are not anticipated to impact groundwater (Appendix B) within the scope of the

IRMs, they must be evaluated at the time DOE releases control of the 200 Areas to ensure protection of human health and the environment under the land use scenario defined at that time.

As an initial evaluation, concentrations of contaminants below 3 m (10 ft) at 216-U-1/2 (worst case) were compared to "ERDF Concentration Limits Based on Postdrilling Intruder Scenario" (Table 4-12 in BHI 1995b). The comparison concluded that contaminants at depth do not exceed the concentrations considered protective of an inadvertent intruder. This indicates that leaving contaminants at depth is consistent with the findings of the ERDF performance assessment (BHI 1995b). Additionally, contaminants at depth may impact groundwater in the distant future. However, Appendix B concludes that even the worst case conditions (uranium at 216-U-1/2) may not impact groundwater, especially within the next 1,000 years. Regardless of current estimations, protection of groundwater will require further consideration during final cleanup of the operable unit.

Table 6-1 200-UP-2 IRM Candidate Waste Sites Summary

Waste Site	Refined COPC	15 mrem/yr PRG, pCi/g	Concentration at 2128[a]	Years to Decay to 15 mrem/yr[a]
216-U-1/2 Cribs	cesium-137	72	171	170
241-U-361 Settling Tank	cesium-137	72	171	170
216-U-16 VCP	cesium-137	72	339[b]	200
216-U-8 Crib	cesium-137	72	339	200
216-U-8 VCP	cesium-137	72	339	200
216-U-12 Crib	cesium-137	72	339[b]	200
216-U-12 VCP	cesium-137	72	339[b]	200
216-U-10 Pond[e]	cesium-137	72	35	100
216-U-11 Trench	cesium-137	72	35	100
216-U-14 Ditch	cesium-137	72	35[c]	100
207-U Retention Basins[e]	cesium-137	72	35[c]	100
216-Z-1D Ditch	americium-241	330	2,455[d]	1,400
	plutonium-239/240	375	1,295,280[d]	285,000
216-Z-11 Ditch	americium-241	330	2,455[d]	1,400
	plutonium-239/240	375	1,295,280[d]	285,000
216-Z-19 Ditch[e]	americium-241	330	2455	1,400
	plutonium-239/240	375	1295280	285,000

[a] Values Determined Using DECAY Software
[b] Assumed Analogous to 216-U-8 Crib and VCP
[c] Assumed Analogous to 216-U-10 Pond
[d] Assumed Analogous to 216-Z-19 Ditch
[e] Includes Unplanned Releases Defined in Table 1-1

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APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

FEDERAL ARARs

CHEMICAL-SPECIFIC

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Atomic Energy Act of 1954, as amended Title 42 USC 2011 et seq.		
Nuclear Regulatory Standards for Protection Against Radiation 10 CFR 20	Relevant and Appropriate	The regulation establishes standards for protection of the public against radiation arising from the use of regulated materials and, as such, is relevant and appropriate. Radioactive material from sources not licensed by the NRC are not subject to these regulations; therefore, this standard is not applicable because the operable unit is not NRC licensed. Remedial alternatives need to limit external and internal exposure from releases to levels that do not exceed 100 mrem/yr, or 2 mrem/hr from external exposure in unrestricted areas. Groundwater beneath this operable unit will be addressed in the 200-UP-1 process.
Clean Air Act, as amended 42 USC 7401 et seq		
National Emission Standards for Hazardous Air Pollutants (NESHAP); Standards for Emission of Radionuclides Other Than Radon from Department of Energy Facilities 40 CFR 61.92	Applicable	These requirements are applicable to the site since the potential to release radioactive contaminants to unrestricted areas exists. Subpart H sets emission limits from the entire facility to ambient air that should not cause any member of the public to receive an effective dose equivalent of 10 mrem/yr. The definition of facility includes all buildings, structures, and operations at one contiguous site.
10 CFR 835.208, Limits for members of the public entering a controlled area	Applicable	Establishes that any member of the public exposed to radiation and/or radioactive material during direct onsite access at a DOE site or facility shall not exceed 0.1 rem total effective dose equivalent in a year.

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Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Radiation Site Cleanup Standards - 40 CFR 196 (Proposed)	To Be Considered	On October 21, 1993, the EPA published an Advanced Notice of Proposed Rulemaking for Development of Radiation Site Cleanup Standards (proposed as 40 CFR 196, 58 FR 54474). The working draft of the proposed regulations (May 1994) presents a cleanup standard of 15 mrem/yr annual effective dose in excess of natural background radiation levels.

LOCATION-SPECIFIC

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
National Historic Preservation Act of 1966 Title 16 USC 470	Applicable	The *National Historic Preservation Act* requires that historically significant properties be protected. The Act requires that agencies undertaking projects must evaluate impacts to properties listed on or eligible for inclusion on the National Register of Historic Places. The National Register of Historic Places is a list of sites, buildings, or other resources identified as significant to United States history. An eligibility determination provides a site the same level of protection as a site listed on the National Register of Historic Places.
Archeological and Historic Preservation Act Title 16 USC 469a	Applicable	This act requires that actions conducted at the site must not cause the loss of any archeological and historic data. This act mandates preservation of the data and does not require protection of the actual facility. The Hanford Cultural Resources Laboratory (HRCL) has been delegated responsibility for compliance with federal statutes, regulations, and directives for protection of cultural resources. Before initiation of intrusive activities at the operable unit, cultural resource surveys will be conducted, and identified sites evaluated for eligibility for listing on the National Register. If the site is determined not to be eligible and mitigation is unavailable, artifacts and data will be recovered and preserved before commencement of the remediation action.
Native American Graves Protection and Repatriation Act Public Law 101-601, as amended	Applicable	This law was enacted to establish protection, ownership, and control of native American human remains and other objects of cultural significance to native Americans that are excavated or discovered on federal lands. The law specifies that inadvertent discovery of native American human remains during construction activities requires work to stop, reasonable efforts made to protect the items discovered, notification in writing to the Secretary of Interior, and appropriate Indian tribe(s) notified. Construction activity may resume 30 days after certification that all notification activities and protection measures required under the law have been enacted.

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Endangered Species Act of 1973 Title 16 USC 1531 et seq.	Applicable	The *Endangered Species Act of 1973* may be applicable as several threatened or endangered species have been identified at the Hanford Site, including peregrin falcons and bald eagles. In addition, there are several species that are candidates for the threatened or endangered status on the Hanford Site, including the long-billed curlew and loggerhead shrike.

ACTION-SPECIFIC

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Waste Acceptance Criteria for the Environmental Restoration Disposal Facility, Hanford Site, Washington	To Be Considered	Waste acceptance criteria are being developed for the Hanford Site ERDF that will provide limits for concentrations of contaminants in waste disposed at the facility. The waste acceptance criteria ensure that the concentration of contaminants that may reach groundwater will not cause the groundwater to exceed acceptable contaminant concentration levels. The waste acceptance criteria are considered TBC to remedial actions at 200-UP-2 because they are not promulgated standards. However, the waste acceptance criteria for ERDF may have a significant role in selecting the preferred remedial alternative.
Clean Air Act of 1977, as amended Title 42 USC 7401 et seq.		
National Ambient Air Quality Standards 40 CFR 50	Applicable	The *Clean Air Act of 1977* regulates emission of hazardous pollutants to the air. Controls for emissions are implemented through federal, state, and local programs. Pursuant to the Clean Air Act, EPA has promulgated National Ambient Air Quality Standards, National Emission Standards for Hazardous Air Pollutants, and New Source Performance Standards. Requirements of these regulations are applicable to airborne releases of radionuclides and criteria pollutants specified under the statute. Specific release limits for particulates are set at 50 ugm/m^3 annually or 150 ugm/m^3 per 24-hour period.
National Emission Standard for Hazardous Air Pollutants (NESHAP), Subpart H - National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities 40 CFR 61	Applicable	These requirements are applicable to the site and remedial alternatives because the potential to release air emissions to unrestricted areas exists. Subpart H sets emissions limits to ambient air from the entire facility not to exceed an amount that would cause any member of the public to receive an effective dose equivalent of 10 mrem/yr. The definition of facility includes all buildings, structures, and operations on one contiguous site. Radionuclide emissions from stacks will be monitored and effective dose equivalent values to members of the public calculated.

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Atomic Energy Act of 1954, as amended, Title 42 USC 2011 et seq. Performance Objectives for the Land Disposal of Radioactive Waste 10 CFR 61 Subpart C	Relevant and Appropriate	Requirements that land disposal facilities be sites, designed, operated, closed and controlled after closure so that reasonable assurance exists that exposures to humans are within the limits established in the performance objectives in §§61.41 through 61.44. Protection may be provided under this regulation either by institutional controls or by barriers. The regulation is <u>not applicable</u> because it applies to land disposal of radioactive waste containing byproduct, source, and special nuclear material received from other persons, but the performance objectives are relevant and appropriate to remedial actions that include land disposal of radioactive waste.
Land Disposal Restrictions, 40 CFR 268	Relevant and Appropriate	These restrictions are relevant and appropriate, if restricted waste is generated during remediation and disposal offsite. Specific treatment standards and prohibitions on storage are included in the requirements. The regulation is not applicable because the state has primacy; however, the state dangerous waste regulations references the federal regulations as a condition of compliance.

STATE ARARs

CHEMICAL-SPECIFIC

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Model Toxics Control Act, Ch. 70.105D RCW		
Model Toxics Control Regulations WAC 173-340-700 through 760	Applicable	Requirements under this section of MTCA are applicable to chemicals in soil and groundwater in the operable unit. This section identifies the methods used to develop cleanup standards and their use in selecting a cleanup action. Cleanup levels are based on protection of human health and the environment, the location of the site and other regulations that apply to the site. In addition to meeting requirements of other regulations, MTCA uses three basic methods to establish cleanup levels: Method A - routine; Method B - standard method; and Method C - conditional. These methods may be used to identify cleanup standards for groundwater, surface water, soils and protection of air quality. Cleanup levels for soils may be calculated using these methods, or may be set at 100 times the most stringent federal or state groundwater protection standard, unless demonstrated that this is not appropriate for the site.
Hazardous Waste Management Act Ch. 70.105 RCW		
Designation of Waste WAC 173-303-070	Applicable	The requirements of this section are applicable to the operable unit since the 216-U-12 Crib received dangerous waste. These requirements establish the methods and procedures to determine if solid waste requires management as dangerous waste.
Dangerous Waste Characteristics WAC 173-303-90	Applicable	This section sets the methods used to classify waste as dangerous or extremely hazardous based on the characteristics of ignitability, corrosivity, reactivity and toxicity. Classifications of waste is applicable to any waste generated at the operable unit.

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Dangerous Waste Criteria WAC 173-303-100	Applicable	This section of the dangerous waste regulations presents criteria and methods to evaluate solid waste to determine if they are dangerous waste. Waste is evaluated against each of these three criteria: toxicity, persistence and carcinogenicity. Specific evaluation methods are presented for each category. This section is applicable since remedial actions at the site are likely to generate solid waste that will require evaluation to determine if it must be managed as dangerous waste.
State Radiation Protection Requirements Ch. 70.98 RCW		
Radiation Protection Standards WAC 246-221	Applicable	This regulation is considered applicable because it establishes standards for acceptable levels of exposure to radiation. The occupational dose limit for adults, excluding planned special exposures, is not to exceed an annual limit of a total effective dose equivalent equal to 5 rem, or the sum of the deep dose equivalent and committed dose equivalent to any individual organ or tissue other than the lens of the eye should not exceed 50 rem. An eye dose equivalent of 15 rem is set for exposure to the eye. The shallow dose equivalent for the skin or any extremities is 50 rem. Occupational dose limits for minors are set at 10% of the annual occupational dose limit for adults. The standard identifies the methods required to demonstrate compliance and provides derived air concentration (DAC) and annual limit on uptake (ALI) values that may be used to determine an individuals occupational dose. Dose limits that individual members of the public may receive in unrestricted areas from external sources are not to exceed 0.002 rem/hr, or 0.5 rem/yr. The standard specifies requirements for monitoring personnel exposure for both external and internal exposure. Chapter 246-221-290 establishes annual average concentration limits for radioactive releases in gaseous and liquid effluent released to unrestricted areas.

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Radiation Protection - Air Emissions WAC 246-247	Applicable	This regulation promulgates air emission limits for airborne radionuclide emissions as defined in WAC 173-480 and 40 CFR 61, Subparts H and I. The ambient air standards under WAC 173-480 requires that the most stringent standard be enforced. Ambient air standards under 40 CFR 61, Subparts H and I must not exceed amounts that result in an effective dose equivalent of 10 mrem/yr to any member of the public. The ambient standard in WAC 173-480 specifies that emission of radionuclides to the air must not cause a dose equivalent of 25 mrem/yr to the whole body or 75 mrem/yr to any critical organ.

LOCATION-SPECIFIC

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Washington Natural Heritage Program, RCW 79.70	To Be Considered	The Washington State Natural Heritage Program is authorized under RCW 79.70, Natural Area Preserves and serves as an advisory council to the Washington State Department of Natural Resources, Fish and Wildlife, the Parks and Recreation Commission, and other state agencies managing state-owned land or natural resources. The requirements of the Natural Heritage Program are "To Be Considered" guidance for remedial actions at the 200-UP-2 Operable Unit since the persistentsepal yellowcress (*Rorippa columbiae*), a plant listed as endangered by the Natural Heritage Program, has been identified within the operable unit, and two species, the Columbia River milkvetch (*Astragalus columbianus*) and Hoover's desert parsley (*Lomatium tuberosum*), listed as threatened, have the potential to occur within the operable unit.

ACTION-SPECIFIC

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Hazardous Waste Management Act, 70.105 RCW		
Land Disposal Restrictions WAC 173-303-140	Applicable	This section of the regulation is applicable to remedial actions conducted at the site that are not corrective actions, as defined in the regulation. The land disposal restrictions identifies dangerous waste (that may result from remedial processes) that is restricted from land disposal, describes requirements for restricted waste, and defines the circumstances under which a prohibited waste may continue to be landfilled.
Division, Dilution, and Accumulation WAC 173-303-150	Applicable	This section of the regulation is applicable to management of dangerous waste, and states that any actions that divide or dilute waste to change their designation is prohibited, except for the purposes of treating, neutralizing, or detoxifying such waste. Subpart (2)(b) requires designation of each phase of the heterogeneous waste, in accordance with the dangerous waste designation requirements of WAC 173-303, and handles each phase accordingly.
Containers WAC 173-303-160	Applicable	This section is applicable to remedial actions at the site because it specifies that containers and inner liners will not be considered as a part of the waste when measuring or calculating the quantity of a dangerous waste. Additionally, requirements for rinsing or vacuum cleaning the containers are specified.
Requirements for Generators of Dangerous Waste WAC 173-303-170	Applicable	Requirements for generators of dangerous waste established under this chapter are applicable to remedial actions performed at the site if dangerous waste is generated. Requirements defined under this section include a 90-day waste accumulation period.
Accumulating Dangerous Waste Onsite WAC 173-303-200	Applicable	Requirements of this section are applicable to remedial actions at the site that generate dangerous waste. Dangerous waste may be accumulated onsite without a permit for 90 days or less after the date of generation. A permit would not be required for this site as it is a NPL site. Requirements are included for labeling, marking, and inspection of the dangerous waste while it is being accumulated.

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
General Waste Analysis WAC 173-303-300	Applicable	Analysis of waste is required to determine the presence of dangerous waste before it is stored, treated, or disposed. These requirements are applicable if waste is generated by remedial actions.
Use and Management of Containers WAC 173-303-630	Applicable	This section discusses procedures to manage of containers used to store dangerous waste, and is applicable if a dangerous waste is generated as a result of remedial actions at the site.
Releases from Regulated Units WAC 173-303-645	Applicable	The requirements of this section establish criteria for the operation and closure of dangerous waste management facilities that are designed to minimize releases into the environment. This section is applicable since dangerous waste management facilities are located in the operable unit. This section also identifies requirements that assist in determining if corrective action is necessary. The section identifies monitoring requirements, the point where compliance should be achieved and duration for which compliance must be demonstrated.
Closure and Post-Closure WAC 173-303-610	Applicable	Requirements under this section of the dangerous waste regulations apply to all owners and operators of dangerous waste management facilities and are applicable to 200-UP-2 since the 216--U-12 Crib is present. This section specifies closure performance standards to provide adequate protection of human health, the environment, and to return the land to the appearance of surrounding areas. Clean closure requires removal of all contaminants and contaminated equipment or decontamination. Numeric cleanup levels calculated under the existing state MTCA are used for soil and groundwater cleanup. This allows owners/operators cleanup authority, to meet RCRA closure requirements, including clean closure, using MTCA in Chapters 173-340-700 through 173-340-760 WAC (excluding WAC 173-340-745).
Other General Requirements WAC 173-303-395	Applicable	The regulations in this section define specific precautions for ignitable, reactive, or incompatible waste. This section is applicable if dangerous waste is generated as a result of remedial actions at the site.

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Selection of Cleanup Actions WAC 173-340-360	Applicable	Specific criteria for various cleanup methods are presented in the regulations. The chapter specifies permanent solutions using cleanup technologies that minimize the amount of untreated hazardous substances remaining onsite. Technologies that recycle by methods destroy or detoxify hazardous substances, are preferred over those cleanup methods that may leave contaminants onsite. Cost may also play a role in determining points of compliance and selection of cleanup actions. For example, if a cleanup action's cost is disproportionate to the incremental increase in protection compared to a lesser preferred cleanup action, the less preferred action may be selected. However, strictly selecting cleanup alternatives based on cost is contrary to the intent of MTCA.
Institutional Controls WAC 173-340-440	Applicable	Defines institutional controls as measures taken to limit or prohibit activities that may interfere with the integrity of an interim action or cleanup action or result in exposure to hazardous substances at a site. Institutional controls include physical measures such as fences or signs and/or legal and administrative mechanisms.
Washington Clean Air Act Ch. 70.94 RCW and Ch. 43.21A RCW		
General Regulations for Air Pollution WAC 173-400	Applicable	Substantive standards established to control and prevent of air pollution under this regulation are applicable to remedial actions proposed for the operable unit. The regulation requires that all sources of air contaminants meet emission standards for visible, particulate, fugitive, odors, and hazardous air emissions.
General Standards for Maximum Emissions WAC 173-400-040	Applicable	This section requires that all emission units use reasonably available control technology, which may be determined for some source categories to be more stringent than the emission limitations listed in this chapter.
Emission Standards for Sources Emitting Hazardous Air Pollutants WAC 173-400-075	Applicable	Requirements of this standard are applicable to remedial actions performed at the site that could result in the emission of hazardous air pollutants. The regulation requires that source testing and monitoring be performed.

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Implementations of Regulations for Air Contaminant Sources WAC 173-403	Applicable	Substantive requirements of this section may be applicable to remedial actions performed at 200-UP-2. A new source would include any process or source that may increase emissions or ambient air concentration of any contaminant for which federal or state ambient or emission standards have been established. Remedial actions under CERCLA must meet the substantive requirement of best available control technology for emission control; however, under CERCLA Section 121, on-site remedial actions are exempt from administrative requirements and do not require a permit.
Ambient Air Quality Standards for Particulate Matter WAC 173-470	Applicable	Requirements for maximum acceptable levels for particulate matter in the ambient air at 150 $\mu g/m^3$ over a 24-hour period, or 60 $\mu g/m^3$ annual geometric mean, are applicable requirements. Also applicable is the 24-hour ambient air concentration standard for particles less than 10um in diameter (PM_{10}), which are set at 105 $\mu g/m^3$ and 50 $\mu g/m^3$ geometric mean. The section defines standards for particle fallout not to exceed 10 g/m^2 per month in an industrial area or 5 g/m^2 per month in residential or commercial areas. Alternate levels for areas where natural dust levels exceed 3.5 g/m^2 per month are set at 6.5 g/m^2 per month, plus background levels for industrial areas, and 1.5 g/m^2 per month plus background in residential and commercial areas.
Controls for New Sources of Toxic Air Pollutants WAC 173-460	Relevant and Appropriate	This standard requires that new sources of air emissions provide emission estimates for toxic air contaminants listed in the regulation. The standard requires that emissions be quantified and used in risk modeling to evaluate ambient impacts and establish acceptable source impact levels. The Toxic Air Pollutants regulations may be potential ARARs for the cleanup actions at the 200-UP-2 Operable Unit that could result in emissions of toxic contaminants to the air.

Requirements	Applicable, Relevant & Appropriate, or To-Be-Considered	Comment
Ambient Air Quality Standards and Emission Limits for Radionuclides WAC 173-480	Applicable	Requirements of this standard are applicable to remedial actions performed at the site and requires that the most stringent federal or state standard be enforced. The WAC 173-480 standard defines the maximum allowable level for radionuclides in the ambient air, which shall not cause a maximum accumulated dose equivalent of 25 mrems/yr to the whole body or 75 mrems/yr to any critical organ. However, ambient air standards under 40 CFR 61 Subparts H and I are not to exceed amounts that result in an effective dose equivalent of 10 mrem/yr to any member of the public. Emission standards for new and modified emission units will use best available radionuclide control technology. The standard requires all sources of emissions to meet levels set in WAC 246-220, including determination of compliance using methods established by the Department of Social and Health Services.
State Radiation Protection Requirements Ch. 70.98 RCW		
Radiation Protection - Air Emissions WAC 246-247	Applicable	This regulation promulgates air emission limits for airborne radionuclide emissions as defined in WAC 173-480 and 40 CFR 61, Subparts H and I. The ambient air standards under WAC 173-480 requires that the most stringent standard be enforced. Ambient air standards under WAC 173-480 are not to exceed amounts that result in an effective dose equivalent of 10 mrem/yr to any member of the public. The ambient standard in WAC 173-480 specifies that emission of radionuclides to the air must not cause a dose equivalent of 24 mrem/yr to the whole body or 75 mrem/yr to any critical organ.

APPENDIX B

PROTECTION OF GROUNDWATER

1.0 INTRODUCTION

This appendix evaluates the potential for future impacts to groundwater from residual contamination in the vadose zone of the 200-UP-2 Operable Unit. Residual contamination refers to contamination remaining at the waste site after remedial measures are complete. The evaluation and conclusions presented are drawn from the application of analytical models for both the radioactive and inorganic contamination and a qualitative assessment of factors affecting the migration of the contaminants to the water table. The result of past releases that may still be impacting the local groundwater and are being remediated by the 200-UP-1 IRM pump-and-treat operation are not addressed in this appendix. The waste management unit judged to present the highest potential for impact is modelled using the no action remediation scenario to determine worst case conditions. The range of residual radioactive contaminants expected at the site from the LFI activities was used as input for the RESRAD model. A screening methodology was applied to the expected metals contaminants. Results of the analytical model runs and screening process are discussed and presented as figures, where applicable. These results are provided in Section 1.1 and 1.2.

The qualitative assessment provides additional information to consider in decisionmaking regarding potential for future groundwater impacts from the operable unit. A number of natural processes are presented that tend to retard migration of waste constituents through the subsurface environment. How those processes affect the 200-UP-2 Operable Unit are described in Section 1.3. In general, the results of the qualitative analyses suggest very low concentrations of contaminants would migrate at very slow rates toward the groundwater and that groundwater would not be impacted in the next 1,000 years.

1.1 ANALYTICAL MODEL ANALYSIS

Future impacts to groundwater from vadose-zone contamination were evaluated using RESRAD. RESRAD is a computer code developed at Argonne National Laboratory for the DOE to calculate site-specific residual radioactive guidelines, radiation dose, and excess lifetime cancer risks. RESRAD modeled radionuclides can also be viewed as surrogates for inorganics with similar transport properties. The RESRAD code allows input of site-specific parameters and can be used to evaluate external, inhalation, ingestion, and groundwater exposure pathways, independently or in total. For purposes of this analysis, RESRAD version 5.61 was used and the groundwater exposure pathway is evaluated.

1.1.1 Verification and Validation of RESRAD

Benchmarking is an exercise where the same set of problems is solved with several different computer codes; the results are then compared and evaluated. RESRAD has been benchmarked against five other computer codes: GENII-S, GENII, DECOM, PRESTO-EPA-CPG, and PATHRAE-EPA. The code was also benchmarked against the methodology presented in the U.S. Nuclear Regulatory Commission NUREG/CR-5512 report (Kennedy and Strenge 1992).

The results of this benchmarking are provided in Faillace et al. (1994). Two types of benchmark analyses were performed. In the first, the default residential-farm scenario in RESRAD was used as a starting point; the parameter values in the other codes were changed to match the RESRAD default scenario to the extent possible. Results obtained from the different codes were then compared for external gamma dose, dust inhalation dose, soil ingestion dose, food ingestion dose, and drinking water dose. The second type of benchmark analysis involved comparison of RESRAD results with published results for GENII and PATHRAE-EPA codes; the RESRAD inputs were adjusted to match the published inputs for the other models as practical.

Verification is the task or procedure by which a mathematical solution to an arbitrarily complex problem is tested for internal mathematical consistency and accuracy. RESRAD has been verified by hand calculation. Internal verification was documented in 1989. Halliburton NUS is performing an independent verification of RESRAD 5.43.

Validation is the task or procedure by which the mathematical model is tested against accurately measured, independent sets of field or laboratory observations made over the range of conditions for which application of the model is intended. Batch and column leach experiments were conducted to validate the leaching model in RESRAD. The code is being included in international code-comparison meetings (VAMP and BIOMOVS II), in some cases using Chernobyl data.

1.1.2 Application to 200-UP-2 Operable Unit

1.1.2.1 Assumptions and Input Parameters. The 216-U-1/2 waste site characteristics were used as input parameters in this application of RESRAD to estimate potential impacts to groundwater. Also, parameters from the Washington State Department of Health for an industrial scenario are the initial inputs to the model. The input parameters are found in Table B-1. The 216-U-1/2 Cribs were selected to represent the 200-UP-2 Operable Unit because there is sufficient geologic and radiological control, and the LFI characterizes the area as containing the highest concentration of subsurface radioactive contamination that could impact groundwater. Most other sites do not have significant uranium concentrations; generally below 100 pCi/g. The saturated hydraulic conductivity of the site, indicates that a relatively short travel time to groundwater could be expected. No action was selected as the remedial alternative to obtain conservative remedial parameters.

Radiological contamination in the 216-U-1/2 Cribs was characterized by borehole logging and collecting samples from three boreholes drilled during the LFI. The boreholes were logged using the radionuclide logging system and, in addition, discrete samples were collected and analyzed in the laboratory. Samples from these boreholes indicated that there was limited lateral spreading and vertically there were two zones of contamination. The first zone extended from approximately 5 to 9 m (16.4 to 29.5 ft). The maximum concentrations occurred of radiological contaminants in the first zone and used in the modeling.

The second contaminated zone is at the top of the caliche layer, at approximately 49 m (161 ft) depth.

Radiological contaminants occur between the two zones; however, the concentrations are at or near background. Table 3-2 in the LFI report (DOE-RL 1995a) summarizes the RLS and laboratory analytical results.

The conceptual model used to represent the 216-U-1/2 Cribs consists of three zones. Zone 1 extends from the bottom of the crib to the caliche layer. Zone 2 is the thick caliche layer. Zone 3 extends from the bottom of the caliche to the top of the saturated zone. The area of contamination used in the model was the zone of contamination beneath the crib.

In addition to uranium soil concentrations, cobalt-60, cesium-137, and americium-241 soil concentrations were also input to the RESRAD run even though it is not probable that these isotopes would contribute groundwater to dose. This approach was taken to add conservatism to the model run. In reality only the long-half life uranium isotopes would likely impact groundwater. Only the groundwater exposure pathway is modelled in accordance with the purpose of this appendix.

1.1.2.2 Model Uncertainties. As with any model there are uncertainties associated with the results. In the case of the RESRAD results, there are several factors that deserve attention. First, there are a number of input parameters that are sensitive and have significant impacts on the model results. These include the infiltration rate, Kd, evapotranspiration coefficient, saturated hydraulic conductivity and hydraulic gradient, B parameter, and thickness of the contaminated and uncontaminated vadose zones. Conservative values based on engineering judgment have been used for a number of the site-specific input parameters which error on the conservative side with respect to model results. For example, Kd values are reported in the literature ranging from 1 to 25 mL/g. The value used in the model is 2 mL/g. Evapotranspiration is also likely to be higher than the input value of 0.75 (no cover).

In addition, the lowest unsaturated hydraulic conductivity that the model will accept as an input parameter is 1E-03 m/yr. Available data suggest that 2E-04 is more representative of the vadose zone. Conservatively high residual water contents of 5 percent were selected for zones 1 and 3 and 8 percent for the silty zone 2.

Another key factor that impacts long-term predictive accuracy of the model is the conceptual model of the RESRAD code. The conceptual model is a simplistic simulation of a generic waste site. Although site-specific input parameters are allowed to be used to support the conceptual model, detailed geologic conditions are not. The current model is a good tool for trending; however, the results tend to be conservative or overestimate the condition.

Because of the uncertainties discussed above, it is not prudent to place as high a degree of confidence in the long-term model predictions versus the near-term predictions. The RESRAD model is capable of making groundwater concentration predictions for up to 10,000 years; however, the model results are only evaluated for a 1,000 year period with highest confidence in the predictions for the first 500 years and a lower degree of certainty in the output values after that period.

1.1.2.3 Model Results. The model results for the 216-U-1/2 Cribs no action remedial alternative showed zero levels of exposure from the groundwater pathway to the industrial worker out to about 1,000 years. This is consistent with the lack of a driver to move contaminants through the vadose zone which makes it extremely unlikely that radiological contaminants would reach the groundwater until after 1,000 years.

1.2 METALS SCREENING

Metal concentrations in soil were screened against several cleanup standards to determine which constituents had concentrations that might lead to groundwater impact. All of the analytical data from the 200-UP-2 LFI were compared against the appropriate cleanup standards. The MTCA defines default vadose zone concentrations that are protective of groundwater as 100x the groundwater maximum contaminant levels (WAC 173-340-740(3)(A)). This default applies unless vadose zone modeling is employed to determine site-specific concentrations that protect groundwater.

For application of the "100x groundwater" methodology, nonradionuclide groundwater maximum contaminant levels are derived from federally promulgated regulations, such as the *Safe Drinking Water Act* (40 CFR 141) and the RCRA Groundwater Standards (40 CFR 264). The State of Washington's MTCA groundwater maximum contaminant levels are also used. Table B-2 presents the groundwater standards and associated 100x concentration used in the screening. The most stringent 100x concentration was used for data screening.

Where the 90th percentile of the lognormal distribution of the Hanford sitewide background concentration exceeded the most stringent cleanup standard, the background value was used to screen out constituents. Those constituents with concentrations that exceeded the most stringent cleanup standard and the Hanford Site background value were compared against a contaminant-specific concentration for soils that would still achieve groundwater protection. These values were obtained from a "Summers" modeling of the 116-C-1 Crib and 100-D Ponds waste sites, where site-specific soils data used in the model are more conservative than would be input into the Summers model for 200 Area soils. This modeling determines the concentration allowable in the soil before potential impacts to groundwater are anticipated.

After all screening of metals concentrations was complete, only iron was left at concentrations which exceeded established screening values. Since there is no established regulatory clean-up standard for iron, it also was eliminated as a COPC.

1.3 QUALITATIVE EVALUATION

This section is a qualitative evaluation of processes that affect transport of contaminants through the vadose zone. Its purpose is to complement the modelling efforts discussed above and provide a qualitatively technical basis for making decisions regarding potential future groundwater impacts. The following qualitative evaluation is mainly directed at uranium contamination; however, other constituents such as iron and chromium are also addressed using the uranium as a surrogate. A variety of natural processes act to attenuate contaminant migration through the subsurface environment. The factors associated with these processes that affect contaminant migration in the 200-UP-2 Operable Unit are discussed below.

1.3.1 Hydraulic Head

Current groundwater contamination is a result of past operations which included average discharges of 1.45E+6 L/yr (0.38E+6 gal/yr) to the 216-U-1/2 Cribs during their operating life (DOE-RL 1995a). However, with this high discharge rate, only the uranium has significantly impacted the groundwater. Discharges to the cribs were discontinued in 1967; therefore, the driving force for contaminant movement has been significantly reduced to just natural infiltration from precipitation less evapotranspiration.

1.3.2 Net Recharge (Rainfall to Evaporation)

The average annual rainfall on the Hanford Site is limited to about 16 cm (6.3 in.) because the Cascade Mountain Range creates a rain shadow (increased precipitation in the Cascades results in much less precipitation at the Hanford Site). Evaporation and transpiration from the site varies, mostly depending on the amount of vegetation. As discussed in Section 2.5, a value of 1.2 cm/yr (0.5 in./yr) was determined to approximate the maximum infiltration (net recharge) through the coarse, unvegetated soils in the waste units. This amount of infiltration is significantly lower than infiltration rates during the years of plant operations and represents a minimal driving force to mobilize contaminants to groundwater.

1.3.3 Current Groundwater Quality

Current contamination in the groundwater is limited mainly to uranium, technetium, and nitrate. Decreasing concentrations demonstrate that contaminants are not migrating from the vadose zone or that the rate of migration continues to decline. Fluctuations in the concentrations are likely due to other activities currently ongoing in the 200 West Area, including the operation of the 200-UP-1 pump-and-treat plant.

1.3.4 Depth to Groundwater

The depth to groundwater in the 200-UP-2 Operable Unit is approximately 70.1 to 73.1 m (230 to 240 ft) below land surface. Most of the metallic and radioactive contamination associated with the individual waste sites is located in the upper 15.2 m (50 ft), as shown by the data in the Borehole Summary Report (Kelty et al. 1995). The more mobile uranium contamination penetrates to the top of the low permeability caliche layer at approximately 49 m (161 ft) below ground surface, leaving approximately 22 m (72 ft) of vadose zone between the contamination and groundwater.

1.3.5 Characteristics of the Vadose Zone

1.3.5.1 Permeability and Porosity. The permeability of the vadose zone is a function of porous media (soils), the liquids present (water), and the liquid saturation. The soils in the operable unit have low (approximately 8 percent) moisture content. Based on analyses documented in the 200-BP-1 Operable Unit RI/FS, moisture content versus permeability curves were developed for four types of soils, including a sandy gravel typical of 200 Area soils (DOE-RL 1993c). Using an average moisture content of 8 percent, results in a vadose zone permeability of 7×10^{-9} cm/sec. Based on a K_d of 2 L/kg (Serne and Wood 1990 and Ames and Serne 1991), the retardation factor for uranium is 11. These parameters are considerations in the travel time of contaminants through the vadose zone, (i.e., the higher the retardation factor, the more the movement of the contaminant through the vadose is attenuated). Because the K_d values for other constituents, such as copper, are higher than uranium, travel times through the vadose zone for these constituents will be even longer.

Total porosity of the vadose zone is approximately 30 percent (DOE-RL 1995a). The pore volume of a 100 by 100 by 9 m (300 by 300 by 30 ft) waste site would be 27,000 m^3. A 1.2 cm/year (0.5 in./year) infiltration rate from precipitation equates to approximately 125 m^3/yr through the waste site, or approximately 0.005 pore volumes. Numerous pore volumes would likely be required to move enough mass of contaminants to significantly affect groundwater quality, (i.e., modeling of ERDF waste at the infiltration rate associated with natural precipitation, show the time for sufficient pore volumes of water required to move the contamination to groundwater would be thousands of years) (DOE-RL 1994b).

1.3.5.2 Fines Content. The fines fraction of the subsurface is generally low near the surface and increases with depth to the caliche layer (Kelty et al. 1995). Fines and clay can act as filters, either physical or ion exchange, to bind contaminants and retard mobility. Interfaces between fine grained and more coarsely grained sediments can result in slower movement of moisture and contaminants in the vadose zone. The fines content of the subsurface provides additional attenuation of contaminants.

1.3.5.3 Plio-Pleistocene Unit (Caliche Layer). The Plio-Pleistocene unit is present throughout the 200-UP-2 Operable Unit and provides a significant hydrologic barrier to the downward migration of contaminants (Kelty et al. 1995). The upper part of the unit is a massive-to-stratified silt to sandy silt. Pedogenic calcium carbonate (caliche) horizons form the lower half of the 0.6 to 20.2 m (2 to 66 ft)-thick unit and create potential perching horizons that will retard the downward flow of moisture.

1.3.5.4 Ion Exchange Capacity and pH. The Hanford Site soils have high ion exchange capacity; this was one of the reasons for selecting the Hanford Site. The pH of the soils is generally basic, which tends to limit the leaching potential of most metals by neutralizing any potential acidic infiltrations.

1.3.6 Contaminant Characteristics

1.3.6.1 Degradability. Uranium undergoes natural radioactive decay. However, because the half-life of uranium-238 is 4.7×10^9 years, decay is not significant. Inorganic constituents do not tend to degrade in the environment.

1.3.6.2 Other Constituents that Could Affect Mobility. Effects on the mobility of the primary contaminants from other constituents in the waste stream are not anticipated, as discharges to adjacent waste disposal facilities have been discontinued. It is expected that institutional controls, at a minimum, will limit future potential discharges through the period of DOE control of the site.

1.3.7 Topography

The local topography is generally flat and slightly irregular. Surface runoff in this area is low because there are no well-defined drainage channels, surface soils are highly permeable, evapotranspiration is high, and runoff has not been directly observed or reported.

1.3.8 Total Contaminant Load (Mass Loading)

Contaminant concentrations within the soils are generally higher within several meters of the bottom of the crib. Uranium concentrations are generally much lower in the intervening section and rise again at the top of the caliche layer.

1.3.9 Volumetric Groundwater Flowrate

Due to relatively low conductivity in the saturated zone (in the range of 6.1 to 30.5 m [20 to 100 ft/day] [WHC 1992a]), the volumetric flowrate is low. This will result in lower potential for migration of contaminants should they reach the aquifer.

1.3.10 Uncertainty of the Data and Assumptions

The quality of the contaminant concentration data is good and the amount of data is adequate for the major areas of contamination. Because there is no intent to introducing new or additional sources of water to the subsurface, neither the local hydrologic head or groundwater flow conditions will increase. With the further reduction of operations and removal of sources of water to the subsurface, there will be no deterioration of the conditions that contribute to the attenuation of contaminant migration.

1.4 CONCLUSIONS

This appendix evaluates the potential for residual contamination in the 200-UP-2 Operable Unit to cause an adverse impact to the groundwater in the future. This effort is focused on long-term future predictions to 1,000 years. The conclusion drawn from the analysis presented in this appendix is that there is minimal potential for significant future groundwater impact.

The conclusion is based on engineering judgment factoring in all of the data presented in the qualitative analysis and the results of the model. The qualitative analysis examined physicochemical properties of 200-UP-2 soils and contaminants. Evaluation of these properties present strong physical evidence that any migration of 200-UP-2 residual contaminants in the future would be extremely slow and at low concentrations. Of particular significance are the lack of any significant driving force to mobilize contaminants and the ERDF modeling results that have shown the slow leaching potential of 200-UP-2 contaminants (DOE-RL 1994b).

The screening approach for metals and radionuclides contaminant concentrations and the RESRAD model were used as additional tools to evaluate potential future groundwater impact. Because RESRAD can conservatively model radionuclide transport, and by surrogate, the performance of metals, it was therefore used to evaluate uranium, the major contaminant of concern for the 200-UP-2 Operable Unit. The model is used as a predictive tool, but has limitations that must be factored into the analysis. The RESRAD groundwater code is based on a simplistic conceptual model of a generalized site which is not capable of factoring all of the site-specific conditions. This would suggest that the model would tend to predict higher impacts than may be realistic. Another key factor which can provide conservatism in the model predictions are the input parameters. Several of the sensitive soil and groundwater properties used in the model are potentially conservative. However, erring on the conservative side for these sensitive parameters was deemed appropriate. The conservatism inherent in the model and sensitive input parameters cause increasing uncertainty with the model predictions over time. The model is capable of predicting up to 10,000 years, but realistically has only been benchmark checked at 500 years. Therefore, the predictions of model was considered appropriate only for a 1,000 year period with a lowered degree of confidence beyond 500 years.

The model predicts no impacts to groundwater for the waste left in place with a no action alternative for the waste sites for the 1,000 year period. In summary, the qualitative evaluation of 200-UP-2 soil and contaminant transport properties, coupled with the screening and RESRAD model results, strongly suggest no future impact to groundwater from the 200-UP-2 Operable Unit residual contamination. Therefore, quantitative PRGs for protection of groundwater are not considered necessary and are not developed for this FFS.

Table B-1 Input Parameters for RESRAD Model (page 1 of 2)

CONTAMINATED ZONE PARAMETERS	UNITS	VALUE
AREA OF CONTAMINATION	M^2	2000
THICKNESS OF CONTAMINATION	M	3
LENGTH PARALLEL TO AQUIFER FLOW	M	50
BASIC DOSE LIMIT	mR/YR	15
TIME SINCE MATERIAL IN GROUND	YEARS	30
COVER/CONTAMINATED ZONE HYDRO DATA	**UNITS**	
COVER DEPTH	M	6
DENSITY	GMS/CM^3	1.6
EROSION RATE	M/YR	.001
TOTAL POROSITY		.3
EFFECTIVE POROSITY		.3
HYDRAULIC CONDUCTIVITY	M/YR	.0022
"B" PARAMETER	DIMENSIONLESS	5.3
EVAPOTRANSPIRATION COEFFICIENT		.75
PRECIPITATION	M/YR	.1524
IRRIGATION	M/R	0
IRRIGATION MODE		OVERHEAD
RUNOFF COEFFICIENT		.2
WATERSHED AREA FOR NEARBY STREAM OR POND	M^2	10^6
SATURATED ZONE HYDROLOGIC DATA	**UNITS**	
DENSITY	GMS/CM^3	1.6
TOTAL POROSITY		.3
EFFECTIVE POROSITY		.3
HYDRAULIC CONDUCTIVITY	M/YR	7300
HYDRAULIC GRADIENT		.002
"B" PARAMETER		3.5
WATER TABLE DROP RATE	M/YR	.001
WELL PUMP INTAKE DEPTH	M	4.5
NONDISPERSION OR MASS BALANCE		ND
WELL PUMPING RATE	M^3/YR	250

Table B-1 Input Parameters for RESRAD Model (page 2 of 2)

UNCONTAMINATED ZONE HYDRAULIC PARAMETERS	UNITS	VALUE ZONE 1	VALUE ZONE 2	VALUE ZONE 3
THICKNESS	M	40	3.5	14.5
SOIL DENSITY	GMS/CM^3	1.6	1.5	1.5
TOTAL POROSITY		0.3	0.4	0.3
EFFECTIVE POROSITY		0.2	0.4	0.1
SOIL SPECIFIC "B" PARAMETER		4.05	5.3	4.05
HYDRAULIC CONDUCTIVITY		0.001	0.001	0.001

INITIAL SOIL CONCENTRATIONS	UNITS	VALUE
AMERICIUM-241	pCi/g	15.8
COBALT-60	pCi/g	2.9
CESIUM-137	pCi/g	1.8×10^6
URANIUM-234	pCi/g	1.4×10^3
URANIUM-235	pCi/g	1.5×10^2
URANIUM-238	pCi/g	1.0×10^4

DISTRIBUTION COEFFICIENTS	Am 241	Co60	Cs137	Sr90	U234/235/238
CONTAMINATED ZONE	20	50	1000	30	2
UNSATURATED ZONES 1, 2, & 3	20	50	1000	30	2
SATURATED ZONE	20	50	1000	30	2
LEACH RATES	NA	NA	NA	NA	NA
SOLUBILITY	NA	NA	NA	NA	NA

Preset parameters for an industrial scenario based on 300-FF-1 FFS.

1.	Inhalation rate	$8400\ m^3$/year
2.	Mass loading for inhalation rate	$0.0002\ gms/m^3$
3.	Dilution length for airborne dust	3 m
4.	Exposure duration	30 years
5.	Shielding factors	
	Inhalation	0.4
	external γ	0.7
6.	Time fractions	
	Indoors	0.171
	Outdoors	0.057
7.	Shape factor for external γ	1
8.	Soil ingestion	25 gms/yr
9.	Drinking water intake	250 l/yr
10.	Fraction of contaminated drinking water	
	At work	1
	Household	0
11.	Depth of soil mixing layer	0.15 m
12.	Groundwater/surface water fractional	
	Usage drinking water	1
	Household usage	0

Table B-2 Screening Levels for Metals Concentrations

Contaminant	Primary MCL µg/l (ppb)	Soil 100X ppm = mg/kg	Secondary MCL µg/l (ppm)	Soil 100X ppm = mg/kg	RCRA GW stds µg/l (ppb)	Soil 100X ppm = mg/kg	MTCA METH B µg/l (ppb)	Soil 100X ppm = mg/kg	Most Stringent Value mg/kg	^ Contaminant-Specific Concentration in soil (mg/kg)
Antimony	6	0.6	N/A	0	N/A	0	6.4	0.640	0.6	14*
Arsenic	N/A	0	N/A	0	50	5	0.05	0.005	0.005	250*
Barium	2000	200	N/A	0	1000	100	1120	112.000	100	41,728*
Cadmium	5	0.5	N/A	0	10	1	8	0.800	0.5	250*
Chromium VI	100	10	N/A	0	50	5	80	8.000	5	4*
Copper	N/A	0	1000	100	N/A	0	592	59.200	59.2	5,790**
Iron	N/A	0	300	30	N/A	0	N/A	0.000	30	22,000**
Lead	N/A	0	N/A	0	50	5	N/A	0.000	5	751*
Manganese	N/A	0	50	5	N/A	0	80	8.000	5	4,173*
Mercury	2	0.2	N/A	0	2	0.2	4.8	0.480	0.2	100*
Nickel	100	10	N/A	0	N/A	0	320	32.000	10	4,500**
Silver	N/A	0	N/A	0	50	5	48	4.800	4.8	3,600**
Zinc	N/A	0	5000	500	N/A	0	4800	480.000	480	250,366*

^ Summers Model
* Values taken from 116-C-1 Site
** Values taken from 100-D Ponds

APPENDIX C

216-U-12 CRIB CLOSURE/POST CLOSURE PLAN

1.0 216-U-12 CRIB CLOSURE/POST CLOSURE PLAN

This appendix summarizes the closure and post closure requirements for the 216-U-12 Crib, a RCRA-permitted TSD, and updates the CERCLA/RCRA Coordination Matrix (Table C-1) and the Closure Plan Roadmap (Table C-2) included in the LFI for the 200-UP-2 Operable Unit (DOE-RL 1995a). These matrices were developed as part of the LFI to provide a roadmap for the integration of CERCLA and RCRA requirements within the operable unit. The premise behind the integration is that much of the RCRA required documentation has a similar or identical counterpart under CERCLA documentation requirements as contained in the work plan, RI report, FS report, proposed plan, and record of decision (ROD). The matrix identifies the required documentation for RCRA then details the CERCLA document that would fulfill that requirement.

The following sections summarize the closure and post closure requirements for the unit, the current contamination status of the unit, and the intended closure strategy for the crib.

2.0 CLOSURE REQUIREMENTS

The 216-U-12 Crib is defined by WAC 173-303 as a dangerous waste landfill. The Dangerous Waste/RCRA closure requirements set forth in WAC 173-303-610 and the Hanford Site Dangerous Waste Permit both establish closure performance standards that require the following:

- minimize the need for further maintenance
- control, minimize, or eliminate to the extent necessary to protect human health and the environment, post closure escape of dangerous waste, dangerous constituents, leachate, contaminated runoff, or dangerous waste decomposition products to the ground, surface water, groundwater, or atmosphere
- comply with the closure requirements set forth in the regulations for the specific facility type.

The State's Dangerous Waste regulations also include a closure performance standard that requires the land to be returned to "the appearance and use of the surrounding land areas to the degree possible given the nature of the previous dangerous waste activity" (WAC 173-303-610 (2)(a)(iii)).

3.0 CRIB CONTAMINATION STATUS

The only regulated dangerous waste disposed of in the U-12 Crib was an aqueous process waste stream that had a pH of 2 or less (Dangerous Waste No. D002, corrosive characteristic waste) due to the presence of nitric acid. The contamination present at the U-12 Crib was assessed through the analogous site approach. The U-12 Crib is analogous to the 216-U-8 Crib. Boreholes were drilled at the U-8 Crib and VCP, and a borehole was drilled outside the U-12 Crib. A discussion of the results is provided below.

3.1 EVALUATION OF CHARACTERIZATION DATA

The 216-U-12 Crib only received corrosive waste. As such, the only nonradiological COPC at this crib would be nitrates. Corrosivity characteristic dangerous waste remaining in the soil would also be at issue for determination of closure under the dangerous waste regulations. However, using analogous data from 216-U-8 reveals certain heavy metals that must be evaluated for the 216-U-12. These constituents are presented in Table C-3 along with the maximum concentrations and corresponding cleanup levels. An analysis of these heavy metals is also included in the discussion below. Data used for comparison with applicable MTCA cleanup levels are maximum concentrations. Maximum concentrations are used in lieu of a statistical analysis of data due to the limited number of data points available. A demonstration of alternative protection of groundwater values for some constituents is made, as indicated using the Summers model. This demonstration is available through WAC 173-340-740(3)(a)(ii)(A) and WAC 173-340-740(4)(b)(ii)(A). A discussion of this model and rationale for its use is provided in Appendix B.

CORROSIVITY AND NITRATES

Corrosive characteristic dangerous waste is not likely remaining on site (in the crib or in the underlying vadose zone). Carbonates in the soil would have buffered (neutralized) the acid well before it reached the aquifer (one of the sediment units used for the vadose zone transport modelling in the LFI, the lower Plio-Pleistocene unit, is described as being "carbonate-rich"). Soil chemical data collected for the 216-U-8 Crib demonstrate that the corrosive characteristic waste is not present at 216-U-8. The 216-U-8 Crib was selected to be the analogous crib for the operable unit (i.e., the worst case based on amount and type of contaminants received). Because 216-U-8 and 216-U-12 received similar waste streams, it was agreed during preparation of the work plan and the sampling strategy that 216-U-8 data would be extrapolated to 216-U-12. In addition, a borehole was drilled at 216-U-12 at the edge of the crib. These borehole data support the fact that the corrosive characteristic dangerous waste is no longer found in the soil column.

The 1993 and 1994 Annual Reports for RCRA Groundwater Monitoring Projects at Hanford Site Facilities (DOE-RL 1994c and DOE-RL 1995d) indicate that there is a fairly significant nitrate plume exceeding drinking water standards in the groundwater downgradient from the crib, which would be expected since the discharge contained nitric acid. In addition, the reports do not discuss pH results, but do discuss an apparent specific conductivity "plume" downgradient from the crib, which suggests that the pH values were within allowable limits (about 6.5 to 8 S.U.). The apparent absence of a low pH "plume" and the presence of a nitrate plume both suggest that the process effluent has been neutralized somewhere in the vadose zone such that it no longer would be classified as a corrosive characteristic dangerous waste (if any effluent remains in the vadose zone).

Based on analogous nitrate data at 216-U-8 (Table C-3), nitrates are not considered to remain above MTCA Method B levels in the soil column. The RCRA Groundwater Monitoring Reports and the LFI suggest that there may be reservoirs of nitrate-rich effluent in the vadose zone that are slowly "gravity-draining" into the aquifer. However, there are no soil analytical data to support this suggestion. The presence of such reservoirs somewhere deep in the vadose zone is possible, but it also is possible that all of the nitrate has already hit the groundwater and is migrating away slowly or that another plume is migrating through the area.

Based on the Part A application appended to the LFI, the process effluent discharged to the crib during the last year of the crib's use (an estimated total of about 1,700,000 gal for that year) was neutralized to some degree before discharge, so that it did not exhibit the characteristic of corrosivity. The migration of this somewhat higher-pH effluent through the vadose zone would have further neutralized and diluted any low-pH material remaining in the soil column from earlier corrosive discharges. The discharge during the last year of operations would likely have flushed any residual low-pH effluent from the discharge piping, so that no dangerous waste (D002 corrosive characteristic waste) remains in the pipe. While no liquid was found in the pipe during the camera survey, a white precipitate was noted, but not sampled.

HEAVY METALS

An analysis of each heavy metal constituents based on the information provided in Table C-3, is presented below.

Contaminants below MTCA Method B Standards

Barium - The maximum barium value in 216-U-8 is below the demonstrated groundwater protection value and MTCA Method B direct soil exposure value.

Beryllium - The maximum beryllium value in 216-U-8 is below Hanford Site natural background at this crib. Background is the default cleanup level under MTCA when it is above groundwater protection and/or direct soil exposure values (WAC 173-340-700(4)(d)).

Copper - The maximum copper value in 216-U-8 is below the 100x groundwater protection value and MTCA Method B direct soil exposure value.

Chromium - The maximum chromium value in 216-U-8 is below the demonstrated groundwater protection value and MTCA Method B direct soil exposure value.

Manganese - The maximum manganese value in 216-U-8 is below background at this crib.

Mercury - The maximum mercury value in 216-U-18 is below the demonstrated groundwater protection value and MTCA Method B direct soil exposure value.

Nickel - The maximum nickel value in 216-U-8 is below the demonstrated groundwater protection value and MTCA Method B direct soil exposure value.

Selenium - The maximum selenium value in 216-U-8 is below the demonstrated groundwater protection value and MTCA Method B direct soil exposure value.

Silver - The maximum silver value in 216-U-8 is below the 100x groundwater protection value and the MTCA Method B direct soil exposure value.

Zinc - The maximum zinc value in 216-U-8 is below the 100x groundwater protection value and the MTCA Method B direct soil exposure value.

<u>**Contaminants above MTCA Method B Standards**</u>

Arsenic - The maximum arsenic value in 216-U-8 is below the demonstrated groundwater protection value and MTCA Method C direct soil exposure values. It is above MTCA Method B residential values.

Cadmium - The maximum cadmium value in 216-U-8 is below the demonstrated groundwater protection value and MTCA Method C direct soil exposure values. It is above MTCA Method B residential values.

<u>**Other**</u>

Iron, Lead, Magnesium - No MTCA values are available for these parameters and, therefore, they are excluded from the analysis of dangerous waste closure options.

3.2 DETERMINATION OF CLOSURE OPTION

Based on the above analysis of maximum concentrations in the analogous 216-U-8 Crib and status of groundwater monitoring at 216-U-12 Crib, the 216-U-12 Crib will be required to undergo modified closure, as defined in the Hanford Site Dangerous Waste Permit Condition II.K. The presence of values of both arsenic and cadmium conclude a modified closure scenario. Concentrations of these constituents are considered protective of groundwater through a Summers Model demonstration, but are above direct soil exposure clean closure (MTCA Method B) values.

The 216-U-12 Crib will undergo modified closure in accordance with the Hanford Site Dangerous Waste Permit Condition II.K.3. This condition requires that institutional controls be provided at a modified closure unit in accordance with MTCA regulation contained in WAC 173-340-440. This regulation states, "Institutional controls are measures undertaken to limit or prohibit activities that may interfere with the integrity of an interim action or cleanup action or result in exposure to hazardous substances at the site..." Because the soil column at 216-U-12 has been determined to exceed MTCA Method B cleanup levels, institutional controls are deemed required due to exposure of dangerous constituents. Institutional controls will consist of those identified in Section 4.4.1 of this FFS. Periodic assessments of the unit to determine the continued effectiveness of the closure option will be performed at least once after a period of five years as required in Condition II.K.3.b.

It should be noted that the RAOs established in this FFS for radionuclide contamination must be met in and under the crib regardless of which closure option is selected. As a result, the remedial alternative(s) selected for the other sites addressed in this FFS may require remedial actions less than or above and beyond those required for modified closure. Should a ROD for 200-UP-2 result in a no action alternative, institutional controls at 216-U-12 Crib will continue to maintain compliance with the dangerous waste regulations and the Hanford Site Dangerous Waste Permit. Should a ROD for 200-UP-2 result in actions at this crib that might interfere with the provided institutional controls, such institutional controls will be considered to be waived during remedial activities. Remedial activities for the alternative chosen for 200-UP-2 will be detailed in the remedial design plan for this operable unit. Upon completion of remedial activities, a reassessment of 216-U-12's status under modified closure will be made. Should institutional controls be deemed to be unnecessary or altered after 200-UP-2 remediation, DOE will request a reduction or change in modified closure requirements through a modification of the Hanford Site Dangerous Waste Permit.

Upon obtaining the ROD for this FFS, incorporation of this unit into the Hanford Site Dangerous Waste Permit can commence through a Permit Modification. It is anticipated that at that time final closure will be demonstrated, closure certification can be made, and post closure care (institutional controls and post closure final status groundwater monitoring) can commence.

4.0 CLOSURE SCHEDULE

No further closure activities are anticipated at 216-U-12 to certify closure under a modified closure option. Sixty days after obtaining modification of the Hanford Site Dangerous Waste Permit to include 216-U-12 as a final status closure unit, certification of closure in accordance with WAC 173-303-610(6) will be completed.

5.0 POST CLOSURE PLAN ADDENDUM

5.1 GROUNDWATER MONITORING

Before or upon incorporation of the 216-U-12 Crib into the Hanford Site RCRA Permit, a final status groundwater monitoring program will be implemented at this crib. Any potential remediation of the groundwater would be addressed through the 200-UP-1 Operable Unit as discussed in the LFI.

5.2 PERSONNEL TRAINING

This section describes the training of personnel required to sample the groundwater and maintain the U-12 Crib groundwater monitoring well network in a safe and secure manner during post closure care.

5.2.1 Outline of the Training Program

This section outlines the introductory and continuing training programs necessary to conduct the post closure groundwater monitoring activities at the U-12 Crib in a safe manner. It also includes a brief description on how training will be designed to meet actual job tasks.

Sampling and Analysis Task Leader and Personnel

The following outline provides the classroom and on-the-job training programs that will be completed by the task leader and any sampling personnel before being qualified to conduct closure/post closure groundwater monitoring activities at the U-12 Crib.

- Hanford General Employee Training
- 40-hour initial hazardous waste worker training and/or 8-hr hazardous waste worker refresher
- Job specific training includes:
  - Medic First Aid
  - Fire Extinguisher
- Waste Management Training includes:
  - Supporting procedures for RCRA groundwater monitoring activities (WHC 1988, WHC 1992b)

5.2.2 Job Title/Job Description

This section provides the job title and the job description of personnel that will be conducting post closure groundwater monitoring activities at the U-12 Crib.

The closure/pos-closure monitoring and inspection will be conducted by sampling personnel as delegated by the Sampling and Analysis Task Leader. The job description for these personnel are described below.

5.2.2.1 Sampling and Analysis Task Leader. After closure of the 216-U-12 Crib, the Sampling and Analysis Task Leader or delegate (samplers) will be responsible for:

- monitoring and reporting on groundwater well security and maintenance
- collecting groundwater level data
- collecting groundwater samples (field and lab)
- sampling and monitoring equipment operation and maintenance
- providing sample chain of custody to the laboratory.

5.2.3 Training Content, Frequency, and Techniques

The training of the Sampling and Analysis Task Leader and sampling personnel will comply with the qualifications and on-the-job (OJT) training requirements in WHC (1988), Environmental Investigation Instruction (EII) 1.7, and comply with the environmental training requirements in Section 11.0 of WHC (1992c).

After personnel have successfully completed the required training courses, the individual will be qualified as a groundwater sampler and/or task leader. All personnel will undergo training and at least an annual review for required courses.

5.2.4 Relevance of Training to Job Position

The Sampling and Analysis Task Leader or delegate are trained to collect potentially contaminated groundwater samples that will be analyzed for dangerous waste and radioactive constituents. In addition, they are trained in areas of collecting field data on groundwater level and reporting on groundwater well security and maintenance. The required training and job description for these personnel are fully described in Sections 5.2.2 and 5.2.3.

5.3 POST CLOSURE CONTACT

The following offices are the official contacts for the 216-U-12 Crib during the post closure care period:

U.S. Department of Energy
Richland Operations Office
Federal Building
825 Jadwin Ave.
P.O. Box 550
Richland, Washington 99352

Bechtel Hanford, Inc.
3350 George Washington Way
Richland, Washington 99352

Table C-1 CERCLA/RCRA Coordination Matrix (page 1 of 2)

Objective	RCRA TSD State and Federal Requirement	RCRA Closure Plan Chapter	CERCLA Past Practice Documentation	200-UP-2 Integrated Document Title	Notes
Identify Investigate	Submit Part A to Regulators	216-U-12 Crib Part A, Form 3, Rev. 3	PA/SI	LFI Report, Appendix A, Attachment 2	Submitted with the LFI Report, June 1995
Characterization, nature, extent, and rate of release or site description	Facility Description and Process Information WAC 173-303-610; 40 CFR 265.112	Ch. 1 Introduction; Ch. 2.0 Facility Description and Location Information; Ch. 3.0 Process Information	RI	U Plant AAMS LFI Work Plan LFI Report, Appendix A	Submitted to regulators in 10/15/92. Submitted to regulators August 92. Submitted to regulators June 1995.
Characterize contaminant constituents and concentrations or maximum amount of waste	Sampling Plan and waste inventory removal WAC 173-303-610(2) and (3)(a)(iii); 40 CFR 265.111 and .112(b)(3)	Ch. 4, Waste Characteristics Ch. 7, Div. 1 and 3	LFI and sampling strategy	U Plant AAMS RCRA Facility Investigation/ Corrective Measures Study Work Plan for the 200-UP-2 Operable Unit	Additional Info. Sample results are contained in Wasemiller et al. (1994) Kelty et al. (1995)
Report extent and risk of contamination	Detailed methods for removal of all hazardous waste WAC 173-303-610 (3)(a)(iv); 173-303-645	Ch. 7, Div. 8 and 9 Ch. 5, All	Field investigation & risk assessment report	LFI/QRA for the 200-UP-2 Operable Unit and Appendix A, Attachment 1. Sections 2 and 3 of this FFS.	LFI Report - Appendix A. contains the introduction and strategy for the RCRA/CERCLA coordination. Attachment 1 has specific closure plan requirements FFS Report - Addresses extent of contamination and risk from sites.
Evaluate alternatives and identify preferred remedy	Detailed steps needed to remove waste WAC 173-303-610(2) and (3)(a)(v)	Ch. 6, Div. 4 and 3	FS Proposed IRM Plan	FFS, Interim Proposed Plan	FFS Report - Sections 5.0 and 6.0 present alternative evaluations. Proposed Plan - Will identify preferred remedy.
Determine potential Federal, State, or local regulations and requirements	Prescribed under WAC 173-303-610 and 40 CFR 265.111	N/A	ARAR	LFI, FFS, Interim PP, Interim ROD	ARARs will be finalized in the ROD
Evaluation of Selected Remedy	Closure Performance Standards WAC 173-303-610(2)(b)	Ch. 6, Div. 4	FFS or Final FFS	200-UP-2 FFS Report	Closure performance standards will be included in the ROD
Expedite Cleanup of Contamination	WAC 173-303-610(3)(c)(iv)	N/A	ERA or IRM	N/A	
Interim Stabilization and/or Cleanup Contamination	Closure/ Post Closure Activities	Ch. 7, Div. 2 and 4 Ch. 8 (if required)	IRM	LFI, FFS, Interim Proposed Plan, Interim ROD	ROD will document cleanup activities required
Proposed Method for Stabilization and/or Cleanup of Contamination	Closure/ Post Closure Activities	Ch. 7, Div. 5 and 6 Ch. 8 (if required)	Proposed IRM Plan	LFI, FFS, Interim Proposed Plan, Interim ROD	ROD will document cleanup activities required

Table C-1 CERCLA/RCRA Coordination Matrix (page 2 of 2)

Objective	RCRA TSD State and Federal Requirement	RCRA Closure Plan Chapter	CERCLA Past Practice Documentation	200-UP-2 Integrated Document Title	Notes
Approve Stabilization and/or Cleanup Method	NOD	All submittals	IRM ROD	N/A	Approval through Hanford Site Dangerous Waste Permit modification process
Design Approved Stabilization and/or Cleanup Method	Closure/ Post Closure Activities	Ch. 7 and Ch. 8 (if required)	IRM Design Report	LFI, FFS, IRM Design (Future)	After approval of ROD, the remedy will be designed.
Realize Stabilization and/or Cleanup Method	Closure/ Post Closure Plan Approval	Closure/ Post Closure Plan Implementation	IRM Implementation	TBD	
Propose Final Remedy Selection	Draft RCRA Site Wide Permit Modification Post Closure Permit Application	Ch. 8 Div 4,5,6 and 7 (if required)	N/A	N/A	
Authorize Selected Remedy	Modify RCRA Site Wide Permit/Regulator Plan Approval	Modify RCRA Site Wide Permit	N/A	N/A	
Design Chosen Remedy	Post Closure Permit Application; Closure Detail Design	Submittal to regulators	N/A	N/A	
Implement Remedy	Site, Clean Closure or Cap as Landfill	ACTION	N/A	N/A	
RCRA Certification of Closure	Certification of Closure	Signed by Independent PE	N/A	Registered Letter from the Owner/Operator to the Regulators	Will require certification by an independent registered PE. Required 60 days after approval of the closure option (effective date of Hanford Site Dangerous Waste Permit modification which incorporates 216-U-12 as a final status unit)

AAMS - aggregate area management study
ARAR - applicable or relevant and appropriate requirement
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFR - Code of Federal Regulations
ERA - expedited response action
FFS - focused feasibility study
IRM - interim remedial measure
LFI - limited field investigation
N/A - not applicable
NOD - notice of deficiency
PA/SI - preliminary assessment/site investigation
PP - proposed plan
QRA - qualitative risk assessment
RCRA - Resource Conservation and Recovery Act
RI - remedial investigation
ROD - record of decision
TBD - to be determined
WAC - Washington Administrative Code

Table C-2 Revised Closure Plan Roadmap (page 1 of 3)

Outline of a Typical RCRA Closure/Post Closure Plan	Equivalent Sections in 200-UP-2 CERCLA Documentation
Chapter 1.0 is an introduction containing two divisions. The first division is an executive summary of the Closure/Post Closure Plan that summarizes the important points of the plan. The second division contains the history of the RCRA Part A Permit Application and a section relating the Part A, Form 3 to the closure plan.	
Division 1: Executive Summary	Attachment 1, Section 1.0 LFI Appendix A
Division 2: History of the Part A, Form 3	Attachment 1, Section 1.0 LFI Appendix A Attachment 2 of LFI Appendix A, Part A permit
Chapter 2.0 provides a Facility Description (3 divisions)	
Division 1: General description of the Hanford Site	Attachment 1, Section 1 of LFI Appendix A U Plant Source AAMSR - Sections 2.1, 2.3. and 3.0. Also Figures 2-6 and 2-7 and Table 2-1
Division 2: Specific facility description	Attachment 1, Section 1.0 of LFI Appendix A Section 3.6.4.3 of LFI Section 3.3.1 of this FFS Appendix D, pages 22, 23 of this FFS U Plant Source AAMSR, Sections 2.1, 2.3. and 3.0. Also Figure 2-6 and Table 2-1
Division 3: Security information	Attachment 1, Section 2 of LFI Appendix A
Chapter 3.0 contains the process description.	
Process description	Attachment 1, Section 1.0 of LFI Appendix A U Plant Source AAMSR - Sections 2.0 through 2.4, Section 3.0 through 3.3, Sections 4.0 and 4.1. Figures 2-1. 2-6. 2-7. and 2-11. Tables 2-1, 2-7 through 2-10, and 4-1. LFI Work Plan - Sections 3.0 and 3.1, 4.0 through 4.2, and 5.0 through 5.3. Figures 5-11 through 5-13. Toebe (1991) - Sections 3.0 and 4.0
Chapter 4.0 provides information about waste characteristics	
1. Estimate of maximum inventory	U Plant Source AAMSR, Section 2.0, Table 2-3. Toebe et al. (1990) Thompson, and Sontag (1991) - Section 4, Table 4.2 Toebe 1991 - Section 6.0, Table 3 Appendix C, Section 3.0 of this FFS
2. Waste types disposed at the 216-U-12 Crib	U Plant Source AAMSR - Section 2.0, Table 4-25 Appendix C, Section 3.0 of this FFS Toebe (1991)
Chapter 5.0 describes Groundwater Monitoring - Contains information on the groundwater monitoring program.	Attachment 1, Section 3.0 of LFI Appendix A Appendix C, Section 6.0 of this FFS

Table C-2 Revised Closure Plan Roadmap (page 2 of 3)

Outline of a Typical RCRA Closure/Post Closure Plan	Equivalent Sections in 200-UP-2 CERCLA Documentation
Chapter 6.0 pertains to Closure Performance Standards (four divisions)	
Division 1: Closure strategy	U-Plant Source AAMSR - Sections 2.6, 2.7, 4.0, 4.1, 5.0, 7.0, 7.1, and 9.3. Appendix B of LFI report 200-UP-2 FFS Appendix C, Section 4.0
Division 2: Minimization of need for further maintenance	200-UP-2 FFS Appendix C, Section 4.0
Division 3: Protection of human health and the environment	200-UP-2 FFS Appendix C, Section 3.0
Division 4: Closure requirements	200-UP-2 FFS Appendix C, Section 2.0
Chapter 7.0 details Closure Activities (nine divisions)	
Division 1: Introduction	U Plant Source AAMSR - Sections 8.0 and 9.0.
Division 2: Removal of dangerous waste inventory	200-UP-2 FFS Appendix C, Section 4.0
Division 3: Facility sampling	Toebe et al. (1990) Thompson and Sontag (1991) - Section 4.0, Table 4.2 Toebe (1991) - Section 6.0, Table 3 LFI Work Plan - Sections 1.0 through 5.0, Tables 5.1, 5.2, 5.8, and 6.0. LFI Work Plan - Section 1.5, Quality Assurance and Attachment 1 Borehole Summary Report for the 200-UP-2 Operable Unit Attachment 1, Section 1.3 of LFI Appendix A Appendix B LFI
Division 4: Removal of contaminated material and waste residue	200-UP-2 FFS Appendix C, Section 4.0
Division 5: Decontamination	200-UP-2 FFS Appendix C, Section 4.0
Division 6: Other required closure activities	200-UP-2 FFS Appendix C, Section 4.0
Division 7: Closure schedule	200-UP-2 FFS Appendix C, Section 4.0
Division 8: Amendment of Closure Plan	LFI Attachment 1, Section 5.0 of Appendix A
Division 9: Certification of closure and survey plat	LFI Attachment 1, Section 5.0 of Appendix A

Table C-2 Revised Closure Plan Roadmap (page 3 of 3)

Outline of a Typical RCRA Closure/Post Closure Plan	Equivalent Sections in 200-UP-2 CERCLA Documentation
Chapter 8.0 describes the Post Closure Plan (if required) (seven divisions)	
Division 1: Inspection plan	LFI Attachment 1, Section 7.0 of Appendix A
Division 2: Monitoring plan	LFI Attachment 1, Section 7.1 of Appendix A FFS Appendix C, Section 5.1
Division 3: Maintenance plan	LFI Attachment 1, Section 7.2 of Appendix A
Division 4: Personnel training	FFS Appendix C, Section 5.2
Division 5: Post Closure contact	FFS Appendix C, Section 5.3
Division 6: Amendment of post closure plan	LFI Attachment 1, Section 7.3 of Appendix A
Division 7: Certification	LFI Attachment 1, Section 7.4 of Appendix A

Table C-3 Constituent List for 216-U-12 Crib

Constituent	Maximum Concentration[1] (Mg/Kg)	Background[2] (mg/kg)	100X Groundwater Protection[3] (mg/l)	Summers Model Value[4] (mg/kg)	MTCA Method B Direct Soil Exposure (mg/kg)	MTCA Method C Direct Soil Exposure (mg/kg)
Arsenic	9.1	6.47	.005	250	1.43	57.1
Barium	1070	132	112	41728	5600	22400
Beryllium	1.00	1.51	.002	not available	0.23	9.3
Cadmium	0.81	not available	.001	250	0.16	6.56
Chromium	28.4	18.5	10.0	23755	80000	320000
Copper	29.4	22.0	59.2	5790	2960	11800
Iron	40400	32600	not available	22000	not available	not available
Lead	8.2	10.2	not available	751	not available	not available
Magnesium	9320	7060	not available	not available	not available	not available
Manganese	505	512	224	4173	11200	44800
Mercury	2.1	0.33	0.20	100	24.0	96.0
Nickel	22.5	19.1	10.0	4500	1600	6400
Nitrate	197	52.0	4400	not available	563000	2252800
Selenium	0.66	not available	8.0	not available	400	1600
Silver	1.8	0.73	5.0	3600	400	1600
Zinc	84	67.8	480	250336	24000	96000

1 These values represent maximum concentrations of constituent found in the analogous 216-U-8 Crib.

2 Background values were obtained from DOE-RL (1995e).

3 These values represent 100 times the most stringent groundwater protection value between maximum contaminant levels or MTCA Method B groundwater protection standards

4 These values represent a demonstration away from the 100 times groundwater protection value and are based on a Summers Model evaluation. Constituents except nickel, silver, chromium and copper are based on a site-specific model for the 116-C-1 Site. Nickel, silver, chromium, and copper are based on a site-specific model for 100-D Ponds.

APPENDIX D

EXTENT OF CONTAMINATION ESTIMATES

EXTENT OF CONTAMINATION ESTIMATES

This section presents dimension estimates for each 200-UP-2 candidate waste site. Also in this section are vertical cross sections of the waste-sites including geologic logging, radiological logging, and soil analytical data from the LFI boreholes used to determine the estimated. The dimensions defined for each site include the site dimensions, the extent of contaminated soil, and the extent of excavation. The waste site profiles serve several purposes. The profiles contain information used to assess the applicability of the Remedial Action alternatives developed in Section 4.0. Additionally, the dimensions may be used to determine the volume of contaminated soil and soil requiring excavation. Such volumes may not necessarily impact the determination of appropriate remedial alternatives, however they are important considerations for developing costs and estimating time required to complete remedial actions.

The site dimensions for each IRM candidate waste site were derived from available documentation relevant to the 200-UP-2 Operable Unit. The majority of information used to ascertain the site dimensions was found in the *U-Plant Source AAMSR* (DOE-RL 1992a). Other applicable documentation used includes the *RFI/CMS Work Plan for the 200-UP-2 Operable Unit* (DOE-RL 1993a), the *Limited Field Investigation for the 200-UP-2 Operable Unit* (DOE-RL 1995a), the Waste Information Data System (WIDS), and existing Hanford construction drawings.

The extents of contamination were determined using relevant information and data from 200-UP-2 Operable Unit documentation and field investigations. The lateral and vertical extents of contamination were defined through screening existing data against the PRG defined in Section 2.7, using radionuclide logging system (RLS) data, and analogous site assumptions. In most cases, the extents of contamination were based on existing site investigation data exceeding the PRG. However, due to the limited quantity of relevant data (i.e., one analytical borehole per waste site), the extent of contamination estimation also relied on the assumption that the existing data are consistent throughout the particular site and that the data are applicable to analogous IRM candidate waste sites.

Using the lateral and vertical extents of contamination, the dimensions for the volume of soil that would require excavation for each IRM candidate waste site were determined. The extent of the excavation necessary to remove the contamination was based on a 1.5 H:1.0 V excavation slope, with the extent of contamination at depth serving as the bottom of the excavation. Contaminated and excavated volumes are presented in Tables D-1 and D-2, respectively.

SITE SYSTEM: 216-U-10 Pond System
SITE NAME: 216-U-10 Pond

WASTE-SITE DIMENSIONS:

216-U-10 Pond consists of a land area that covers approximately 12 ha (30 ac) = 121,000 m^2 (1,307,000 ft^2).

Covered with an average of 1.2 m (4 ft) of backfill soil.

CONTAMINATED VOLUME DIMENSIONS:

Lateral Area = 12 ha (30 ac) = 121,000 m^2 (1,307,000 ft^2)
Depth = Ground surface to 2 m (7 ft) bgs = 2 m (7 ft)

Assumptions:
- The lateral extent of contamination is assumed to be the waste site dimensions (Figure D-1).
- The vertical extent of contamination is assumed to be defined by borehole 299-W22-231 and test pit 216-U-10-TP data (Figures D-2 and D-3).

EXCAVATED VOLUME DIMENSIONS:

Base of excavation is 12 ha (30 ac) = 121,000 m^2 (1,307,000 ft^2) at a depth of 2 m (7 ft).
Top of excavation is 127,000 m^2 (1,371,000 ft^2).

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-10 Pond System
SITE NAME: 216-U-14 Ditch

WASTE-SITE DIMENSIONS:

Earthen ditch that has been backfilled.

Length = 1,700 m (5,600 ft)
Width of Bottom = 2.4 m (8 ft)
Width of Top = 8.5 m (28 ft)
Depth = 1.2 m (4 ft)

CONTAMINATED VOLUME DIMENSIONS:

Length = 1,700 m (5,600 ft)
Width = 8.5 m (28 ft)
Depth = 2.4 m (8 ft)

Assumptions:
- The lateral extent of contamination is assumed to be defined by the top of the ditch dimensions (Figure D-1).
- The vertical extent of contamination is assumed to extend 1.2 m (4 ft) below the bottom of the ditch (Figure D-3).

EXCAVATED VOLUME DIMENSIONS:

Base of excavation dimensions are 8.5 by 1,700 m (28 by 5,600 ft) at a depth of 2.4 m (8 ft). Top of excavation dimensions are 16 by 1,700 m (52 by 5,600 ft).

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-10 Pond System
SITE NAME: 216-Z-1D Ditch

WASTE-SITE DIMENSIONS:

Earthen ditch that has been backfilled.

Length = 1,300 m (4,300 ft)
Width of Bottom = 1.2 m (4 ft)
Width of Top = 4.3 m (14 ft)
Depth = 0.6 m (2 ft)

CONTAMINATED VOLUME DIMENSIONS:

Length = 1,300 m (4,300 ft)
Width = 4.3 m (14 ft)
Depth = 1.8 m (6 ft)

Assumptions:
- The lateral extent of contamination is assumed to be defined by the top of the ditch dimensions (Figure D-1).
- The vertical extent of contamination is assumed to extend 1.2 m (4 ft) below the bottom of the ditch (Figure D-3).

EXCAVATED VOLUME DIMENSIONS:

Base of excavation dimensions are 4.3 by 1,300 m (14 by 4,300 ft) at a depth of 1.8 m (6 ft). Top of excavation dimensions are 9.8 by 1,300 m (32 by 4,300 ft).

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-10 Pond System
SITE NAME: 216-Z-11 Ditch

WASTE-SITE DIMENSIONS:

Earthen ditch that has been backfilled.

Length = 800 m (2,615 ft)
Width of Bottom = 1.2 m (4 ft)
Width of Top = 4.3 m (14 ft)
Depth = 0.6 m (2 ft)

CONTAMINATED VOLUME DIMENSIONS:

Length = 560 m (1,830 ft) (not including section same as 216-Z-1D Ditch)
Width = 4.3 m (14 ft)
Depth = 1.8 m (6 ft)

Assumptions:
- The lateral extent of contamination is assumed to be defined by the top of the ditch dimensions (Figure D-1).
- The vertical extent of contamination is assumed to extend 1.2 m (4 ft) below the bottom of the ditch (Figure D-3).

EXCAVATED VOLUME DIMENSIONS:

Base of excavation dimensions are 4.3 by 560 m (14 by 1,830 ft) at a depth of 1.8 m (6 ft). Top of excavation dimensions are 9.8 by 560 m (32 by 1,830 ft).

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-10 Pond System
SITE NAME: 216-Z-19 Ditch

WASTE-SITE DIMENSIONS:

Earthen ditch that has been backfilled.

Length = 840 m (2,765 ft)
Width of Bottom = 1.2 m (4 ft)
Width of Top = 7.3 m (24 ft)
Depth = 1.2 m (4 ft)

CONTAMINATED VOLUME DIMENSIONS:

Length = 680 m (2,220 ft) (not including section same as 216-Z-1D Ditch)
Width = 7.3 m (24 ft)
Depth = 2.4 m (8 ft)

Assumptions:
- The lateral extent of contamination is assumed to be defined by the top of the ditch dimensions (Figure D-1).
- The vertical extent of contamination is assumed to extend 1.2 m (4 ft) below the bottom of the ditch (Figure D-3).

EXCAVATED VOLUME DIMENSIONS:

Base of excavation dimensions are 7.3 by 680 m (24 by 2,220 ft) at a depth of 2.4 m (8 ft). Top of excavation dimensions are 15 by 680 m (48 by 2,220 ft).

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-10 Pond System
SITE NAME: 216-Z-20 Crib

WASTE-SITE DIMENSIONS:

Gravel filled, drain field-type trench.

Length of bottom = 463 m (1,519 ft)
Width of bottom = 3 m (10 ft)
Length of top = 463 m (1,519 ft)
Width of top = 20 m (64 ft) (assuming a 1.5:1 side slope)
Depth = 5.5 m (18 ft)

CONTAMINATED VOLUME DIMENSIONS:

No contamination is assumed present in the 0 to 3 m (0 to 10 ft) bgs range defined by the PRGs.

Assumptions: - gravel fill (3.7 to 5.5 m [12 to 18 ft] bgs) is assumed contaminated but not addressed due to PRGs.

EXCAVATED VOLUME DIMENSIONS:

No excavated volume calculated because no contamination assumed.

SITE SYSTEM: 216-U-10 Pond System
SITE NAME: 216-U-9 Ditch

WASTE-SITE DIMENSIONS:

Earthen ditch.

Length = 2,000 m (7,000 ft)
Width of Bottom = 2 m (7 ft)
Width of Top = 9.8 m (32 ft)
Depth = 1.5 m (5 ft)

CONTAMINATED VOLUME DIMENSIONS:

No contamination was detected at the site.

EXCAVATED VOLUME DIMENSIONS:

Because there was no contamination detected, no excavation volume will be estimated.

SITE SYSTEM: 216-U-10 Pond System
SITE NAME: 216-U-11 Trench Overflow Area

WASTE-SITE DIMENSIONS:

Flat area where standing water from overflow of the 216-U-11 Trench would occasionally exist.

Length = 240 m (800 ft)
Width = 180 m (600 ft)
Depth = 0 m (0 ft)

Assumptions: - Assume waste-site dimensions are defined by the area between the "arms" of the 216-U-11 Trench.

CONTAMINATED VOLUME DIMENSIONS:

Length = 240 m (800 ft)
Width = 180 m (600 ft)
Depth = 0.15 m (0.5 ft)

Assumptions:
- The lateral extent of contamination is assumed to be defined by the waste-site dimensions (Figure D-1).
- The vertical extent of contamination is assumed to be the top 15 cm (6 in.) of soil per Mark Wasemiller of IT Hanford.

EXCAVATED VOLUME DIMENSIONS:

The excavation dimensions are 240 by 180 m (800 by 600 ft) to a depth of 0.15 m (0.5 ft).

SITE SYSTEM: 216-U-10 Pond System
SITE NAME: 216-U-11 Trench

WASTE-SITE DIMENSIONS:

Earthen ditch that has been backfilled.

Length = 1.375 m (4,510 ft)
Width of Bottom = 1.5 m (5 ft)
Width of Top = 7.6 m (25 ft)
Depth = 1.2 m (4 ft)

CONTAMINATED VOLUME DIMENSIONS:

Length = 1.375 m (4,510 ft)
Width = 7.6 m (25 ft)
Depth = 2. 4 m (8 ft)

Assumptions:
- The lateral extent of contamination is assumed to be defined by the top of the trench dimensions (Figure D-1).
- The vertical extent of contamination is assumed to extend 1.2m (4 ft) below the bottom of the trench (Figure D-3).

EXCAVATED VOLUME DIMENSIONS:

Base of excavation dimensions are 7.6 by 1,375 m (25 by 4,510 ft) at a depth of 2.4m (8 ft). Top of excavation dimensions are 15 by 1,375 m (49 by 4,510 ft).

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-10 Pond System
SITE NAME: 207-U Retention Basins

WASTE-SITE DIMENSIONS:

Consists of two concrete-lined, open, settling ponds. The UN-200-W-111 and UN-200-W-112 are directly to the north and south of the basins, respectively.

Basins:	Uncontrolled Releases:
Length = 32 m (106 ft) each	Length = 12 m (40 ft) each
Width = 32 m (106 ft) each	Width = 3 m (10 ft) each
Depth = 2 m (6.5 ft)	Depth = 2.4 m (8 ft)

CONTAMINATED VOLUME DIMENSIONS:

Surface Contamination:	Uncontrolled Releases:
Length = 75 m (246 ft)	Length = 12 m (40 ft) each
Width = 38 m (123 ft)	Width = 3 m (10 ft) each
Depth = 0.6 m (2 ft)	Depth = 2.4 m (8 ft)

Assumptions:
- The lateral extent of contamination is assumed to be the dimensions of the waste unit, as defined in DOE-RL (1992a) (Figure D-1).
- The vertical extent of contamination is assumed a conservative, engineering-based judgment.
- Investigations show that the basins did not leak; therefore, no contamination below basins is present.

EXCAVATED VOLUME DIMENSIONS:

Surface Contamination:
Due to shallow depth, base of excavation equals top of excavation, 75 by 38 m (246 by 123 ft) to a depth of 0.6 m (2 ft).

Each Uncontrolled Release:
Base of excavation dimensions are 12 by 3 m (40 by 10 ft) at a depth of 2.4 m (8 ft). Top of excavation dimensions are 19 by 10.4 m (64 by 34 ft).

Each Concrete Liner:
Base of excavation dimensions are 32 by 32 m (106 by 106 ft) at a depth of 2 m (6.5 ft). Top of excavation dimensions are 38.3 by 38.3 m (125.5 by 125.5 ft). Note that both (1,900,000 l [500,000 gal] each) basins are empty.

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-1/2 Crib System
SITE NAME: 216-U-1/2 Cribs

WASTE-SITE DIMENSIONS:

Each crib consists of a 3.7 by 3.7 by 1.2 m (12 by 12 by 4 ft) timber structure set in a 6 m (20 ft) deep excavation and backfilled to grade.

Length of Bottom = 3.7 m (12 ft)
Width of Bottom = 3.7 m (12 ft)
Length of Top = 16 m (52 ft)
Width of Top = 7.6 m (25 ft)
Depth = 6 m (20 ft)
Distance between Cribs = 18 m (60 ft) from base

CONTAMINATED VOLUME DIMENSIONS:

Length = 53 m (174 ft)
Width = 31 m (102 ft)
Depth = 3 m (10 ft)

Assumptions:
- The lateral extent of contamination is assumed to extend 7.6 m (25 ft) from the outer edges of the cribs, which is approximately the distance to borehole 299-W19-11 (Figure D-4).
- The vertical extent of contamination is assumed to be 0 to 3 m (0 to 10 ft) bgs due to analytical data collected in borehole 200-W19-96. Note that high concentrations of cesium-137 and strontium-90 were found in borehole 299-W19-96 from 3 to 9 m (10 to 30 ft) bgs, but will not be addressed under the industrial land use scenario (Figures D-5 and D-6).

EXCAVATED VOLUME DIMENSIONS:

Base of excavation dimensions are 53 by 31 m (174 by 102 ft) at a depth of 3 m (10 ft). Top of excavation dimensions are 62 by 40 m (204 by 132 ft).

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-1/2 Crib System
SITE NAME: 241-U-361 Settling Tank

WASTE-SITE DIMENSIONS:

The settling tank is 6 m (20 ft) in diameter by 5.8 m (19 ft) high and buried so that the top is 1.8 m (6 ft) bgs.

CONTAMINATED VOLUME DIMENSIONS:

Top 1.8 m (6 ft):
Length = 76 m (250 ft)
Width = 60 m (200 ft)
Depth = 1.8 m (6 ft)

Settling Tank:
6 m (20 ft) diameter
Depth = 5. 8 m (19 ft) (1.8 to 7.6 m [6 to 25 ft] bgs)

Assumptions:

Top 1.8 m (6 ft)	-	Per Mark Wasemiller of IT Hanford, consolidation of contaminated soil and an uncontrolled release are assumed to form an extent of contamination 76 by 60 m (250 by 200 ft) laterally to a depth of 1.8 m (6 ft) (Figures D-4 and D-6).
Settling Tank	-	Extent of contamination assumed to be the dimensions of the tank.

EXCAVATED VOLUME DIMENSIONS:

Top 1.8 m (6 ft):
Base of excavation dimensions are 76 by 60 m (250 by 200 ft) at a depth of 1.8 m (6 ft). Top of excavation dimensions are 82 by 66 m (268 by 218 ft).

Settling Tank:
Base of excavation dimensions are 6 m (20 ft) in diameter at a depth of 5.8 m (19 ft). Top of excavation dimensions is 23 m (77 ft) in diameter.

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-1/2 Crib System
SITE NAME: 2607-W5 Drain Fields

WASTE-SITE DIMENSIONS:

Comprised of two drain fields, each:

Length = 41 m (136 ft)
Width = 30 m (100 ft)
Depth = 0.8 m (2.5 ft)

CONTAMINATED VOLUME DIMENSIONS:

Site is still active.

EXCAVATED VOLUME DIMENSIONS:

Site is still active.

SITE SYSTEM: 216-U-1/2 Crib System
SITE NAME: 2607-W5 Septic Tank

WASTE-SITE DIMENSIONS:

Underground concrete tank.

Length = 9 m (30 ft)
Width = 4 m (13 ft)
Depth = 3.4 m (11 ft)

CONTAMINATED VOLUME DIMENSIONS:

Site is still active.

EXCAVATED VOLUME DIMENSIONS:

Site is still active.

SITE SYSTEM: 216-U-1/2 Crib System
SITE NAME: Stainless Steel Pipeline

WASTE-SITE DIMENSIONS:

Stainless steel pipeline, approximately 300 m (1,000 ft) long and buried at a depth of 3 m (10 ft) bgs.

CONTAMINATED VOLUME DIMENSIONS:

Field investigations determined no contamination of the surrounding soils has occurred; however, an excavated volume will be calculated to remove the pipeline.

EXCAVATED VOLUME DIMENSIONS:

Base of excavation dimensions are 300 by 0.3 m (1,000 by 1 ft) at a depth of 3 m (10 ft). Top of excavation dimensions are 314 by 9.5 m (1,030 by 31 ft).

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-1/2 Crib System
SITE NAME: 216-U-16 Crib

WASTE-SITE DIMENSIONS:

Gravel-filled, drain field-type crib.

Length of bottom = 80 m (262 ft)
Width of bottom = 58 m (191 ft)
Length of top = 95 m (313 ft)
Width of top = 74 m (242 ft)
Depth = 5.2 m (17 ft)

CONTAMINATED VOLUME DIMENSIONS:

No contamination assumed to exist, as defined by PRGs.

Assumptions: - Because the gravel fill is located below the 3 m (10 ft) bgs range defined by the PRGs, no contamination is assumed to exist between 0 to 3 m (0 to 10 ft) bgs range. It should be noted that the gravel fill from 3.7 to 5.2 m (12 to 17 ft) bgs is assumed contaminated (Figures D-4 and D-7).

EXCAVATED VOLUME DIMENSIONS:

No excavation is calculated because no contamination assumed between 0 to 3 m (0 to 10 ft) bgs.

SITE SYSTEM: 216-U-1/2 Crib System
SITE NAME: 216-U-16 Vitrified Clay Pipeline

WASTE-SITE DIMENSIONS:

VCP, 46 cm (18 in.) in diameter, approximately 270 m (900 ft) long and buried at a depth of 3 m (10 ft) bgs.

CONTAMINATED VOLUME DIMENSIONS:

Length = 270 m (900 ft)
Width = 3 m (10 ft)
Depth = 1.2 m (4 ft) (1.8 to 3 m [6 to 10 ft] bgs)

Assumptions: - The extent of contamination is assumed analogous to the 216-U-8 pipeline (Figures D-4 and D-7).

EXCAVATED VOLUME DIMENSIONS:

Base of excavation dimensions are 270 by 3 m (900 by 10 ft) at a depth of 3 m (10 ft).
Top of excavation dimensions are 280 m by 12 m (930 by 40 ft).

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-8 Crib System
SITE NAME: 216-U-8 Crib

WASTE-SITE DIMENSIONS:

Consists of 3 timber structures, each 4.9 by 4.9 by 3 m (16 by 16 by 10 ft). The timber structures are buried in a backfilled excavation.

Length of Bottom = 49 m (160 ft)
Width of Bottom = 15 m (50 ft)
Length of Top = 68 m (222 ft)
Width of Top = 34 m (112 ft)
Depth = 9.5 m (31 ft)

CONTAMINATED VOLUME DIMENSIONS:

Length = 68 m (222 ft)
Width = 34 m (112 ft)
Depth = 0.9 m (3 ft)

Assumptions:
- The lateral extent of contamination is assumed to be the top of the crib dimensions (Figure D-8).
- The vertical extent of contamination is assumed to be 0.9 m (3 ft) of contaminated soil at the ground surface consolidated under the RARA project interim stabilization. Note that high concentrations of cesium-137 were detected in Borehole 299-W19-94 from 9 to 12 m (30 to 40 ft) bgs, but will not be addressed, as defined by the PRGs (Figures D-9 and D-10).

EXCAVATED VOLUME DIMENSIONS:

Length = 68 m (222 ft)
Width = 34 m (112 ft)
Depth = 1.5 m (5 ft) (due to 0.6 m [2 ft] soil cover over 0.9 m [3 ft] contaminated material)

SITE SYSTEM: 216-U-8 Crib System
SITE NAME: 216-U-8 Vitrified Clay Pipeline

WASTE-SITE DIMENSIONS:

VCP, 15 mcm (6 in.) in diameter, approximately 314 m(1,030 ft) long and 3 m (10 ft) bgs.

CONTAMINATED VOLUME DIMENSIONS:

Length = 314 m (1,030 ft)
Width = 3 m (10 ft)
Depth = 1.2 m (4 ft) (1.8 to 3 m [6 to 10 ft] bgs)

Assumptions:
- The lateral extent of contamination is assumed to be the length of the pipeline by 3 m (10 ft) centered on the pipeline based on data from Wasemiller et al. (1994) (Figure D-8).
- The vertical extent of contamination is assumed to be from 1.8 to 3 m (6 to 10 ft) bgs based on data from Wasemiller et al. (1994). Note: the data showed contamination from 3 to 4.6 m (10 to 15 ft) bgs is present, but will not be addressed as defined by the PRGs (Figures D-9 and D-11).

EXCAVATED VOLUME DIMENSIONS:

Base of excavation dimensions are 314 by 3 m (1,030 by 10 ft) at a depth of 3 m (10 ft). Top of excavation dimensions are 323 by 12 m (1,060 by 40 ft).

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-12 Crib System
SITE NAME: 216-U-12 Crib

WASTE-SITE DIMENSIONS:

Gravel filled, drain field-type trench

Length of Bottom = 30 m (100 ft)
Width of Bottom = 3 m (10 ft)
Length of Top = 46 m (150 ft)
Width of Top = 18 m (60 ft)
Depth = 4 m (13 ft)

CONTAMINATED VOLUME DIMENSIONS:

Length = 46 m (150 ft)
Width = 18 m (60 ft)
Depth = 1.8 to 3 m (6 to 10 ft) bgs = 1.2 m (4 ft)

Assumptions:
- The lateral extent of contamination is assumed to be the dimensions of the top of the waste site (Figure D-8).
- The vertical extent of contamination is assumed to be analogous to the bottom of the 216-U-8 Crib; therefore from the top of the gravel fill (1.8 m [6 ft] bgs) to the bottom of the zone of intrusion (4 m [13 ft] bgs) as defined by the PRGs. Note: contamination is assumed present below 3 m (10 ft), but will not be addressed as defined by the PRGs (Figure D-12).

EXCAVATED VOLUME DIMENSIONS:

Base of excavation dimensions are 46 by 18 m (150 by 60 ft) at a depth of 3 m (10 ft).
Top of excavation dimensions are 55 by 27 m (180 by 90 ft).

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-12 Crib System
SITE NAME: 216-U-12 Vitrified Clay Pipeline

WASTE-SITE DIMENSIONS:

VCP, 15 cm (6 in.) in diameter, approximately 120 m (400 ft) long and 3 m (10 ft) bgs.

CONTAMINATED VOLUME DIMENSIONS:

Length = 120 m (400 ft)
Width = 3 m (10 ft)
Depth = 1.2 m (4 ft) (1.8 to 3 m [6 to 10 ft] bgs)

Assumption: - The extent of contamination is assumed to be analogous to the 216-U-8 VCP (Figures D-8 and D-12).

EXCAVATED VOLUME DIMENSIONS:

Base of excavation dimensions are 120 by 3 m (400 by 10 ft) at a depth of 3 m (10 ft).
Top of excavation dimensions are 130 by 12 m (430 by 40 ft).

Excavation slopes 1.5 H:1.0 V

SITE SYSTEM: 216-U-4, 216-U-4A
SITE NAME: 216-U-4 Reverse Well, 216-U-4A French Drain

WASTE-SITE DIMENSIONS:

216-U-4 Reverse Well:
8 cm (3 in.) diameter steel pipe extending 23 m (75 ft) bgs.

216-U-4A French Drain:
1.3 m (51 in.) diameter concrete pipe extending from 1.5 to 2.7 m (5 to 9 ft) bgs.

CONTAMINATED VOLUME DIMENSIONS:

No contamination exists in the 0 to 3 m (0 to 10 ft) range exceeding the PRG of 100 mrem/yr (Figures D-13, D-14, and D-15).

EXCAVATED VOLUME DIMENSIONS:

No excavation calculated because no contamination warranting an IRM exists at this site.

Waste Site Dimensions	
216-U-10 Pond	- 12.2 hectares (30 acres)/1.8 m (6 ft.) deep
216-U-14 Ditch	- 1,700 m (5,600 ft.) long/1.2 m (4 ft.) deep
216-Z-1D Ditch	- 1,311.5 m (4,300 ft.) long/.6 m (2 ft.) deep
216-Z-11 Ditch	- 797.6 m (2,615 ft.) long/.6 m (2 ft.) deep
216-Z-19 Ditch	- 843.3 m (2,765 ft.) long/1.2 m (4 ft.) deep
216-Z-20 Crib	- 463.3 m (1,519 ft.) long/5.5 m (18 ft.) deep
216-U-11 Trench	- 1,375.5 m (4,510 ft.) long/1.2 m (4 ft.) deep
216-U-9 Ditch	- 2,135 m (7,000 ft.) long/1.5 m (5 ft.) deep
207-U Basins	- 75 m (246 ft.) x 37.5 m (123 ft.)/2 m (6.5 ft.) deep

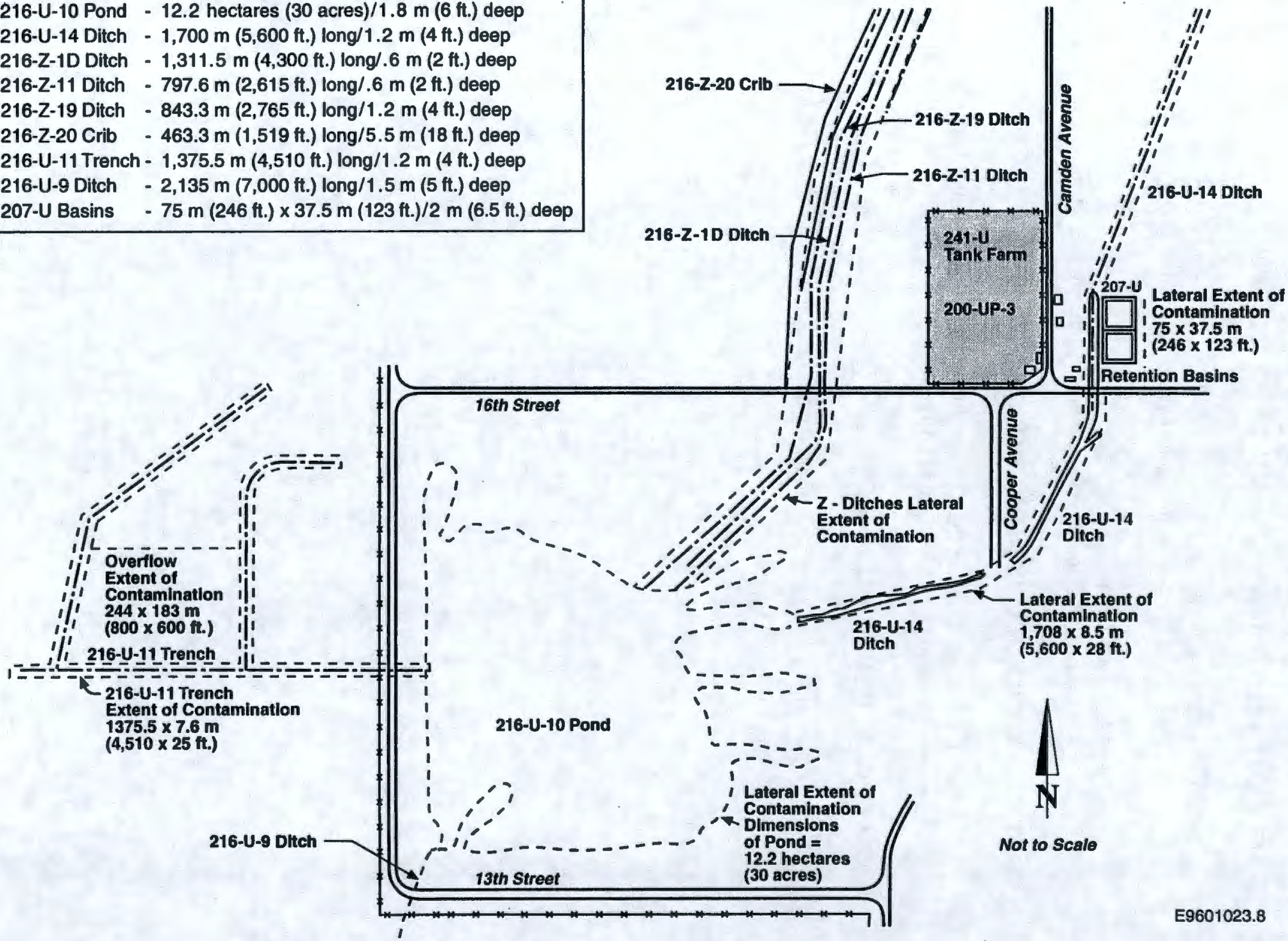


Figure D-1 216-U-10 System Lateral Contamination

9613401.3008

Figure D-2 216-U-10 Pond Borehole Data (page 1 of 2)

200-UP-2
216-U-10 Pond

Depth (Feet): 10, 20, 30, 40, 50, 60, 70

Lithology, Borehole 299-W23-231:
- 0-4.3' Sand fill pond bottom at 4.3' abundant with organic matter
- 4.3-6' Sand
- 6-28' Sandy Gravel
- Hanford Unit 1/ Hanford Unit 2 Contact at 28'
- 28-33' Sand and Interbedded Silt
- 33-98' Sand

New Analytical Data (pCi/g)

Am-241	Cs-137	Co-60	Eu-152	Eu-154	Pu-238	Pu-239/240	Ra-226	Ra-228	Th-228	U-234	U-238	Aroclor-1260 µg/kg	Chromium mg/kg
5.45	1150	.093	.023	.168	5.39	26.5				8.81	8.26		
.318	66.1	0	.033	.005	.284	1.61				2.48	2.36	48	10.5
.084	.778	.025	.018	0	.131	.287				1.57	1.54	34	8.1
												34	5.1
.037	.018	.004	.045	.033	.087	.106				.478	.443	34	7.2
.009	.004	.013	.003	.029	.014	0				.652	.644	34	7.4
.010	0	0	.063	0	0	.004				.807	.809	35	9.4
.007	.008	.004	.126	.049	.002	0				.748	.835	35	12.6

RLS 299-W23-231

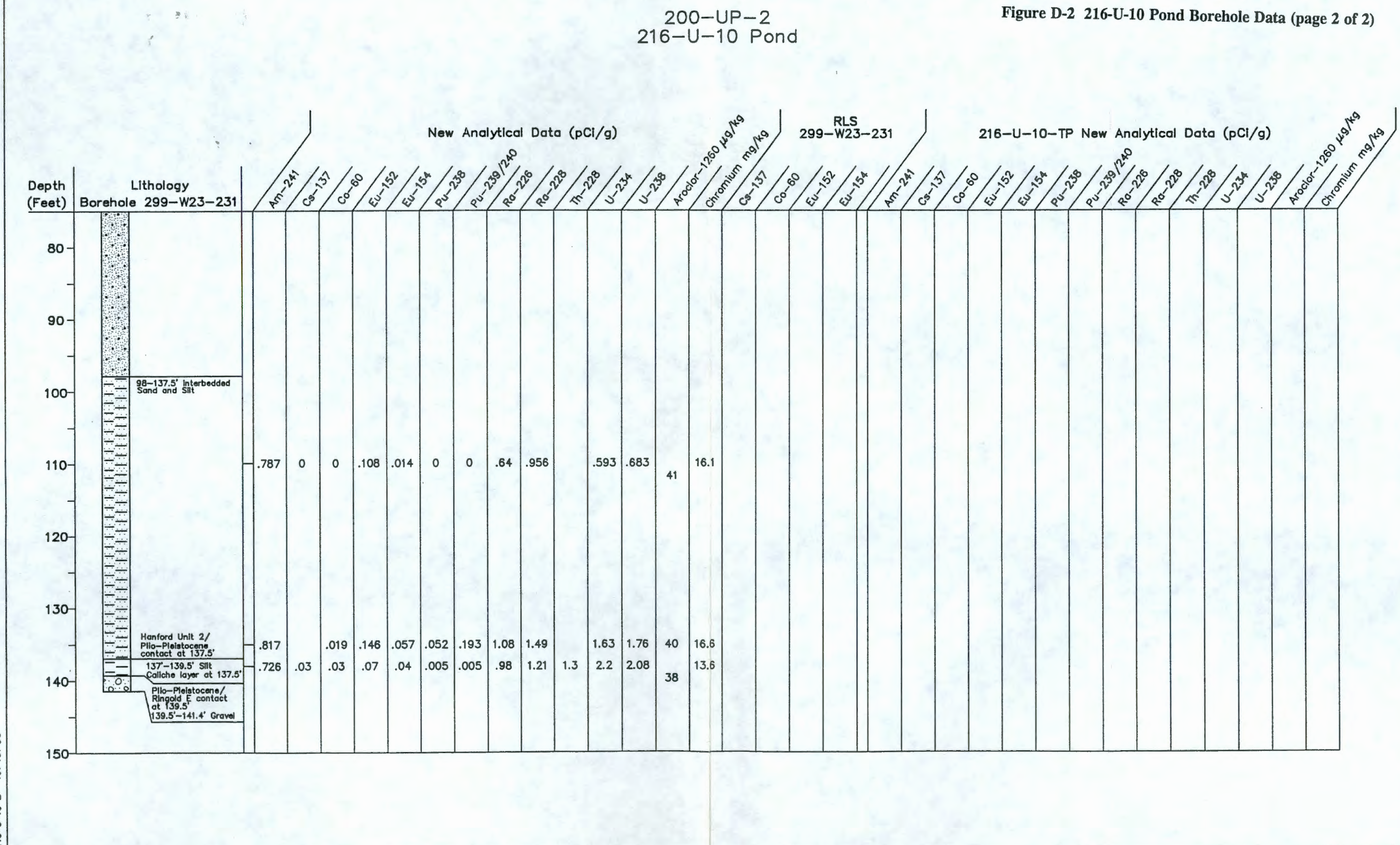
Cs-137	Co-60	Eu-152	Eu-154

216-U-10-TP New Analytical Data (pCi/g)

Am-241	Cs-137	Co-60	Eu-152	Eu-154	Pu-238	Pu-239/240	Ra-226	Ra-228	Th-228	U-234	U-238	Aroclor-1260 µg/kg	Chromium mg/kg
45	4800	.41	6	4	23	36	5	2.6	5	85	88	220	82.7
.005	1.78	.04	.1	.07	.015	.018	1.08	.85	.83	.77	.8	35	9.6
0	1	.04	.1	.07	.016	.008	.48	.59	.77	.63	.55	34	6.9
.014	1.3	.01	.04	.03	.019	.023	.36	.49	.51	.48	.43	34	7.6

216-U-10 10/10/95

Figure D-2 216-U-10 Pond Borehole Data (page 2 of 2)



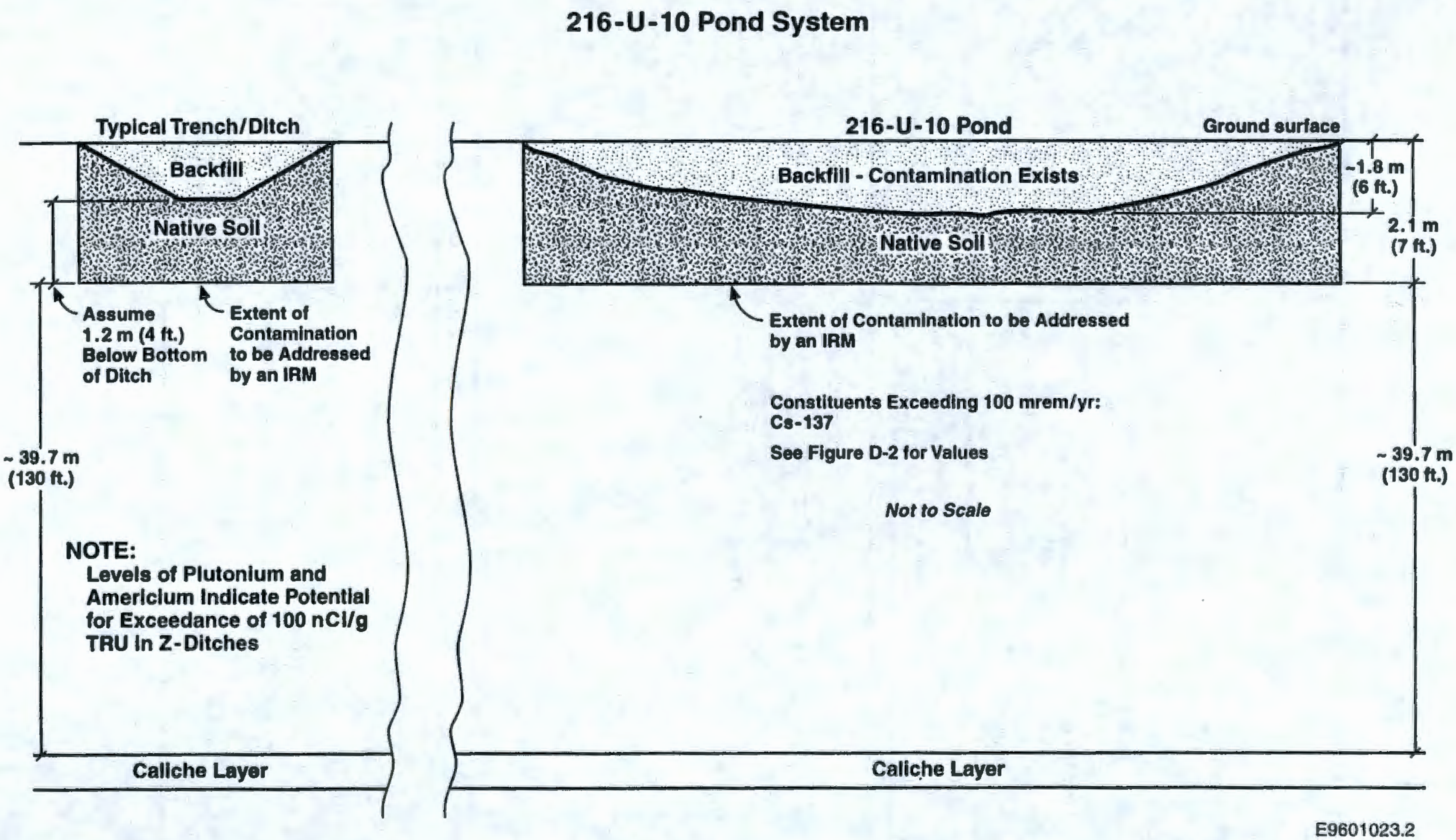
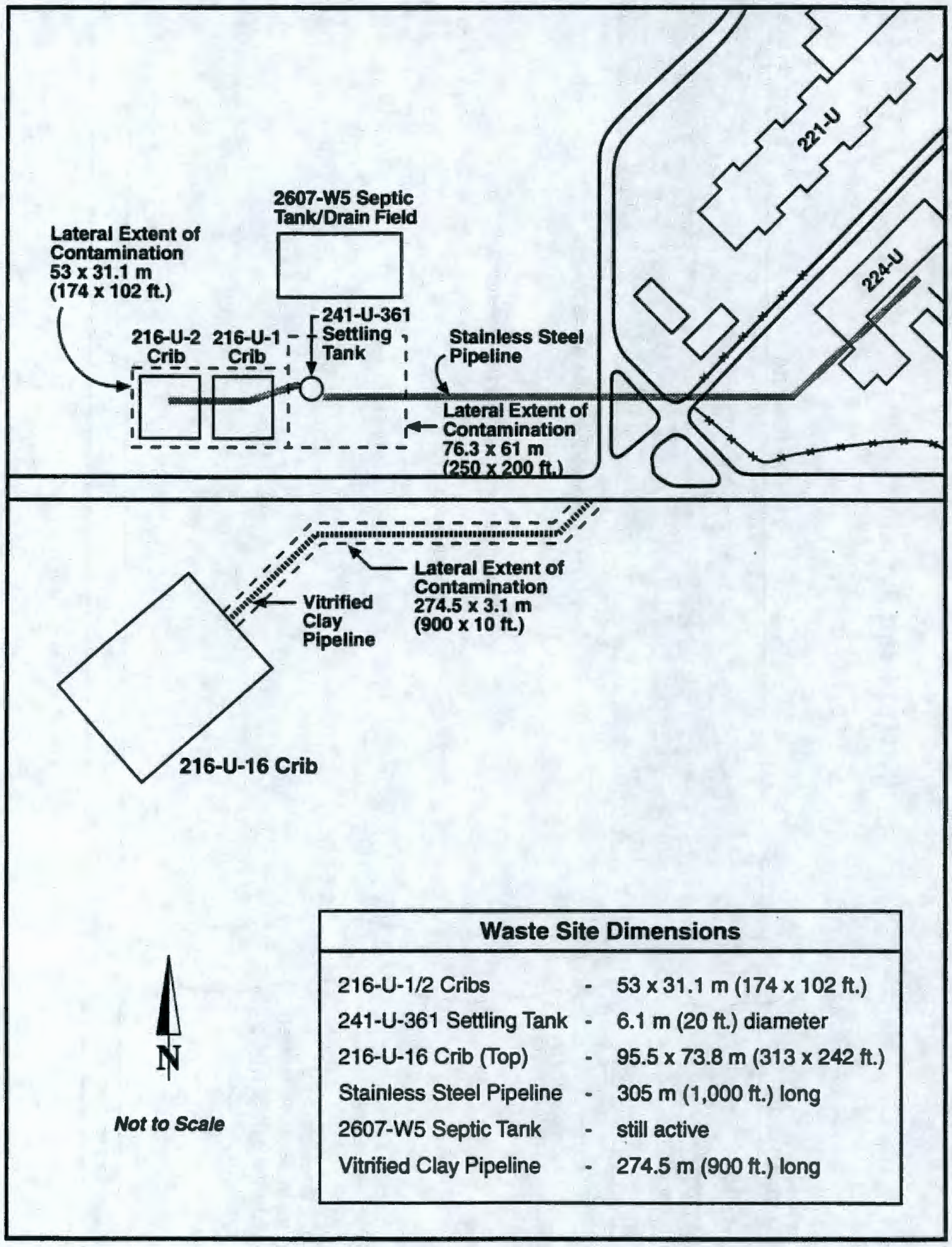


Figure D-3 216-U-10 System Vertical Contamination

Figure D-4 216-U-1/2 System Lateral Contamination



Waste Site Dimensions

216-U-1/2 Cribs	-	53 x 31.1 m (174 x 102 ft.)
241-U-361 Settling Tank	-	6.1 m (20 ft.) diameter
216-U-16 Crib (Top)	-	95.5 x 73.8 m (313 x 242 ft.)
Stainless Steel Pipeline	-	305 m (1,000 ft.) long
2607-W5 Septic Tank	-	still active
Vitrified Clay Pipeline	-	274.5 m (900 ft.) long

E9601023.1

Figure D-5 216-U-1/2 System Borehole Data (page 1 of 2)

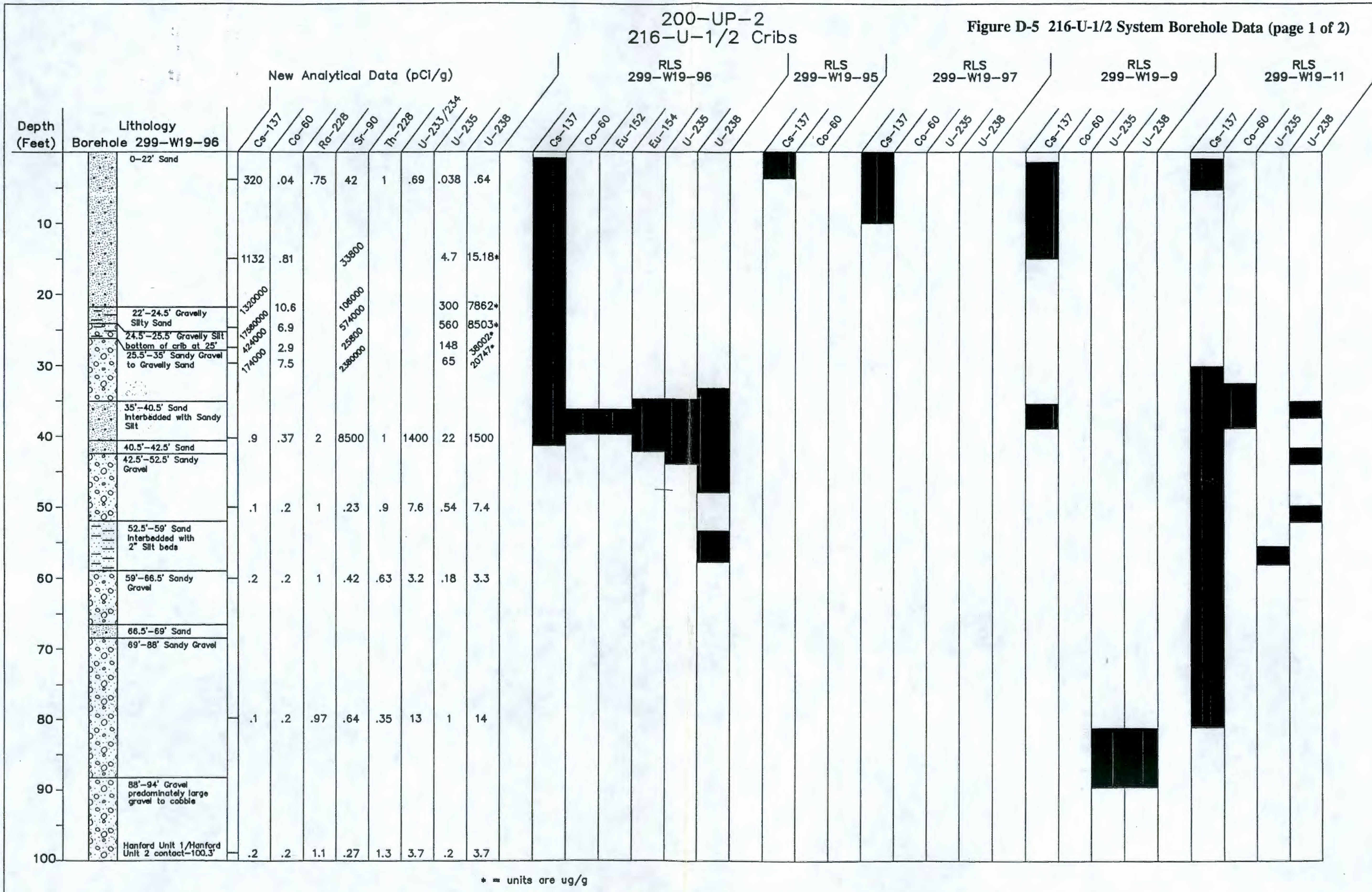
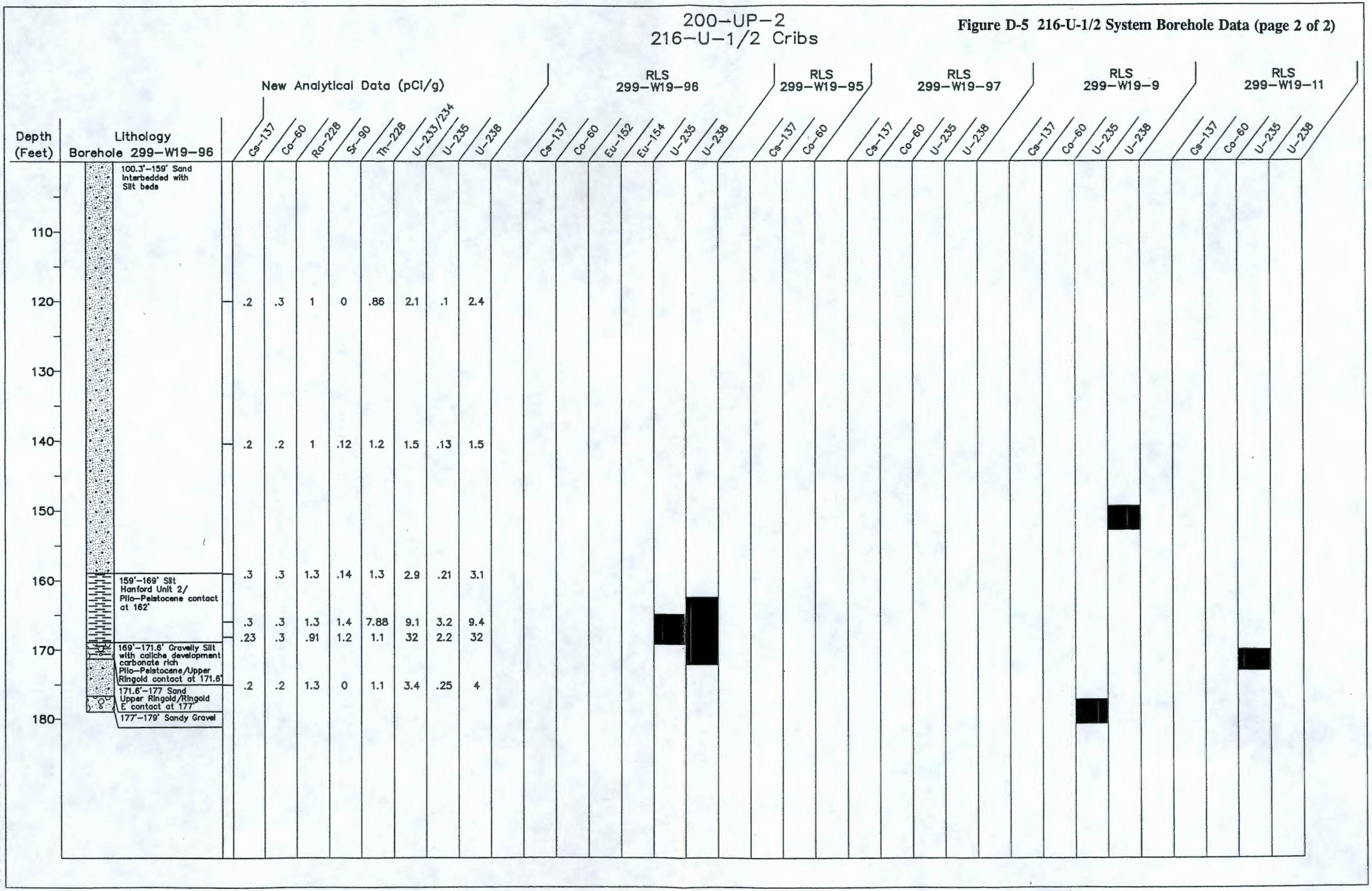


Figure D-5 216-U-1/2 System Borehole Data (page 2 of 2)



9613401.3013

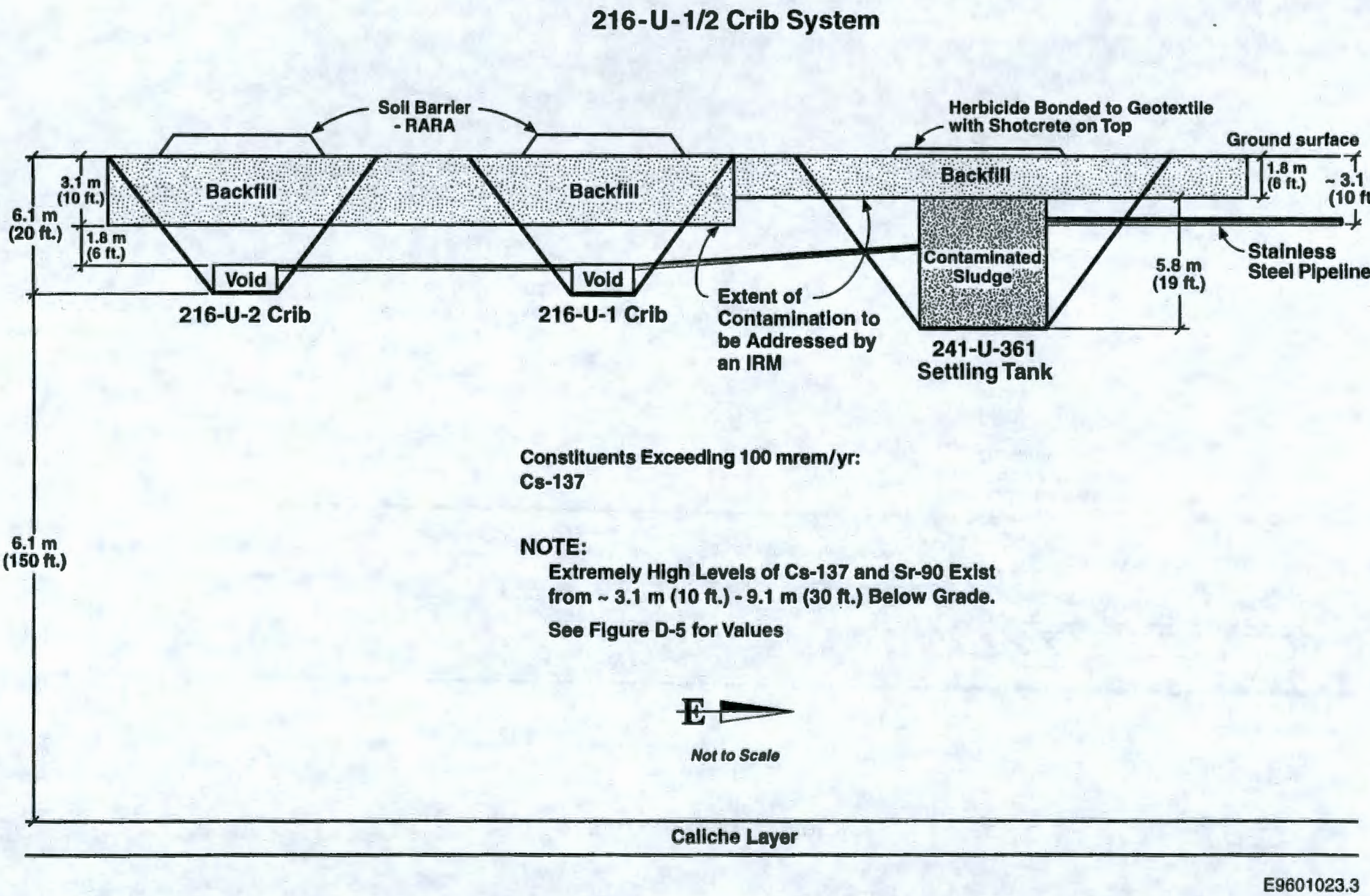


Figure D-6 216-U-1/2 System Vertical Contamination

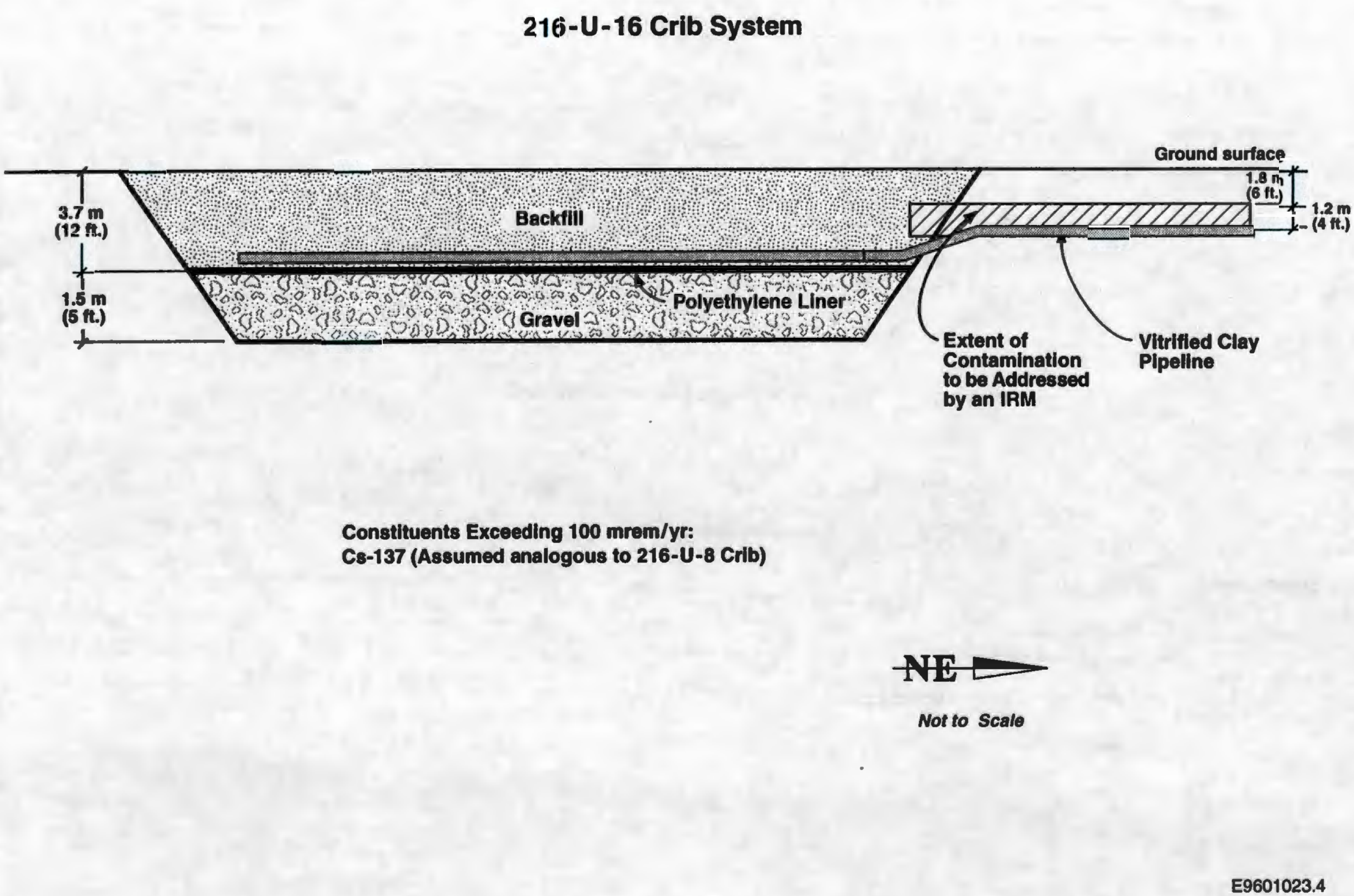
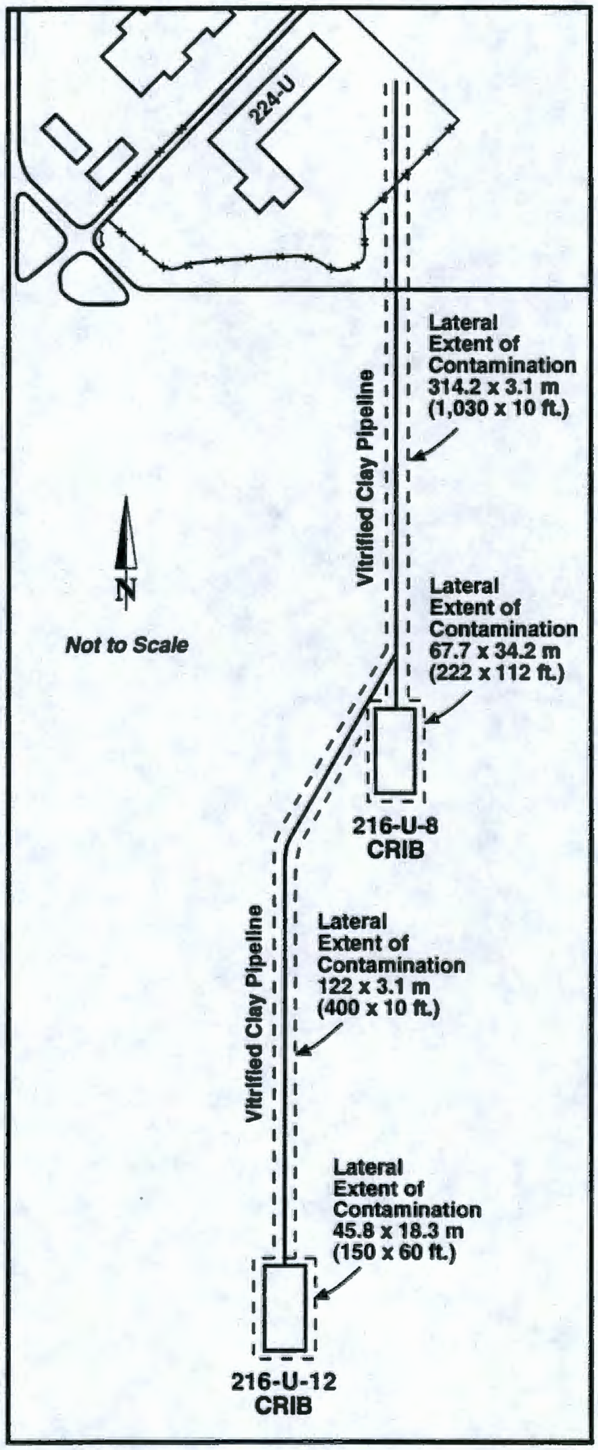


Figure D-7 216-U-16 Crib Vertical Contamination

Figure D-8 216-U-8 System Lateral Contamination



Waste Site Dimensions		
216-U-8 Crib (Top)	-	67.7 x 34.2 m (222 x 112 ft.)
216-U-8 VCP	-	314.2 m (1,030 ft.) long
216-U-12 Crib (Top)	-	45.8 x 18.3 m (150 x 60 ft.)
216-U-12 VCP	-	122 m (400 ft.) long

E9601023.9

200-UP-2
216-U-8 Crib

Figure D-9 216-U-8 System Borehole Data (page 1 of 2)

Depth (Feet): 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

Lithology, Borehole 299-W19-94:
- 0-1' surface stabilized with crushed rock
- 1-4' Sand
- 4-21' Sand with occasional gravel/cobblestones
- 21-31' Crib Gravel
- 31' bottom of Crib
- 31'-76.5' Sand
- 76.5-80.5' Sand interbedded fine to coarse
- 80.5-89.5 Slightly Silty Sand
- 89.5-128' Sand interbedded Silt with fine to coarse grained sand

New Analytical Data (pCi/g)

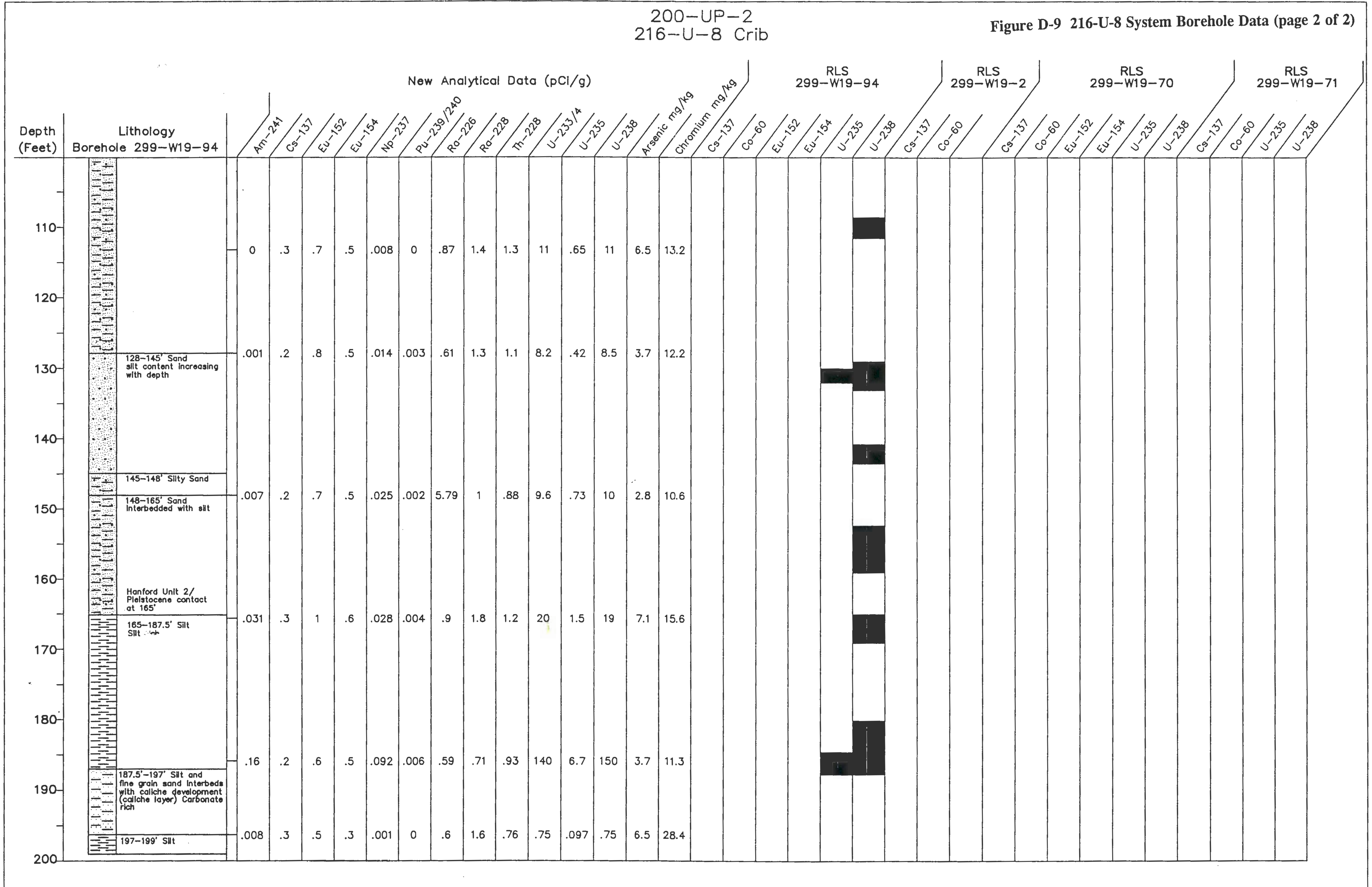
Am-241	Cs-137	Eu-152	Eu-154	Np-237	Pu-239/240	Ra-226	Ra-228	Th-228	U-233/4	U-235	U-238	Arsenic mg/kg	Chromium mg/kg
.002	.2	.2	.2	.019	.005	.76	1.2	.94	.58	.024	.55	8.8	9.1
.004	.2	.3	.2	.012	0	.5	.83	.81	.44	.039	.43	9.1	11.6
.001	.06	.09	.05	.003	.007	.49	.53	.53	.77	.024	.84		12.5
.733	91190	5.4	3.9	.1	4.95					10.9	150		
.155	24430	4.4	3.2	.5	.12					18	227		23.5
.2	1700	6	3.1	.035	.01	2	2.1	2	28	1.1	29	4.8	12.5
.003	3.4	.3	.2	.018	0	.44	.71	.6	4.4	.32	4.3	3.1	8.7
0	56	.5	.3	.004	0	.61	1.7	1.2	6.3	.38	6.2	5.6	10.1
0	.78	.3	.2	.011	.015	.46	1.1	.81	5	.38	5.1	4.1	8.8
.007	29	.4	.3	.003	0	1.1	1	1.4	6.8	.39	7	4.8	12

216-U-8 10/19/95

9613401.3016

200-UP-2
216-U-8 Crib

Figure D-9 216-U-8 System Borehole Data (page 2 of 2)



New Analytical Data (pCi/g)

Am-241	Cs-137	Eu-152	Eu-154	Np-237	Pu-239/240	Ra-226	Ra-228	Th-228	U-233/4	U-235	U-238	Arsenic mg/kg	Chromium mg/kg
0	.3	.7	.5	.008	0	.87	1.4	1.3	11	.65	11	6.5	13.2
.001	.2	.8	.5	.014	.003	.61	1.3	1.1	8.2	.42	8.5	3.7	12.2
.007	.2	.7	.5	.025	.002	5.79	1	.88	9.6	.73	10	2.8	10.6
.031	.3	1	.6	.028	.004	.9	1.8	1.2	20	1.5	19	7.1	15.6
.16	.2	.6	.5	.092	.006	.59	.71	.93	140	6.7	150	3.7	11.3
.008	.3	.5	.3	.001	0	.6	1.6	.76	.75	.097	.75	6.5	28.4

216-U-8b 10/19/95

9613401.3017

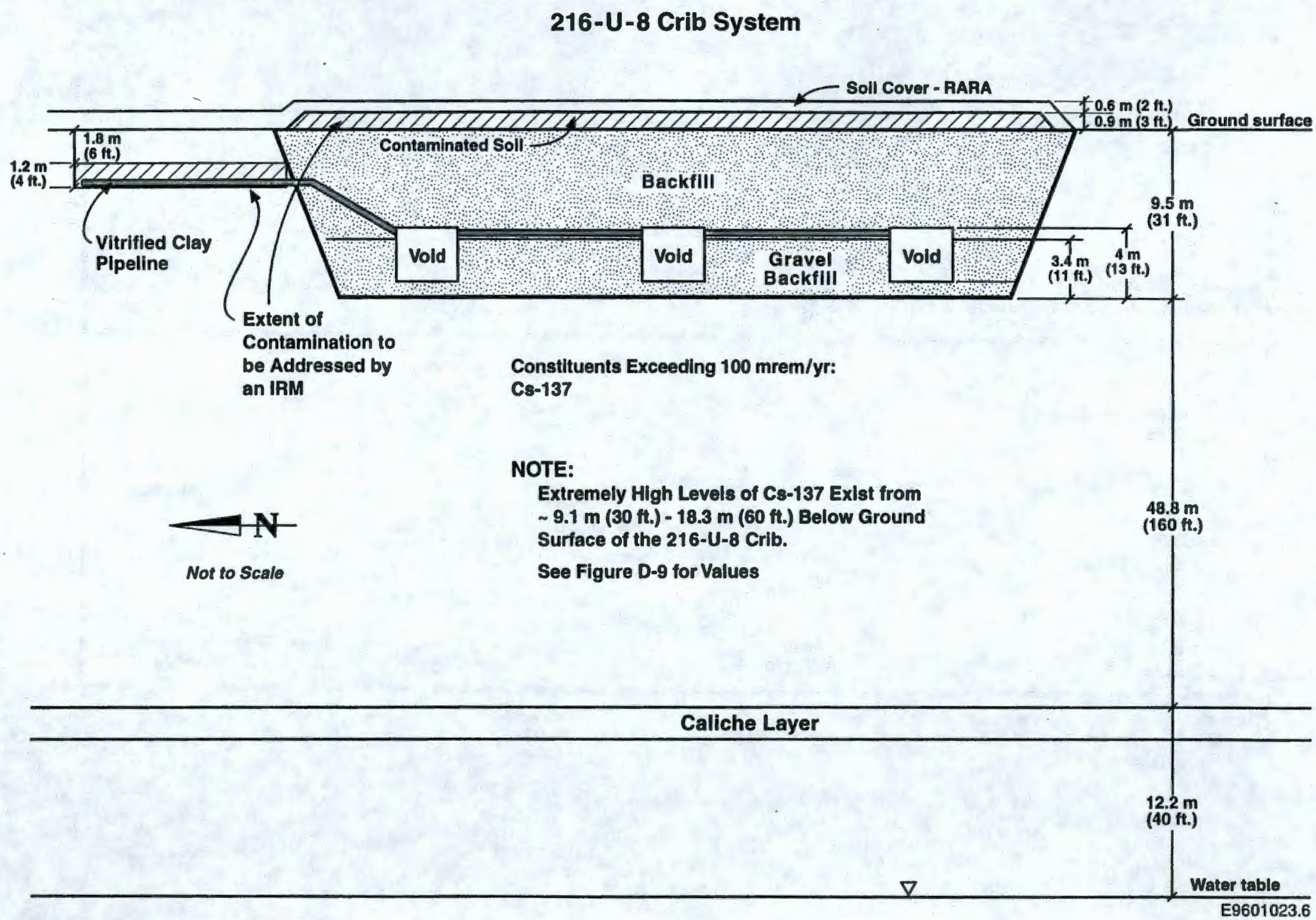


Figure D-10 216-U-8 System Vertical Contamination

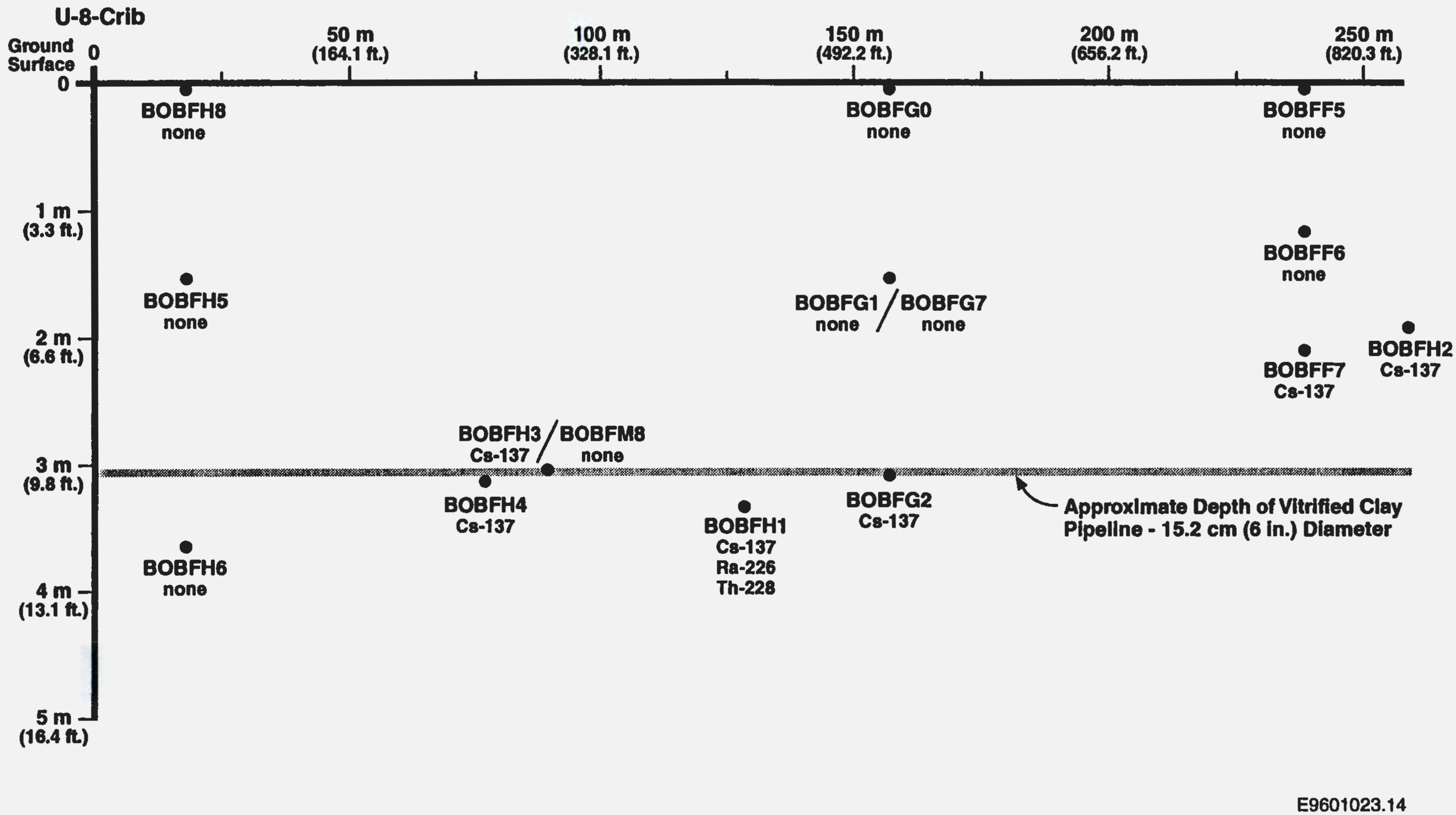


Figure D-11 216-U-8 VCP Borehole Data

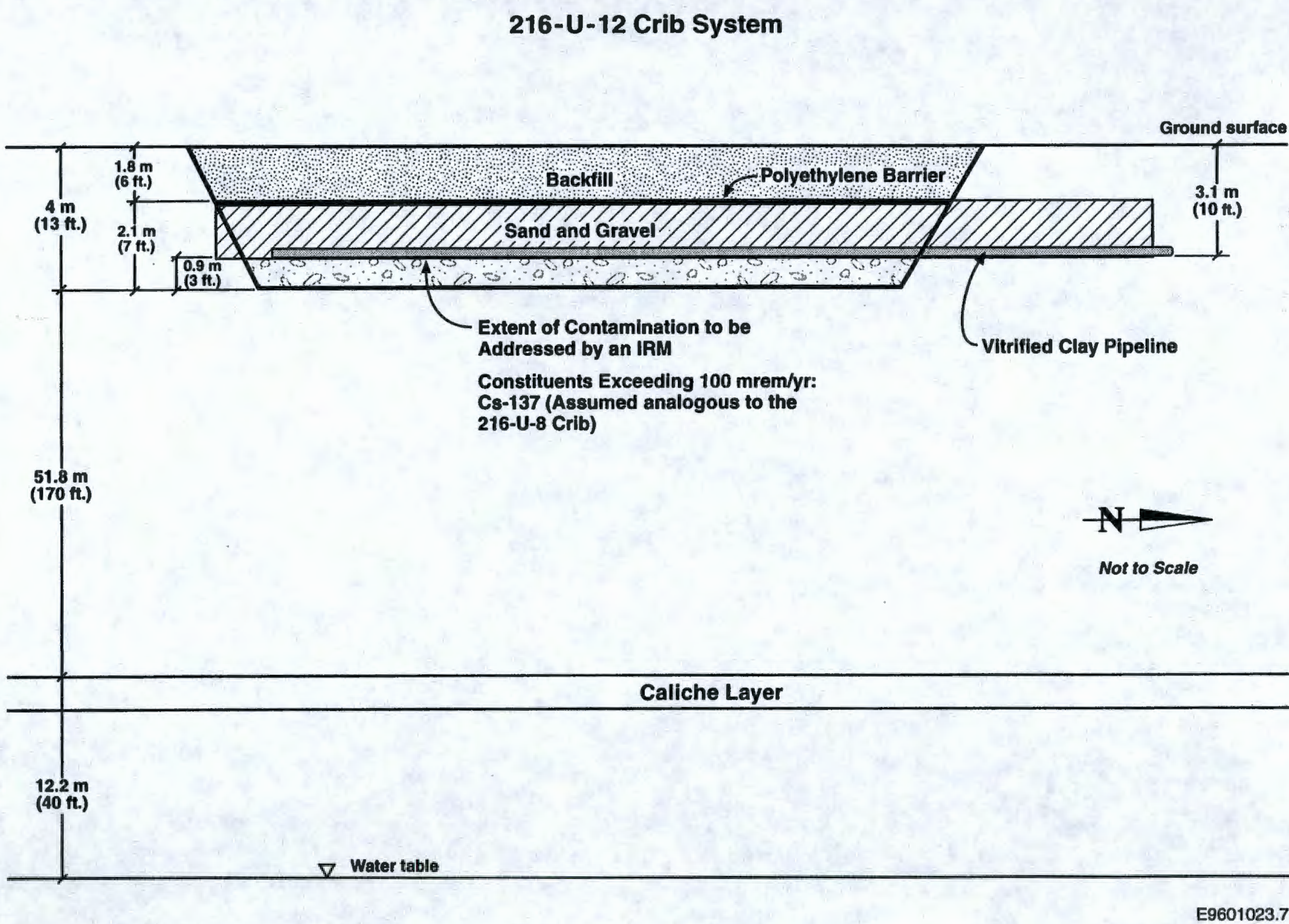
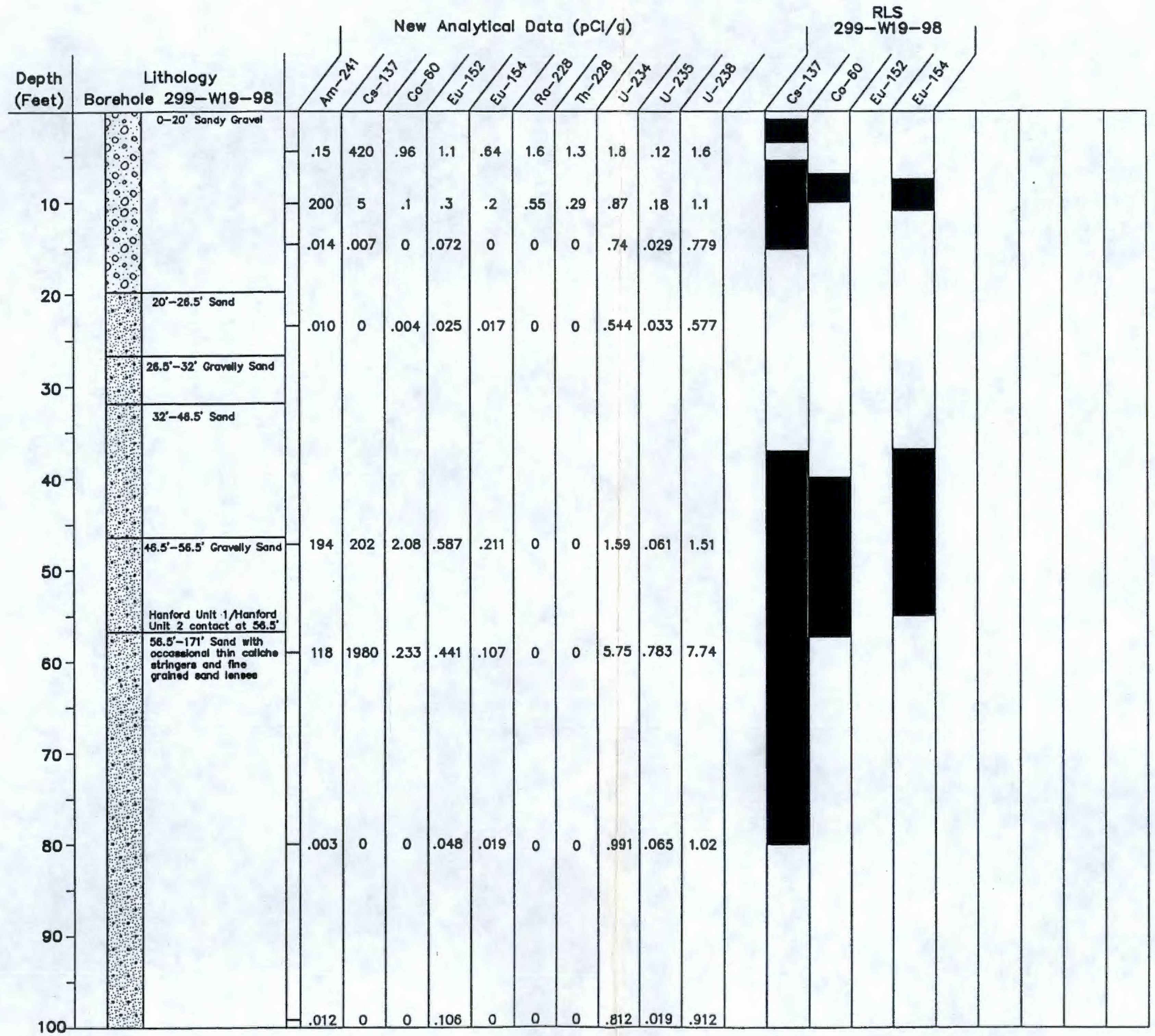


Figure D-12 216-U-12 Crib Vertical Contamination

Figure D-13 216-U-4, -4a System Borehole Data (page 1 of 2)

200-UP-2
216-U-4,-4A



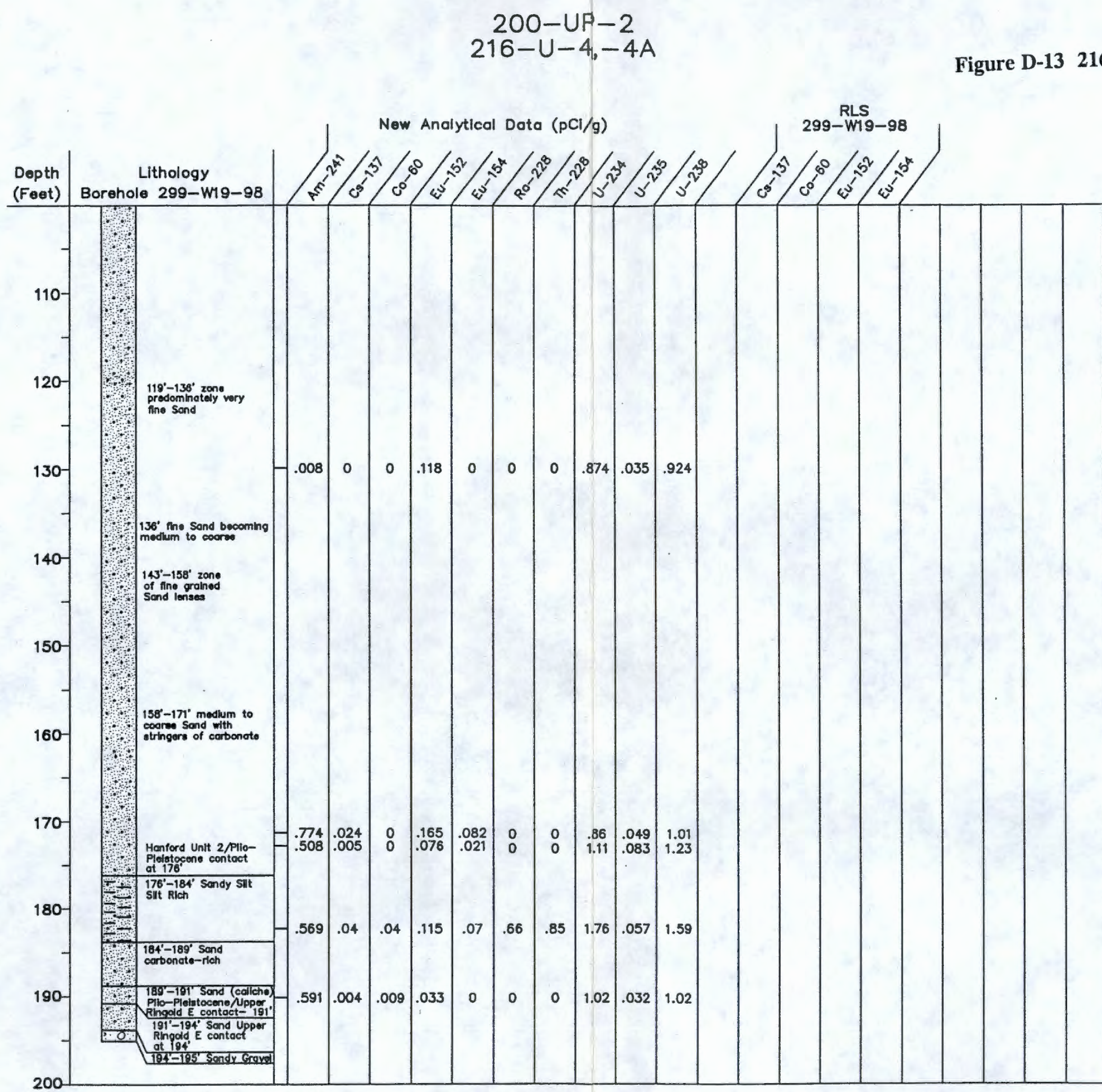
New Analytical Data (pCi/g)

Depth (approx.)	Am-241	Cs-137	Co-60	Eu-152	Eu-154	Ra-228	Th-228	U-234	U-235	U-238
~5	.15	420	.96	1.1	.64	1.6	1.3	1.8	.12	1.6
10	200	5	.1	.3	.2	.55	.29	.87	.18	1.1
~15	.014	.007	0	.072	0	0	0	.74	.029	.779
~23	.010	0	.004	.025	.017	0	0	.544	.033	.577
~47	194	202	2.08	.587	.211	0	0	1.59	.061	1.51
~59	118	1980	.233	.441	.107	0	0	5.75	.783	7.74
80	.003	0	0	.048	.019	0	0	.991	.065	1.02
100	.012	0	0	.106	0	0	0	.812	.019	.912

216-U-4,4A 10/19/95

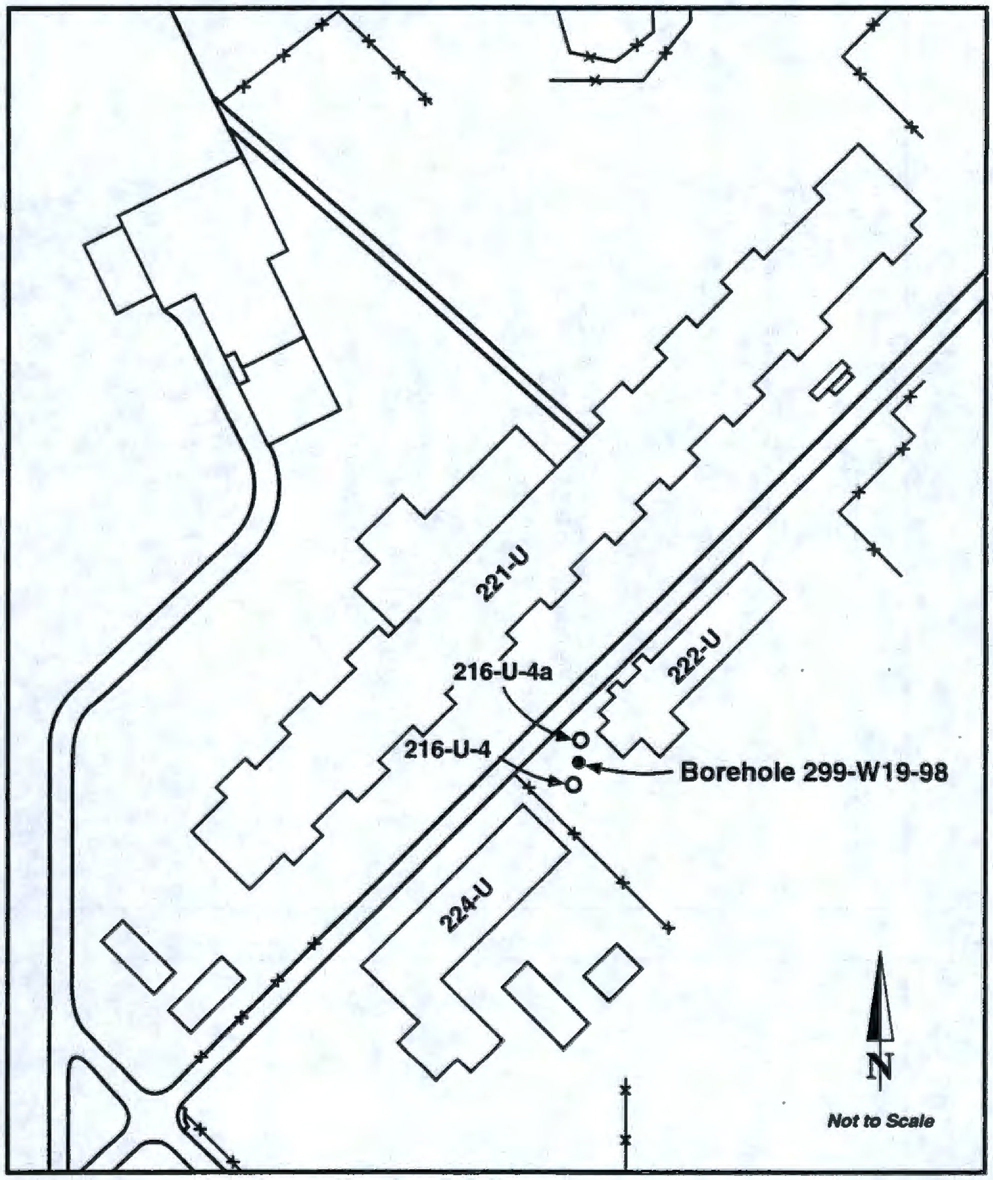
9613401.3020

Figure D-13 216-U-4, -4a System Borehole Data (page 2 of 2)



216-U-4b 10/19/95

Figure D-14 216-U-4, -4a System Lateral Contamination



Waste Site Dimensions		
216-U-4 Reverse Well	-	7.6 cm (3 in.) diameter
	-	22.9 m (75 ft.) deep
216-U-4a French Drain	-	129.5 cm (51 in.) diameter
	-	1.5 to 2.7 m (5 to 9 ft.) bgs.

E9601023.10

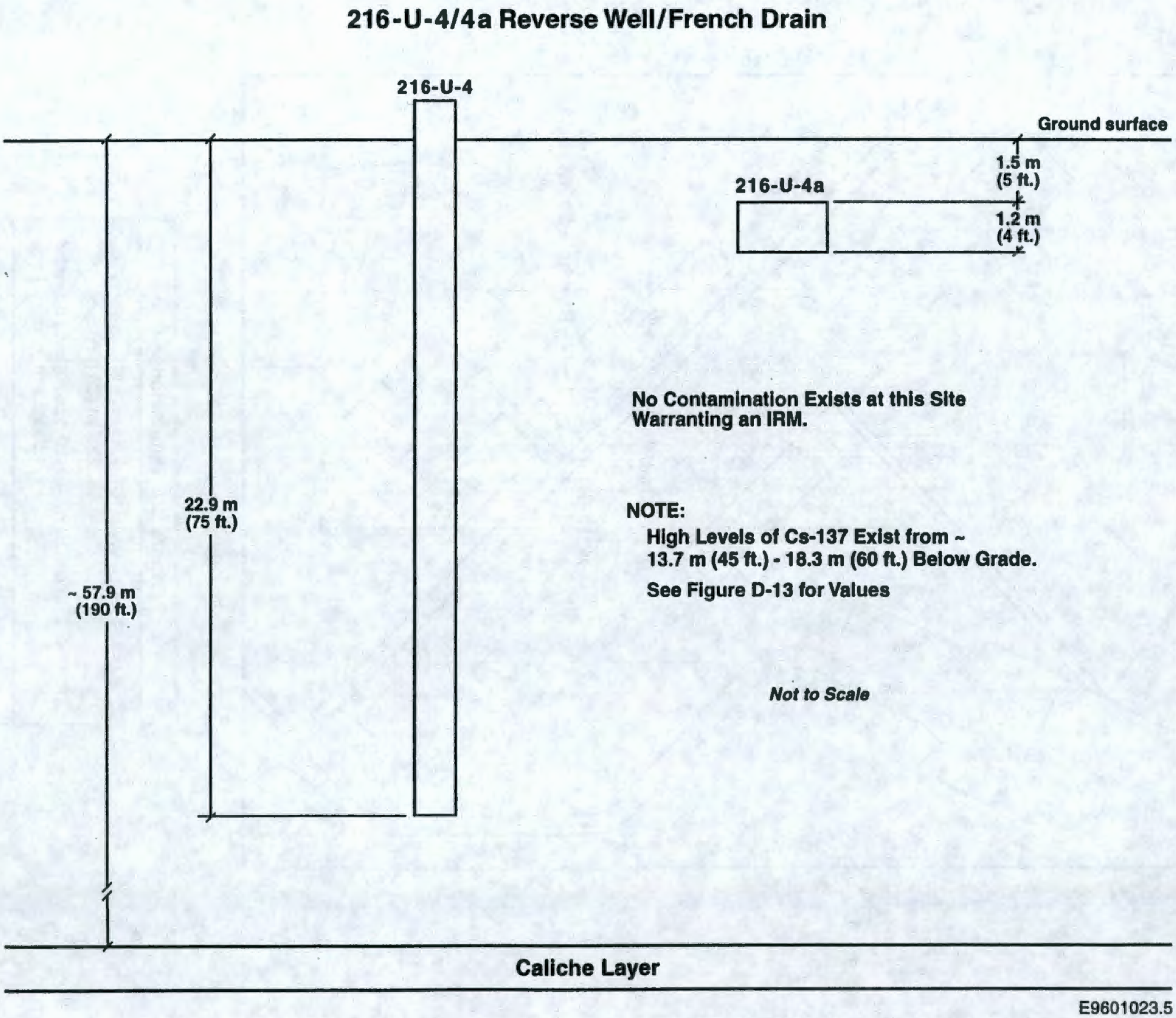


Figure D-15 216-U-4, -4a System Vertical Contamination

Table D-1 200-UP-2 Operable Unit - Contamination Soil Volumes

216-U-10 Pond System

	Contaminated Volume ft^3	Contaminated Volume CY
U-10 Pond	9,149,000	338,900
U-11 Trench	902,000	33,400
U-11 Trench Area	240,000	8,900
U-9 Ditch	0	0
Total	10,291,000	381,200
U-14 Ditch	940,800	34,800
207-U Basin	15,570	580
UN-200-W-111	3,200	120
UN-200-W-112	3,200	120
Total	962,770	35,620
Z-1D Ditch	361,200	13,400
Z-11 Ditch	219,660	8,100
Z-19 Ditch	530,880	19,700
Z-20 Crib	0	0
Total	1,111,740	41,200

216-1/2 Crib System

	Contaminated Volume ft^3	Contaminated Volume CY
U-1/2 Cribs	177,500	6,600
U-361 Settling Tank	6,000	200
U-361 Tank Area	300,000	11,100
W-5 Septic Tank	NA	NA
W-5 Drain Fields	NA	NA
Stainless Steel Pipe	0	0
U-16 Crib	0	0
U-16 VCP	36,000	1,300
Total	519,500	19,200

216-U-8 Crib System

	Contaminated Volume ft^3	Contaminated Volume CY
U-8 Crib	74,600	2,800
Vitrified Clay Pipe	41,200	1,500
Total	115,800	4,300

216-U-12 Crib System

	Contaminated Volume ft^3	Contaminated Volume CY
U-12 Crib	36,000	1,300
Vitrified Clay Pipe	16,000	600
Total	52,000	1,900

216-U-4 Reverse Well, -4A French Drain

	Contaminated Volume ft^3	Contaminated Volume CY
U-4,-4A	0	0

Table D-2 200-UP-2 Operable Unit - Excavated Soil Volumes

216-U-10 Pond System

	Excavated Volume ft^3	Excavated Volume CY
U-10 Pond	9,372,000	347,000
U-11 Trench	1,310,900	48,600
U-11 Trench Area	240,000	8,900
U-9 Ditch	0	0
Total	10,922,900	404,500
U-14 Ditch	1,764,500	65,400
207-U Basin/Releases	75,200	2,800
Total	1,839,700	68,200
Z-1D Ditch	577,600	21,400
Z-11 Ditch	245,800	9,100
Z-19 Ditch	627,200	23,200
Z-20 Crib	0	0
Total	1,450,600	53,700

216-1/2 Crib System

	Excavated Volume ft^3	Excavated Volume CY
U-1/2 Cribs	221,800	8,200
U-361 Settling Tank	364,000	13,500
W-5 Septic Tank	NA	NA
W-5 Drain Fields	NA	NA
Stainless Steel Pipe	128,600	4,800
U-16 Crib	0	0
U-16 VCP	215,000	8,000
Total	929,400	34,500

216-U-8 Crib System

	Excavated Volume ft^3	Excavated Volume CY
U-8 Crib	124,300	4,600
Vitrified Clay Pipe	327,200	12,100
Total	451,500	16,700

216-U-12 Crib System

	Excavated Volume ft^3	Excavated Volume CY
U-12 Crib	124,200	4,600
Vitrified Clay Pipe	98,300	3,600
Total	222,500	8,200

216-U-4 Reverse Well, -4A French Drain

	Excavated Volume ft^3	Excavated Volume CY
U-4,-4A	0	0

APPENDIX E

NEPA CONSIDERATIONS

1.1 RESOURCES

The following sections provide Hanford Sitewide information and 200 Areas specific information regarding geological, hydrological, meteorological, cultural, ecological, and visual resources. Discussions are also included regarding Hanford Site recreation, noise levels, socioeconomics, employment, economics, transportation, health care, police and fire protection, and utilities.

1.1.1 Geology

The Hanford Site is situated in the Pasco Basin, a sediment-filled basin on the Columbia Plateau. The sediments of the Pasco Basin are underlain by the Miocene-age Columbia River Basalt Group, a thick sequence of flood basalts that cover a large area in eastern Washington, western Idaho, and northeastern Oregon. The sediments overlying the basalts, from oldest to youngest, include the Miocene-Pliocene Ringold Formation, local alluvial deposits of possible late Pliocene or probable early Pleistocene age, local early "Palouse" soil of mostly eolian origin derived from either the reworked Pleistocene unit or upper Ringold material, glaciofluvial deposits of the Pleistocene Hanford Formation, and surficial Holocene eolian and fluvial sediments.

The geology in the 200 West and 200 East Areas is surprisingly different, although they are separated by a distance of only 6 km (4 mi). One of the most complete suprabasalt stratigraphic sections on the Hanford Site, with most of Lindsey's (1991a) Ringold units, as well as the Plio-Pleistocene unit, early "Palouse" soil, and the Hanford formation is found in the 200 West Area. There are numerous reports on the 200 West Area, including Connelly et al. (1992), Lindsey (1991b), and Tallman et al. (1979).

1.1.2 Hydrology

Surface water at the Hanford Site includes the Columbia River (northern and eastern sections), Columbia Riverbank springs, springs on Rattlesnake Mountain, onsite ponds, and offsite water systems directly east and across the Columbia River from the Hanford Site. In addition, the Yakima River flows along a short section of the southern boundary of the Site (Cushing 1995).

The Columbia River is the second largest river in North America and the dominant surface-water body on the Hanford Site. The existence of the Hanford Site has precluded development of this section of river for irrigation and power, and the Hanford Reach is now being considered for designation as a National Wild and Scenic River, as a result of congressional action in 1988 (Cushing 1995).

The primary uses of the Columbia River include the production of hydroelectric power, extensive irrigation in the Mid-Columbia Basin, and as a transportation corridor for barges. Several communities located on the Columbia River rely on the river as their source of drinking water. Water from the Columbia River along the Hanford Reach is also used as a source of drinking water by several onsite facilities and for industrial uses (Dirkes 1993). In addition, the Columbia River is used extensively for recreation, including fishing, hunting, boating, sailboarding, waterskiing, diving, and swimming (Cushing 1995).

The Yakima River borders a small length of the southern portion of the Hanford Site. Approximately one-third of the Hanford Site is drained by the Yakima River System (Cushing 1995).

1.1.3 Groundwater

The unconfined aquifer at the Hanford Site is referred to as the upper or suprabasalt aquifer system because portions of the upper aquifer system are locally confined or semiconfined. However, because the entire suprabasalt aquifer system is interconnected on a sitewide scale, it will be called the Hanford Site unconfined aquifer for the purpose of this report. Aquifers located within the Columbia River Basalts are referred to as the confined aquifer system (Cushing 1995).

Confined aquifers within the Columbia River Basalts are within relatively permeable sedimentary interbeds and the more porous tops and bottoms of basalt flows. Hydraulic-head information indicates that groundwater in the confined aquifers flows generally toward the Columbia River and, in some places, toward areas of enhanced vertical flow communication with the unconfined system (Bauer et al. 1985; Spane 1987; DOE 1988).

Groundwater in the unconfined aquifer at the Hanford Site generally flows from recharge areas in the elevated region near the western boundary of the Hanford Site toward the Columbia River on the eastern and northern boundaries. The Columbia River is the primary discharge area for the unconfined aquifer. Natural areal recharge from precipitation across the entire Hanford Site is thought to range from almost 0 to 10 cm (0 to 4 in.) per year, but is probably less than 2.5 cm (1 in.) per year (Gee and Heller 1985 and Bauer and Vaccaro 1990). Since 1944, the artificial recharge from Hanford Site waste water disposal operations has been significantly greater than the natural recharge. An estimated 1.68 by 10^{12} L (4.4 by 10^{11} gallons) of liquid was discharged to disposal ponds, trenches, and cribs (Cushing 1995).

1.1.4 Meteorology

The Hanford Site is located in a semiarid region of southeastern Washington State. The Cascade Mountains, beyond Yakima to the west, greatly influence the climate of the Hanford Site area by means of their "rain shadow" effect; this mountain range also serves as a source of cold air drainage, which has a considerable effect on the wind regime on the Hanford Site (Cushing 1995). Climatological data are available for the Hanford Meteorological Station, which is located between the 200 East and 200 West Areas.

Ranges of daily maximum and minimum temperatures vary from normal highs to 2°C (36°F) in early January to 35°C (95°F) in late July. The record maximum temperature is 45°C (113°F) and the record minimum temperature is -31°C (-24°F). From 1946 through 1993, the average monthly temperatures range from a low of -0.9°C (30°F) in January to a high of 24.6°C (76°F) in July.

Relative humidity/dew point temperature measurements are made at the Hanford Meteorological Station and at the three 60 m (200 ft) towers located in the 300, 400, and 100 N Areas. The annual average relative humidity at the Hanford Meteorological Station is 54 percent. It is highest during the winter months, averaging about 75 percent, and lowest during the summer, averaging about 35 percent (Cushing 1995).

Wind data are collected at the Hanford Meteorological Station. Monthly average wind speeds are lowest during the winter months, averaging 10 to 11 km/h (6 to 7 mi/h), and highest during the summer, averaging 14 to 16 km/h (8 to 10 mi/h). Wind speeds that are well above average are usually associated with southwesterly winds. However, the summertime drainage winds are generally northwesterly and frequently reach 50 km/h (30 mi/h). These winds are most prevalent over the northern portion of the Hanford Site (Cushing 1995).

Average annual precipitation at the Hanford Meteorological Station is 16 cm (6.3 in.). Most precipitation occurs during the winter with more than half of the annual amount occurring from November through February. Days with more than 1.3 cm (0.51 in.) precipitation occur less than 1 percent of the year. Rainfall intensities of 1.3 cm/h (0.51 in./h) persisting for 1 hour are expected only once every 500 years. Winter monthly average snowfall ranges from 0.8 cm (0.32 in.) in March to 14.5 cm (6 in.) in December. The record monthly snowfall of 62 cm (24 in.) occurred in February 1916. The seasonal record snowfall of 142 cm (56 in.) occurred during the winter of 1992-1993. The Snowfall accounts for about 38 percent of all precipitation from December through February (Cushing 1995).

Air quality near the Hanford Site is considered good because there are only a few industrial sources of air pollutants. The Benton-Franklin Counties Clean Air Authority routinely compiles emission inventories for permitted major sources of pollutants. In areas where the National Ambient Air Quality Standards have been achieved, the EPA has established the Prevention of Significant Deterioration program to protect existing ambient air quality. The Hanford Site operates under a Prevention of Significant Deterioration permit issued by the EPA in 1980. The permit provides specific limits for emissions of oxides of nitrogen from the Plutonium Uranium Extraction (PUREX) and UO_3 plants (Cushing 1995).

1.1.5 Cultural Resources

An archaeological survey has been conducted of all undeveloped portions of the 200 East Area and a portion of the 200 West Area. Additional surveys of undeveloped portions of the 200 West Area are required. The only evaluated historic site is the old White Bluffs freight road that crosses diagonally through the 200 West Area. The road, which was formerly an Indian trail, has been in continuous use since antiquity and has played a role in Euro-American immigration, development, agriculture, and the Hanford Site operations. This property has been determined by the State Historic Preservation Officer to be eligible for the National Register of Historic

Places, although the segment that passes through the 200 West Area is considered to be a noncontributing element. The nomination of this historic property is pending. A 100-m (328-ft) easement has been created to protect the road from uncontrolled disturbance. Historic period buildings from the Manhattan Project and Cold War eras that have not been evaluated for National Register eligibility are located in both the 200 East and 200 West Areas.

1.1.6 Ecology

The Hanford Site is one of the few large areas of land in the region that has not been developed for agricultural use. It is unique because the general public's use of the area is restricted, and use of the land is limited to nuclear projects. The main Hanford Site is bounded on the north by the Saddle Mountains, on the east by the Columbia River, and on the south and west by the Yakima River and Rattlesnake Hills, respectively. The dominant topographical features include Rattlesnake Mountain, the Columbia River and associated aquatic habitats, unstabilized sand dunes near the Columbia River, Gable Mountain and Gable Butte that interrupt the rolling landscape of the Hanford Site, and the 200 Areas Plateau.

Vegetation. The Hanford Site has been classified primarily as a shrub-steppe grassland (Daubenmire 1970) composed of the following plant communities:

- sagebrush/bluebunch wheatgrass
- sagebrush/cheatgrass or sagebrush/Sandberg's bluegrass
- sagebrush-bitterbrush/cheatgrass
- greasewood/cheatgrass-saltgrass
- winterfat/Sandberg's bluegrass
- thyme buckwheat/Sandberg's bluegrass
- cheatgrass-tumblemustard
- willow or riparian
- spiny hopsage
- sand dunes.

Almost 600 species of plants have been identified at the Hanford Site (Sackschewsky et al. 1992). Dominant plants include big sagebrush (*Artemesia tridentata*), rabbitbrush (*Chrysothamnus spp*), cheatgrass (*Bromus tectorum*), tumbleweed (*Salsola kali*), tumblemustard (*Sisymbrium altissimum*), and Sandberg's bluegrass (*Poa sandbergii*). Cheatgrass and tumbleweed, introduced invader species, thrive at the many disturbed areas on the Hanford Site. Other important understory plants include Indian ricegrass (*Oryzopsis hymenoides*), needle-and-thread grass (*Stipa comata*), and sand dropseed (*Sporobolus cryptandrus*).

The 200 Areas are characterized according to the sagebrush/cheatgrass or Sandberg's bluegrass communities of the 200 Areas Plateau. The dominant plants on the 200 Area Plateau are big sagebrush, rabbitbrush, cheatgrass, and Sandberg's bluegrass, with cheatgrass often providing half of the total plant cover.

The dryland areas of the Hanford Site were treeless in the years before land settlement. However, for several decades before 1943, trees were planted and irrigated on most of the farms to provide windbreaks and shade. Today those trees that still persist provide nesting sites for many species of passerines and raptors, and roosting sites for bald eagles.

Disturbed communities on the 200 Areas Plateau are mainly the result of either mechanical disturbance or range fires. Mechanical disturbance, including construction activities, soil borrow areas, road clearings, and fire breaks, results in drastic changes to the plant community. These changes include a complete loss of soil structure and disruption of nutrient cycling. The main colonizing plants in these disturbed areas are the annual weeds Russian thistle, tumblemustard and bur-ragweed (*Ambrosia acanthicarpa*). Vegetation in the 200-UP-2 Area has also been described and mapped by Stegen (1994), as predominately *Chrysothamnus nauseosus/Bromus tectorum* and *Agropyron sibericum/Salsola kali*.

The Washington State Department of Natural Resources, Natural Heritage Program, classifies rare plants in three categories: endangered, threatened, and sensitive, depending on the overall distribution of the taxon and condition of its natural habitat. No endangered species are likely to occur near the 200 Area, two threatened species might occur there, but have not been observed anywhere on the Hanford Site yet: Columbia milk vetch (*Astragalus columbianus*) and Hoover's desert parsley (*Lomatium tuberosum*). Several sensitive species have been documented on or near the 200 Area: few-flowered collinsia (*Collinsia sparsiflora var. bruciae)*, gray cryptantha (*Cryptantha leucophaea*), Piper's daisy (*Erigeron piperianus*), Palouse milk vetch (*Astragalus arrectus*), and coyote tobacco (*Nicotiana attenuata*).

Insects. More than 300 species of terrestrial and aquatic insects have been identified at the Hanford Site (ERDA 1975). Grasshoppers and darkling beetles are among the more conspicuous groups and, along with other species, are important as food for many wildlife species. Harvester ants are also very common and have been implicated in the uptake of radionuclides from waste sites as a result of mound-building activities.

Reptiles and Amphibians. Twelve species of amphibians and reptiles occur on the Hanford Site (Fitzner and Gray 1991). The side-blotched lizard (*Uta stansburiana*) is the most abundant reptile on site. Short-horned (*Phyrnosoma douglassi*) and sagebrush lizards (*Sceloporous graciosus*) are also common in selected habitats. The most common snakes are the gopher snake (*Pituophis melanoleucus*), yellow-bellied racer (*Coluber constrictor)*, and the western rattlesnake (*Crotalus viridus*). Striped whipsnakes (*Masticophis taeniatus*) and desert night snakes (*Hypsiglena torquata*) are infrequently observed. A few species of toads and frogs are located near aquatic habitats.

Birds. Approximately 238 species of bird have been observed at the Hanford Site (Landeen et al. 1992). The most common passerine birds include horned larks (*Eremophila alpestris*), western meadowlarks (*Sturnella neglecta*), western kingbirds (*Tyrannus verticalis*), and rock doves (*Columa livia*). The horned lark and western meadowlark are the most common nesting birds. Game birds (hunted off the Hanford Site) include mourning dove (*Zenaida macroura*) and California quail (*Callipepla californica*).

In recent years, the number of nesting ferruginous hawks (*Buteo regalis*) on site have increased because of their use of transmission lines as nesting sites. Other raptor species that nest on site are prairie falcon (Falco mexicanus), northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*), Swainson's hawk (*Buteo swainsoni)*, and the red-tailed hawk (*Buteo jamaicensis). Burrowing owls (*Athene cuniculria), great horned owls (*Bubo virginianus*), long-eared owls (*Asio otus*), short-eared owls (*Asio flammeus*), and barn owls (*Tyto alba*) also nest at the site.

Mammals. Approximately 40 species of mammals have been identified at the Hanford Site (Downs et al. 1993). The largest mammals at the Hanford Site are the Rocky Mountain elk (*Cervus elaphus*) and mule deer (*Odocoilus hemionus*). The Rocky Mountain elk are present on the Fitzner-Eberhardt Arid Land Ecology Reserve. They have grown in number from approximately 6 animals in 1972 to more than 200 animals. Elk and deer do well on the Fitzner-Eberhardt Arid Land Ecology Reserve because of available forage with no competition from domestic livestock, easy access to drinking water, mild winters, their ability to accommodate extreme summer temperatures, and the lack of hunting. Mule deer are found throughout the Hanford Site, but are more common to riparian sites along the Columbia River and the Fitzner-Eberhardt Arid Land Ecology Reserve.

Other mammal species include badgers (*Taxidea taxus*), coyotes (*Canis latrans*), blacktail jackrabbits (*Lepus californicus*), Townsend's ground squirrel (*Spermophilus townsendii*), Great Basin pocket mice (*Perognathus parvus*), Northern pocket gopher (*Thomomys talpoides*), and deer mice (*Peromyscus maniculatus*). Badgers are known for their digging capability and have been implicated several times for encroaching into inactive burial grounds in the 200 Areas. Most of the badger excavation areas result from badgers searching for prey (mice and ground squirrels). Coyotes are the principal Hanford Site predators, consuming rodents, insects, rabbits, birds, snakes, and lizards.

The Great Basin pocket mouse is the most abundant small mammal, which thrives in sandy soils and lives entirely on seeds from native and revegetated plant species. Other small mammals include the Townsend ground squirrel, western harvest mouse, white-footed deer mouse, and the grasshopper mouse.

Mammals associated more closely with buildings and facilities include cottontails, house mice, Norway rats, and some bat species. Seven species of bats have been observed at the Hanford Site. Other mammals, such as skunks, raccoons, weasels, porcupines and bobcats, can also be observed.

Wildlife species of concern occurring near the 200-UP-2 Operable Unit include burrowing owls, prairie falcons, sage sparrows (*Amphispiza belli*), and loggerhead shrikes (*Lanius ludovicianus*).

Aesthetics and Visual Resources. Land on the Hanford Site is generally flat with little relief. Rattlesnake Mountain, rising to 1,060 m (3,478 ft) above mean sea level, forms the western boundary of the Hanford Site, and Gable Mountain and Gable Butte are the highest land forms on the Hanford Site. The view toward Rattlesnake Mountain is visually pleasing, especially in the springtime when wildflowers are in bloom. Large rolling hills are located to the west and far north. The Columbia River, flowing across the northern part of the site and forming the eastern boundary is generally considered scenic, with its contrasting blue against a background of brown basaltic rocks and desert sagebrush.

1.1.7 Noise

Studies at the Hanford Site on the propagation of noise have been concerned primarily with occupational noise at work sites. Environmental noise levels have not been extensively evaluated because of the remoteness of most Hanford Site activities and isolation from receptors covered by federal or state statutes.

Environmental noise measurements were made in 1981 during site characterization of the Skagit/Hanford Nuclear Power Plant Site (PSPL 1982). Fifteen sites were monitored and noise levels ranged from 30 to 60.5 dBA. The values for isolated areas ranged from 30 to 38.8 dBA. Measurements taken around the sites where the Washington State Supply System was constructing nuclear power plants (WNP-1, WNP-2, and WNP-4) ranged from 50.6 to 64 dBA. Measurements taken along the Columbia River near the intake structures for WNP-2 were 47.7 and 52.1 dBA compared to more remote river noise levels of 45.9 dBA (measured about 5 km [3 mi] upstream of the intake structures). Community noise levels in North Richland (3000 Area at Horn Rapids Road and the Bypass Highway) were 60.5 dBA (Cushing 1995).

In addition, site characterization studies performed in 1987 included measurements of background environmental noise levels at five sites on the Hanford Site. Noise levels are expressed as equivalent sound levels for 24 hours (leq-24). Wind was identified as the primary contributor to background noise levels with winds exceeding 19 km/hr (12 mph) significantly affecting noise levels. Hanford Site background noise levels in undeveloped areas are described as a mean leq-24 of 24 to 36 dBA. Periods of high wind, which normally occur in the spring, would elevate background noise levels (Cushing 1995).

Hanford Site Sound Levels. Most industrial facilities on the Hanford Site are located far enough away from the boundary that noise levels at the boundary are not measurable or are barely distinguishable from background noise levels. However, there is the potential for noise from field activities, such as well-drilling activities involving operation of heavy equipment.

In the interest of protecting Hanford Site workers and complying with the Occupational Safety and Health Administration standards for noise in the workplace, the Hanford Environmental Health Foundation has monitored noise levels resulting from several routine operations performed at the Hanford Site. Occupational sources of noise propagated in the field are summarized in Cushing (1995).

1.1.8 Socioeconomic

The Hanford Site plays a dominant role in the socioeconomics of the Tri-Cities (Richland, Pasco, and Kennewick) and other parts of Benton and Franklin counties. The agricultural community also has a significant effect on the local economy. Major changes in Hanford Site activity and employment would potentially affect the Tri-Cities and other areas of Benton and Franklin Counties.

Three major sectors are currently the principal driving forces of the economy in the Tri-Cities: (1) the DOE and its contractors operating the Hanford Site; (2) Washington Public Power Supply System in its construction and operation of nuclear power plants; and (3) the agricultural community, including a substantial food-processing component. Most of the goods and services produced by these sectors are exported outside the Tri-Cities. In addition to the direct employment and payrolls, these major sectors also support a large number of jobs in the local economy through their procurement of equipment, supplies, and business services.

In addition to these three major employment sectors, three other components can be readily identified as contributors to the economic base of the Tri-Cities. The first of these, loosely termed "other major employers, includes five major employers: (1) Siemens Nuclear Power Corporation, (2) Sandvik Special Metals, (3) Boise-Cascade, (4) Burlington Northern Railroad, and (5) Iowa Beef Processors. The second component is tourism. The Tri-Cities area has increased it convention business substantially in recent years, in addition to recreational travel. The final component in the economic base relates to the local purchasing power generated not from current employees but from retired former employees. Government transfer payments in the form of pension benefits constitute a significant proportion of total spendable income in the local community.

In 1994, Hanford employment accounted directly for 25 percent of total nonagricultural employment in Benton and Franklin Counties and slightly more than 0.8 percent of all nonagricultural statewide jobs. The total wage payroll for the Hanford Site was estimated at $740 million in 1994, which accounted for an estimated 45 percent of the payroll dollars earned in the area (Cushing 1995).

Previous studies have revealed that each Hanford Site job supports about 1.2 additional jobs in the local service sector of Benton and Franklin Counties and about 1.5 additional jobs in the Washington State's service sector (Scott et al. 1989). Similarly, each dollar of the Hanford Site income supports about 2.1 dollars of total local incomes and about 2.4 dollars of total statewide incomes. Based on these multipliers in Benton and Franklin Counties, Hanford directly or indirectly accounts for more than 40 percent of all jobs (Cushing 1995).

1.1.9 Demography

Estimates for 1994 placed population totals for Benton and Franklin Counties at 127,000 and 42,899, respectively (OFM 1994b). When compared to the 1990 census data in which Benton County had 112,560 residents and Franklin County's population totaled 37,473, the current population totals reflect the continued growth occurring in these two counties.

In 1994, 95 percent of all housing (of 41,562 total units) in the Tri-Cities was occupied. Single-unit housing, which represents nearly 59 percent of the total units, has a 98 percent occupancy rate throughout the Tri-Cities. Multiple-unit housing, defined as housing with two or more units, has an occupancy rate of 95 percent, a 4 percent increase since 1990. Pasco has the lowest occupancy rate, 93 percent, in all categories of housing; followed by Kennewick with 96 percent, and Richland with 97 percent. Representing 11 percent of the housing unit types, mobile homes have the lowest occupancy rate, 90 percent (Cushing 1995).

1.1.10 Transportation

The Tri-Cities serve as a regional transportation and distribution center with major air, land, and river connections. The Tri-Cities have direct rail service, provided by Burlington Northern and Union Pacific, that connects the area to more than 35 states. The Washington Central Railroad also serves eastern Washington. Union Pacific operates the largest fleet of refrigerated rail cars in the United States and is essential to food processors that ship frozen food from this area. Passenger rail service is provided by Amtrak, which has a station in Pasco (Cushing 1995).

Docking facilities at the Ports of Benton, Kennewick, and Pasco are important aspects of this region's infrastructure. These facilities are located on the 525 km (326 mi) long commercial waterway, which comprises the Snake and Columbia rivers, that extends from the Ports of Lewiston-Clarkston in Idaho to the deep-water ports of Portland, Oregon, and Vancouver, Washington. The average shipping time from the Tri-Cities to these deep-water ports by barge is 36 hours (Evergreen Community Development Association 1986).

Daily air passenger and freight services connect the area with most major cities through the Tri-Cities Airport located in Pasco. The airport is served by one national and two regional commuter airlines. There is a main runway and a minor crosswind runway. The main runway is 2,350 m (7,700 ft) long and 46 m (150 ft) wide, and can accommodate landings and takeoffs by medium-range commercial aircraft, such as the Boeing 727-200 and Douglas DC-9. The Tri-Cities Airport handled about 188,000 passengers in 1994. Projections indicate that the recently expanded terminal can serve almost 300,000 passengers annually. The Richland and Kennewick airports serve only private aircraft.

The Tri-Cities are linked to the region by five major highways. Route 395 joins the area with Spokane to the northeast. Routes 395 and 240, which cross through the Hanford Site, connect with Interstate 90 to the north. Route 12 links the region with Yakima to the northwest, with Lewiston, Idaho to the east, and Walla Walla to the southeast. The area is also linked to Interstate 84 to the south, via Interstate 82 and Route 14. Interstate 82 also connects the area to the Yakima Valley and Interstate 90 in Ellensberg. Routes 240 and 24 traverse the Hanford Site and are maintained by Washington State.

The Hanford Site railroad system extends from the west side of Richland, Washington throughout the Hanford Site. The DOE controls the rail access into the Hanford Site; the agency rail system ties in with the Union Pacific Railroad southeast of the Richland "Y" area near the U.S. Highway 12 and Route 240 interchange. Burlington Northern and Union Pacific have priority rights over the DOE rail system between the Richland "Y" area and the DOE 1100 Area. The DOE tracks serving the Hanford Site are installed parallel to the Route 240 bypass around the Richland, Washington urban area (DOE 1986).

The Hanford Site Road System includes 607 km (377 mi) of asphalt-paved road. Most of the Hanford Site roads were constructed in the 1940s as part of the Manhattan Project and subsequently did not meet current design criteria for lane width, shoulder width and slope, horizontal and vertical alignment, and drainage provisions. From 1981 to date, numerous projects have been completed to reconstruct portions of the road system to current design standards and correct traffic safety problems (DOE-RL 1989).

1.1.11 Health Care and Human Services

The Tri-Cities have three major hospitals and five minor emergency centers. All three hospitals offer general medical services and include a 24-hour emergency room, basic surgical services, intensive care, and neonatal care (Cushing 1995).

The Tri-Cities offer a broad range of social services. State human service offices in the Tri-Cities include the Job Services of the Employment Security Department; Food Stamp; the Division of Developmental Disabilities; Financial and Medical Assistance; Child Protective Service; emergency medical service; a senior companion program; and vocational rehabilitation (Cushing 1995).

1.1.12 Police and Fire Protection

Police protection in Benton and Franklin Counties is provided by Benton and Franklin counties' sheriff departments, local municipal police departments, and the Washington State Patrol Division headquartered in Kennewick. The Kennewick, Richland, and Pasco municipal departments maintain the largest staffs of commissioned officers with 66, 44, and 43, respectively (Cushing 1995).

The Hanford Fire Patrol, including 155 firefighters, is trained to dispose of hazardous waste and to fight chemical fires. During the 24-hour duty period, five firefighters cover the 1100 Area, seven protect the 300 Area, seven watch the 200 East and 200 West Areas, six are responsible for the 100 Area, and six cover the 400 Area, which includes the Washington Public Power Supply System area. To perform their responsibilities, each station has access to a hazardous material response vehicle that is equipped with chemical fire extinguishing equipment, a truck that carries foam, halon, and Purple-K dry chemical, a mobile air truck that provides air for gasmasks, and a transport tanker that supplies water to six brush trucks. They have five ambulances and contact with local hospitals (Cushing 1995).

1.1.13 Utilities

Water. The principal source of water for the Tri-Cities and the Hanford Site is the Columbia River. Richland, Pasco, and Kennewick used an average of 49 billion liters (12.94 billion gallons) in 1994. Each city operates its own supply and treatment system. The Richland Water Supply System derives about two-thirds of its water from the Columbia River, while the remainder is split between a well field in North Richland and groundwater wells. The city of

Pasco system also draws from the Columbia River for its water needs. The Kennewick system uses two wells and the Columbia River for its supply (Cushing 1995).

Electricity. Electricity in the Tri-Cities is provided by the Benton County Public Utility District, Benton Rural Electrical Association, Franklin County Public Utility District, and City of Richland Energy Services Department. All the power that these utilities provide in the local area is purchased from the Bonneville Power Administration, a federal power marketing agency. Natural gas, provided by the Cascade Natural Gas Corporation, serves a small portion of residents, with 6,000 residential customers in December 1994 (Cushing 1995).

Electrical power for the Hanford Site is purchased wholesale from the Bonneville Power Administration. Energy requirements for the Hanford Site during fiscal year 1988 exceeded 550 average megawatts (DOE-RL 1993d). The electrical power supplied by the Bonneville Power Administration is provided to the 100 and 200 Areas, 300 Area, and 400 Area systems on the Hanford Site (DOE-RL 1989). The City of Richland distributes power to the 700, 1100, and 3000 Areas, which constitute approximately 2 percent of the total Hanford Site usage.

1.2 COMMON EVALUATION CONSIDERATIONS

In addition to the nine CERCLA criteria, specific environmental resources (such as air quality) and NEPA issues (such as cumulative impacts) are considered during the selection of Remedial Alternatives. Consideration of environmental resources and NEPA issues are required to meet the DOE Secretarial Policy on NEPA, and provide a complete evaluation of the Remedial Alternatives. Several of the CERCLA evaluation criteria involve consideration of environmental resources, but the emphasis is frequently directed at the potential effects of contaminants on living organisms. Environmental resources in the NEPA context also includes consideration of potential effects on resources, such as transportation, air quality, socioeconomic, and visual resources. The NEPA process also considers several issues, such as indirect and cumulative impacts, the irreversible and irretrievable commitment of resources, and the actions that may be taken to avoid or mitigate environmental impacts. The NEPA-related resources and issues are described in subsequent sections.

1.2.1 Resource Impacts

1.2.1.1 Transportation Impacts. The proposed Remedial Alternatives are not expected to create any long-term negative transportation impacts. If adverse impacts to transportation are detected, remedial activities will be modified or halted until the impact is mitigated.

The No Action and Institutional Control alternatives will not affect transportation. These alternatives will not require the transport of any equipment, construction materials, or waste. Commuter traffic flow would not increase or decrease.

The Containment and Removal/Disposal alternatives will require transport of equipment, construction materials and solid waste that could result in transportation impacts. The construction-related and commuter (worker) traffic flow for the Removal/Disposal alternatives would be higher than for the containment alternative because contaminated materials would be transported from the site and clean borrow material would be transported to the site for use as backfill.

1.2.1.2 Ecological Impacts. The No Action and Institutional Control alternatives would not affect existing natural resource conditions. However, these alternatives do not include revegetation or other habitat enhancement activities. Without revegetation or other habitat enhancement efforts, most sites would not be restored to a native condition.

The Containment and Removal/Disposal alternatives would destroy existing vegetation at a waste site. In most cases, this is a minor impact because most waste sites in the 200 Area have already been disturbed. Contaminant removal or onsite containment, followed by revegetation and restoration efforts would benefit natural resources in the long term.

1.2.1.3 Air Quality Impacts. Hanford Site air quality is generally good. The proposed remediation alternatives are not expected to cause long-term negative impacts to existing air quality. Site restoration and revegetation efforts will preclude long-term wind erosion problems due to remediation activities.

The No Action and Institutional Control alternatives would not affect short-term air quality. However, the Containment and Removal/Disposal alternatives will generate fugitive dust. Dust control measures will be used as needed to ensure that short-term impacts on air quality are minimized.

1.2.1.4 Cultural Resource Impacts. For 200 Area waste sites where cultural resources are present, measures will be implemented to ensure that cultural resource concerns are properly addressed.

The No Action and Institutional Control alternatives are not expected to disturb cultural resources. However, if cultural resources are contaminated or legitimate access to cultural resources is denied due to contamination levels, these alternatives may not be appropriate.

The Containment alternative would contain the waste in place and, therefore, would leave any existing cultural resources in place. However, cultural resources are not expected to occur at waste sites that have already been disturbed. The alternatives would generally result in the protection of cultural resources adjacent to the waste site since remedial activities would not extend more than 3 m (10 ft) beyond the boundary of the waste site.

The potential for the Removal/Disposal alternative to disturb cultural resources would be high. Actions to abate adverse impacts to significant cultural resources would be required before initiating these alternatives.

1.2.1.5 Socioeconomic Impacts. The outlook for the Tri-Cities economy is uncertain. The local economy could decline or grow in the next 30 years depending on economic activity not directly related to DOE and the Hanford Site. Near-term reductions in the Hanford Site work force will probably have a negative impact on the local economy.

If the No Action and Institutional Control alternatives are implemented, waste management activities in the 200 Areas would continue. These alternatives achieve the principles adopted by the Hanford Advisory Board Work Group for cultural/socioeconomic impacts. There would be no need for transition of the work force to provide economic stability. These alternatives would continue to provide economic diversification because of the continued employment levels. The demand for recreational services, social services, facilities, and activities exerted by the employees associated with the 200 Areas and their families would not change.

The socioeconomic impacts of the Containment alternative would be relatively minimal. Workers would be employed for several years to perform the work associated with the alternative. The alternative meets the principles established by the Hanford Advisory Board Work Group for cultural/socioeconomic impacts. These alternatives allow for work force transition from scientific/engineering to the excavation and construction trades. Effects on social services and recreation would probably be imperceptible because of the few employees involved. The effects on public services such as water supplies and waste water treatment facilities would be minimal.

If the Removal/Disposal alternative is implemented, workers would be employed to remove contaminated material, perform site restoration, and transport contaminated materials to a disposal site. The number of employees involved in these activities would be higher than employment levels for the containment alternative. Nonetheless, the impact would be minor compared to the overall Tri-City area employment. The growth in the local government tax base associated with increases in housing and commercial activity resulting from these alternatives would be insignificant. These alternatives achieve the principles adopted by the Hanford Advisory Board Working Group for cultural and socioeconomic impacts. The demand for recreation, social services, and public services caused by employees and families associated with this alternatives may be greater than that exerted by the No Action alternative and the Containment alternative. Nevertheless, the demand would still have only a very small effect on the Tri-Cities capacity to accommodate these needs.

1.2.1.6 Noise and Visual Resources Impacts. No long-term noise or visual resource impacts are anticipated from any of the Remedial alternatives under consideration. The installation of above-grade barriers could potentially impact visual resources. Noise increases in the 200 Areas would return to background levels (for waste management activities) following remediation. Visual impacts will be mitigated through site revegetation and habitat restoration actions.

No adverse short-term impacts to noise or visual resources are anticipated for the No Action or Institutional Control alternatives. Sporadic and temporary short-term impacts to noise levels would occur because of transportation and construction activities under the containment and Removal/Disposal alternatives. Short-term visual resource impacts are anticipated during site remediation. These short-term impacts could be abated by minimizing the footprint of the remediation zone to the extent possible.

1.2.2 Issues

1.2.2.1 Mitigation Measures. Adverse impacts may not be able to be avoided; therefore, remedial action planning should minimize adverse impacts to the extent practicable by implementing mitigation measures. Mitigation measures may include restoring or protecting other areas within the Hanford Site or off site to compensate for damages that may be incurred during the cleanup effort.

Natural resources, for the purposes of mitigation, are considered to be physical resources such as land, water, and air; biological resources such as wildlife habitat or plants and animals; human resources such as remedial workers, and cultural resources such as Indian artifacts or historical sites. Studies have been conducted at the operable units within the 200 Areas to characterize these resources. There are current ongoing and planned studies to complete the characterization of these resources where necessary. With this information, the natural resources will be fully described before developing the designs for remedial action.

Natural resources can be impacted in a variety of ways during implementation of remedial actions. For example, excavation, treatment, and construction activities can unnecessarily destroy wildlife habitat; disrupt normal breeding, nesting, or feeding activities of animals; increase wind and water erosion; or unearth native Indian artifacts. Final mitigation measures, to either eliminate or reduce the adverse consequences of the remedial activities, will be developed as an integral component of the remedial design. The mitigation plans will be incorporated into the design specifications, and also made part of the contractual obligations for remedial contractors working on the site. In that way, mitigation becomes an integral component of the remedial activities.

The following general mitigation measures are examples of actions that may be taken to protect the physical, biological, human, and cultural resources that occur in the 200 Areas:

Physical Resources

- stockpile topsoil when possible
- minimize the width of construction corridors, the size of equipment yards and parking lots, and the amount of cut and fill required
- place equipment yards, treatment systems, and support services in formerly disturbed areas when possible
- develop and implement erosion control plans
- curtail or halt operations during high wind periods
- suppress fugitive dust with water, commercial suppressants, or temporary mulches
- prevent runoff and sediment transport to wetlands and the Columbia River.

Biological Resources

- avoid wetlands, riparian habitats, and other sensitive areas when possible
- restrict the removal or destruction of trees
- use native species for revegetation or, when possible, plan for successional replacement of temporary ground cover with native species
- comply with the bald eagle management plan
- schedule construction activities to avoid breeding, nesting, winter roosting, and other sensitive seasonal activities
- prepare biological resource management plans
- work with DOE, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers to mitigate impacts to wetlands
- when possible, rectify impacts that cannot be avoided or minimized.

Human Resources

- develop health and safety plans to protect onsite workers
- implement rigorous health and safety protocols
- minimize exposure to contaminants
- minimize generation of fugitive dust
- monitor air quality
- practice as low as reasonably achievable (ALARA).

Cultural Resources

- complete cultural resource surveys of areas to be remediated before implementing any action
- complete data recovery and analysis plans, have these approved by the State Historic Preservation Office, and conduct data recovery and analysis before initiating remedial actions
- develop cultural resource action plans for operable unit
- train construction workers to recognize and report potential cultural resources
- work with the Indian nations to identify traditional use sites, prepare cultural resource mitigation plans, and evaluate the sensitivity of each waste site area.

1.2.2.2 Irreversible and Irretrievable Commitment of Resources. The alternatives that leave contaminated material in an operable unit would result in commitment of land-to-waste management, institutional controls, and monitoring. Selection of an alternative that leaves contamination in the operable unit may be considered an irreversible and irretrievable commitment of land-to-waste management. However, the 200 Area has been designated as a waste management area over the long term; therefore, leaving waste in place is consistent with surrounding land uses.

Remediation of the 200 Areas will require the irreversible commitment of millions of federal dollars. Depending on the Remedial alternative, other irreversible commitments of resources include importing soil and rock for barriers and using consumables such as fuel, electricity, chemicals, and disposable protective equipment.

If sensitive habitats or cultural resources are involved in remedial actions, mitigation measures will be taken to minimize impacts. However, irreversible damage could occur to habitats, flora, and fauna during remediation. It is also possible that cultural resources could be destroyed during the remedial action.

1.2.2.3 Indirect and Cumulative Impacts. Based on improvements to the overall protection of human health and the environment, the net cumulative impact of the remedial actions is expected to be positive. Remedial actions may remove or isolate the contaminants, making land in the 200 Areas available for other waste management uses. Negative impacts from remediating the operable units within the 200 Area are expected to be minor and short term. However, there is potential for indirect and cumulative impacts as a result of remediating any one operable unit within the 200 Areas.

Remedial activities at any one of the Operable Units in the 200 Area may potentially involve cumulative impacts due to interactions with other projects within the 200 Area, as well as interactions with other projects on the Hanford Site. For the purposes of this FFS, it was assumed that interactions with projects outside the Hanford Site, would be insignificant because of the remote location of the 200 Areas relative to the Tri-Cities and major agricultural operations in the region.

The potential indirect and cumulative impacts of remedial actions and other activities within the 200 Areas will be dependent upon the scheduling of the remedial action at one site relative to the remedial actions at the other numerous operable units, and the scheduling of other activities within the 200 Areas. Indirect and cumulative impacts may result from the interaction of activities at:

- other source operable units
- groundwater operable units
- decontamination and decommissioning (D&D) activities
- treatability studies
- construction of ERDF
- waste treatment activities.

Cumulative and indirect impacts in the 200 Areas will be greater if remedial activities at several operable units occur at the same time. Conversely, if the work can be properly sequenced, cumulative impacts can be reduced or avoided.

Indirect and cumulative impacts may also occur because of interactions with projects outside of the 200 Areas. Remedial actions, treatability studies, and D&D work are also occurring in the 100 and 300 Areas, and other portions of the Hanford Site. Clean fill materials needed to remediate many of the waste sites may come from a limited number of borrow pits. The schedules, demands on labor and equipment resources, requirements for disposal volume and fill material, and budget needs must all be considered under the issue of cumulative impacts. The indirect effects of these numerous projects on transportation, restoration of natural resources, and future land use must also be considered.

Remediation of the 200 Area operable units should lead to long-term cumulative benefits to natural resources as a result of removing or controlling contaminants, revegetating currently disturbed areas, and restoring natural habitats.

1.2.2.4 Environmental Justice. The Environmental Justice Executive Order (E.O. 12898, February 1994) states:

> "Each federal agency shall make achieving environmental justice part of its mission by identifying and addressing as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."

Low-income and minority populations involved in Hanford Site remedial actions include members of the Native American groups and local agricultural employees. The proposed alternatives have been assessed for potential disproportionate impacts to these low-income and/or minority populations.

Native American groups that use the Columbia River for fishing and wildlife recreation are concerned about potential adverse human health effects from contaminants located on the Hanford Site. Compared to other alternatives, the No Action and Institutional Control alternatives represent a low risk of inadvertent excavation of Native American cultural resources.

The Containment and Removal/Disposal alternatives include construction activities that would provide employment for a small number of general laborers. However, excavation always poses the risk of unearthing Native American burials. Consequently, the risk of an adverse impact on Native Americans is disproportionately large compared to other segments of the population. The containment or removal alternatives, however, reduce or preclude the possibility of long-term lateral migration of contaminants from current locations to the Columbia River. These alternatives, with appropriate abatement actions, will generally address Native American concerns.

1.2.2.5 Short-term Impacts to Human Health. Short-term impacts to human health during implementation of a remedial action can be grouped either as potential impacts to workers performing the remedial action or potential impacts to the community. Potential impacts to workers include physical hazards associated with construction activities, and exposures to chemical or radionuclide contaminants. Physical hazards to workers include slip, trip and falls, operation of heavy equipment, excavation and trenching, sharp objects, operation of motor vehicles, lifting hazards, heat and cold stress and noise. Contaminant exposure hazards include incidental ingestion of soil, inhalation of fugitive dust generated during remedial action and external exposure to radionuclides. Potential impacts to the community would largely be associated with inhalation of fugitive dust generated during remedial action.

Physical and contaminant exposure hazards to workers will vary with the magnitude of contamination in soil and the type of remedial action to be performed at a site. In general, potential hazards to workers will be lower for Remedial alternatives that do not involve extensive contact with contaminated soils and waste. For example, alternatives involving removal could involve greater hazards associated with heavy equipment and vehicular operation because of the excavation and transport of waste to treatment and disposal facilities. Alternatives involving removal also have hazards associated with excavation, that are not likely to be present with other Remedial alternatives. Finally, each alternative other than institutional controls are associated with potential contaminant exposure hazards by bringing workers into proximity with contaminated soils and waste.

APPENDIX F

RESRAD MODELING RESULTS

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1.0 RESRAD MODELING RESULTS

The RESRAD computer code is used to determine the preliminary remediation goals for radionuclide contaminants present at the 200-UP-2 Operable Unit. RESRAD was also used to determine the dose to a individual at the waste site. RESRAD is a computer code developed at Argonne National Laboratory for the DOE to calculate site-specific residual radioactive guidelines. The RESRAD code allows input of site-specific parameters. For purposes of this FFS, RESRAD version 5.61 was used to evaluate the external, inhalation, and ingestion pathways.

1.1 APPLICATION TO 200-UP-2 OPERABLE UNIT

1.1.1 Assumptions and Input Parameters

Operable unit/site-specific data are used where available as input parameters in this application of RESRAD to determine acceptable soil concentrations for each radioactive contaminant of concern (Table F-2). Also, parameters agreed to during the preparation of the 300-FF-1 FS (DOE-RL 1995c) serve as the initial inputs to the model. The model was run for 15 mrem/yr assuming the no action alternative. The resulting soil concentrations are then scaled to determine the equivalent concentrations at 100 mrem/yr, the PRG for the 200-UP-2 Operable Unit (Table F-2).

A reasonable exposure scenario was developed based on DOE waste management land use during the period of potential interim actions. The waste management scenario exposure pathways and durations believed to represent the scenario were adapted from the 300-FF-1 industrial scenario. The reasonable worst-case waste management scenario that is thought to be possible is an individual spending 1,500 hours/yr in a building located on a contaminated waste site and 500 hours/yr outside on the same site. Since present conditions at the 200-UP-2 sites would not result in any exposure greater than background a mechanism for exposure was developed for a representative generic waste site. The generic waste site was created as a result of the excavation of a trench 3 m by 3 m (9.84 by 9.84 ft) and placement of a 1 m (3.28 ft) pipeline through the site which would result in contaminated soils being distributed on the surface. The width of the site 25 m (82 ft) was based on a typical area disturbed as a result of access road placement, trench excavation, and spoils pile location. The length of the site 100 m (328 ft) was based on the length of a typical 200-UP-2 Crib. Placement of the pipeline results in two zones of contamination that contribute to the worker's exposure. One zone is the 3 m (9.84 ft) by 3 m (9.84 ft) backfilled trench. The excavated soil was assumed to be uniformly mixed and the final concentration of contaminants in the trench was based on the volume weighted average of contaminants in the trench prior to excavation. The second zone is a 0.15 m (.5 ft) inch thick layer covering the entire site. It was assumed that not all the contaminated soil was returned to the trench. The contaminated soil was uniformly mixed with clean surface soils and spread over the entire site. The mixing with clean soils results in a factor of three dilution of the contaminants present in the backfilled trench. The individual is conservatively estimated to stand in the center of the site at the edge of the trench for the modeling. The specific input parameters to the model are presented in Table F-1. Exposure pathways for external exposure, inhalation, and soil ingestion are modeled for each zone of contamination separately due to the configuration of the program. Therefore Table F-1 contains a separate column of inputs for the trench and soil cover contaminated zones. The separate configurations are modeled using the relationship that the trench concentration is three times the surface soil concentration until a soil concentration equivalent to 15 mrem/yr is achieved. The soil concentration for the trench that corresponds to 100 mrem/yr becomes the preliminary remediation goal against which the site specific volume weighted average concentrations are compared. The results are shown in Table F-2.

Table F-1 RESRAD Modeling Input Parameters

Parameter	Units	Trench	Soil Cover
Contaminated Zone Parameters			
Area of Contamination	m^2	300	2500
Thickness of Contamination	m	3	.15
Basic Dose Limit	mrem/yr	15	15
Time Since Material in Ground	yr	20	20
Cover and Contaminated Zone Hydrologic Data			
Density of Cover	gm/cm^3	1.6	N/A
Thickness of Cover	m	.15	0
Erosion Rate of Cover	m/yr	0.001	0.001
Total Porosity	--	0.3	0.3
Effective Porosity	--	0.3	0.3
Hydraulic Conductivity	m/yr	0.001	0.001
"B" Parameter	--	15	15
Evapotranspiration Coefficient	--	0.75	0.75
Precipitation	m/yr	0.1524	0.1524
Irrigation	m/yr	0	0
Irrigation Mode	--	0	0
Runoff Coefficient	--	0.2	0.2
Inhalation Rate	m^3/yr	8400	8400
Mass Loading for Inhalation Rate	g/m^3	0.0002	0.0002
Exposure Duration	yr	30	30
Shielding Factors Inhalation External Gamma	 -- --	 0.4 0.7	 0.4 0.7
Dilution Length for Airborne Dust	m	3	3
Time Fractions Indoors Outdoors	 -- --	 0.17 0.057	 0.17 0.057
Shape Factor for External Gamma Fractions of Annular Areas radius 1 fraction 1 radius 2 fraction 2	 m^2 m m	-1 3 0.5 50 0.0364	1
Ingestion Pathway Data, Dietary Parameters			
Soil Ingestion	g	36.5	36.5
Ingestion Pathway Data, Nondietary Parameters			
Depth of Soil Mixing Layer	m	0.15	0.15

Table F-2 RESRAD Modeling Results

Radionuclides	15 mrem/yr Exposure (pCi/g)	100 mrem/yr Exposure (pCi/g)
Americium-241	330	2200
Cobalt-60	15	100
Cesium-137	72	480
Europium-152	36	240
Europium-154	33	220
Neptunium-237	126	840
Plutonium-238	390	2600
Plutonium-239/240	375	2500
Radium-226	15*	NA
Radium-228	15*	NA
Strontium-90	7500	50,000
Thorium-228	28.5	190
Uranium-234	1500	10,000
Uranium-235	270	1800
Uranium-238	810	5400

* Concentrations from DOE 5400.5 - assumes 0.15 m (6 in.) cover.

APPENDIX G

COST ESTIMATE TABLES

1.0 COST ESTIMATE SUMMARY

This appendix presents the cost estimates for each remedial alternative for each 200-UP-2 IRM candidate waste site. The estimates rely heavily upon the cost estimates recently completed for the 300-FF-1 Operable Unit. This was done to maintain consistency between cost estimating for Hanford Site remedial actions, and to expedite the estimating process.

The estimates contained in this appendix consist of four primary components. First, Basic Unit Costs for remedial activities (e.g., excavation) are defined on Table G-1. Notes are provided on this table that indicate the origin of the unit costs. The majority of the unit costs are derived directly from the 300-FF-1 estimate, but have been escalated to 1996 dollar values (using a 5 percent rate of inflation).

The second major component is the Common Factors table (Table G-2). This table provides the miscellaneous contingencies, overheads, and present value factors used to estimate total costs for the remedial actions. As with Table G-1, the values are primarily derived from the 300-FF-1 cost estimate.

The third component is the Site Quantities table (Table G-3), which provides the quantities (e.g., areas and volumes) of contaminated materials, and/or remediation materials required at each individual site.

Finally, the fourth component is the cost estimates themselves. These estimates rely upon Table G-1 through G-3 for input. For example, the unit costs from Table G-1 are multiplied by the quantities on Table G-3 to obtain total costs for a given line item. The factors from Table G-2 are then incorporated to provide total cost, including overheads and contingencies. The total costs are presented as net present value, which allows a comparison of each alternative with respect to 1996 dollar value.

Table G-1 Basic Unit Costs

Item	Unit Cost	Units	Source/Comments
SITE WORK (labor, materials and equipment):			Not including contractor overhead & profit & other add-ons.
Capital Costs:			
Excavate material	$19.50	cy	Includes pre-screening of soil. Derived from 300-FF-1 cost estimate.
Disposal of contaminated material	$22.29	ton-short	Hauling & ERDF Disposal. Derived from 300-FF-1 cost estimate
Backfill/Regrade	$6.91	cy	Spread & compact clean soil. Derived from 300-FF-1 cost estimate.
Biointrusion Barrier	$3.51	sf	Includes layering of basalt, gravel, sand and pea gravel derived from preliminary barrier design.
Void Grouting	$229.00	cy	Includes grout and drilling wells. Based on vender quotes.
Air monitoring	$110,250	LS	Sampling stations & monitoring during remedial action; allowance. Derived from 300-FF-1 cost estimate.
Pumping, trans. & disposal of liquid material	$12,509	LS	Average of three contractor estimates
Site Preparation	$221,095	LS	Includes: mob/demob/road maint./dust suppressant. Derived from 300-FF-1 cost estimate.
Maintenance Costs, Present Value:			
Biointrusion Barrier maintenance	$0.02	sf/yr	Includes monitoring and maintenance, as needed. Assumed to be one-half of RARA costs due to engineered barrier with a longer design life.
Soil cover replacement	$0.03	sf/yr	Estimate from RARA program at $0.50/sf every 20 years. Therefore, $0.025/sf/yr are the annual allocation costed over a 132 year IRM timeframe.
Surveillance/Maintenance (e.g. soil covers)	$0.04	sf/yr	Estimate from RARA program including surveillance (surveying) and maintenance (herbicides) of waste sites.

cy = cubic yard
ERDF = Environmental Restoration Disposal Facility
ft = feet
sf = square feet
RARA = Radiation Area Remedial Actions
LS = lump sum
ft/yr = feet per year
sf/yr = square feet per year
DOE/RL = U.S. Department of Energy/Richland Operations

Table G-2 Common Factors

Item	Value	Source/Comments
Interest rate (net of inflation)	5%	EPA value; for present value calculations
Long term maintenance period	132 yr	Longest period was used
Present value factor using above	19.97	Calculated rate of 19.97 is at its maximum by the time 132 years is reached
Contractor overhead & profit (OH&P)	25%	Mid-range value for site remediation from DOE/RL-94-49, Rev. 0
Engineering & construction surveillance (E&CS)	70%	Rounded sum of factors from DOE/RL-94-49, Rev. 0
Definitive design	9%	Average of Pond & Burial Ground calc. (100BC 1995 adjusted to 300-FF-1).
On-site indirects (e.g., field non-manual including QA and Safety, training, direct distribs).	46%	Average of Pond & Burial Ground calc. from DOE/RL-94-49, Rev. 0
PM/CM	15%	Average of Pond & Burial Ground calc. from DOE/RL-94-49, Rev. 0
Contingency	25%	Appropriate for FS from DOE/RL-94-49, Rev. 0
Combined factor	266%	OH&P, E&CS, contingency from DOE/RL-94-49, Rev. 0

EPA = U.S. Environmental Protection Agency
DOE/RL = U. S. Department of Energy/Richland Operations
OH&P = Overhead and Profit
E&CS = Engineering and Construction Surveillance
PM/CM = Project Management/Contract Management
FS = Feasibility Study

Table G-3 Site Quantities

Site	Contaminated Material Weight (tons-short)	Excavated Volume (cy)	Backfill Volume (cy)	RARA and Biointrusion Barrier Area (sf)	Grout Volume (cy)
216-U-8 Crib/Vitrified Clay Pipeline	6,948	16,700	4,300	63,400	294
216-U-10 Pond/216-U-11 Trench	617,460	404,500	381,200	2,081,200	0
216-U-14 Ditch/207-U Retention Basins	57,766	68,200	35,600	307,800	0
216-Z-1DDitch/216-Z-11 Ditch/216-Z-19 Ditch	66,704	53,700	41,200	430,000	0
216-U-1 Crib/216-U-2 Crib/241-U-361 Settling Tank/ Stainless Steel Pipeline/Vitrified Clay Pipeline	31,170	34,500	19,200	101,500	144
216-U-12 Crib/216-U-16 Vitrified Clay Pipeline	3,120	8,200	1,900	22,000	4

ft = feet
cy = cubic yards

Table G-4 Cost Estimated for Continued Surveillance and Maintenance for 216-U-8 Crib/Vitrified Clay Pipeline

Item	Quantity	Units	Unit Cost	Cost[a]	Notes
CAPITAL COSTS					No additional capital cost beyond existing controls
LONG TERM MAINTENANCE COSTS, PRESENT VALUE					
Surveillance/Maintenance	63,400	sf/yr	$0.04	$50,639	RARA covers in place since 1994
Subtotal long term maintenance costs (net present value)				$50,639	
Contingency			25%	$12,660	
NET PRESENT VALUE COST FOR LONG TERM MAINTENANCE CARE				$63,299	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				$63,299	

[a] Costs are for mid-1996.

[b] The sum of capital costs and the net present value for long term maintenance care costs.

ft = feet

RARA = Radiation Area Remedial Actions

ft/yr = feet per year

Table G-5 Cost Estimate for Continued Surveillance and Maintenance for 216-U-10 Pond/216-U-11 Trench

Item	Quantity	Units	Unit Cost	Cost[a]	Notes
CAPITAL COSTS					No additional capital cost beyond existing controls.
LONG TERM MAINTENANCE COSTS, PRESENT VALUE					
Surveillance/Maintenance	2,081,200	sf/yr	$0.04	$1,662,303	RARA covers now in place since 1985
Soil Cover Replacement	1,040,600	sf/yr	$0.03	$519,470	Based on RARA estimate of $0.50/sf over 50% of pond and trench every 20 years for 132 years.
Subtotal long term maintenance costs (net present value)				$2,181,772	
Contingency			25%	$545,443	
NET PRESENT VALUE COST FOR LONG TERM MAINTENANCE CARE				**$2,727,215**	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				**$2,727,215**	

[a] Costs are for mid-1996.

[b] The sum of capital costs and the net present value for long term maintenance care costs.

ft = feet
RARA = Radiation Area Remedial Actions
ft/yr = feet per year
sf/yr = square feet per year

Table G-6 Cost Estimate for Continued Surveillance and Maintenance for 216-U-14 Ditch/207-U Retention Basins

Item	Quantity	Units	Unit Cost	Cost[a]	Notes
CAPITAL COSTS					No additional capital costs beyond existing controls.
LONG TERM MAINTENANCE COSTS, PRESENT VALUE					
Surveillance/Maintenance	307,800	sf/yr	$0.04	$245,847	
Subtotal long term maintenance costs (net present value)				$245,847	
Contingency			25%	$61,462	
NET PRESENT VALUE COST FOR LONG TERM MAINTENANCE CARE				**$307,309**	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				**$307,309**	

[a] Costs are for mid-1996.

[b] The sum of capital costs and the net present value for long term maintenance care costs.

ft = feet

ft/yr = feet per year

Table G-7 Cost Estimate for Continued Surveillance and Maintenance for 216-Z-1D Ditch/216-Z-11 Ditch/216-Z-19 Ditch

Item	Quantity	Units	Unit Cost	Cost[a]	Notes
CAPITAL COSTS					No additional capital cost beyond existing controls.
LONG TERM MAINTENANCE COSTS, PRESENT VALUE					
Surveillance/Maintenance	430,000	sf/yr	$0.04	$343,451	
Subtotal long term maintenance costs (net present value)				$343,451	
Contingency			25%	$85,863	
NET PRESENT VALUE COST FOR LONG TERM MAINTENANCE CARE				**$429,314**	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE)[b]				**$429,314**	

[a] Costs are for mid-1996.

[b] The sum of capital costs and the net present value for long term maintenance care costs.

ft = feet

ft/yr = feet per year

9613401.3041

Table G-8 Cost Estimate for Continued Surveillance and Maintenance for 216-U-1 Crib/216-U-2 Crib/241-U-361 Settling Tank/ Stainless Steel Pipeline/Vitrified Clay Pipeline

Item	Quantity	Units	Unit Cost	Cost[a]	Notes
CAPITAL COSTS					No additional capital cost beyond existing controls.
LONG TERM MAINTENANCE COSTS, PRESENT VALUE					
Surveilllance/Maintenance	101,500	sf/yr	$0.04	$81,070	RARA covers in place since 1991
Soil Cover Replacement	83,100	sf/yr	$0.03	$41,484	Based on RARA estimate of $0.50/sf every 20 years for 132 years at the 216-U-1/2 and 241-U-361 (excludes 216-U-16 VCP).
Subtotal long term maintenance costs (net present value)				$122,554	
Contingency			25%	$30,639	
NET PRESENT VALUE COST FOR LONG TERM MAINTENANCE CARE				**$153,193**	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				**$153,193**	

[a] Costs are for mid-1996.

[b] The sum of capital costs and the net present value for long term maintenance care costs.

ft = feet

RARA = Radiation Area Remedial Actions

ft/yr = feet per year

sf/yr = square feet per year

Table G-9 Cost Estimate for Continued Surveillance and Maintenance for 216-U-12 Crib/Vitrified Clay Pipeline

Item	Quantity	Units	Unit Cost	Cost[a]	Notes
CAPITAL COSTS					No additional capital cost beyond existing controls.
LONG TERM MAINTENANCE COSTS, PRESENT VALUE					
Surveillance/Maintenance	22,000	sf/yr	$0.04	$17,572	
Subtotal long term maintenance costs (net present value)				$17,572	
Contingency			25%	$4,393	
NET PRESENT VALUE COST FOR LONG TERM MAINTENANCE CARE				**$21,965**	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				**$21,965**	

[a] Costs are for mid-1996.

[b] The sum of capital costs and the net present value for long term maintenance care costs.

ft = feet

ft/yr = feet per year

9613401.3042

Table G-10 Cost Estimate for Void Grout (where applicable)/Biointrusion Barrier/ Surveillance and Maintenance for 216-U-8 Crib/Vitrified Clay Pipeline

Item	Unit Cost	Units	Qty	Cost[a]	Notes
CAPITAL COSTS					
Biointrusion Barrier	$3.51	sf	63,400	$222,534	
Void Grouting	$229.00	cy	294	$67,326	
Air monitoring	$110,250.00	LS		$110,250	
Site preparation	$221,095.00	LS		$221,095	
Subtotal Capital				$621,205	
Contractor overhead and profit	25%			$155,301	
Subtotal				$776,506	
Engineering and construction surveillance	70%			$543,554	
Subtotal				$1,320,060	
Contingency	25%			$330,015	
TOTAL CAPITAL COSTS				**$1,650,075**	
LONG TERM MAINTENANCE COSTS, PRESENT VALUE					
Biointrusion Barrier maintenance	$0.02	sf/yr	63,400	$25,320	
Subtotal long term maintenance costs (net present value)				$25,320	
Contingency	25%			$6,330	
NET PRESENT VALUE COST FOR LONG TERM MAINTENANCE CARE				**$31,650**	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE)[b]				**$1,681,725**	

[a] Costs are for mid-1996.

[b] The sum of capital costs and the net present value for long term maintenance care costs.

cy = cubic yard
ft = feet
sf = square feet
LS = lump sum
ft/yr = feet per year
sf/yr = square feet per year

Table G-11 Cost Estimate for Void Grout (where applicable)/Biointrusion Barrier/ Surveillance and Maintenance for 216-U-10 Pond/216-U-11 Trench

Item	Unit Cost	Units	Qty	Cost[a]	Notes
CAPITAL COSTS					
Biointrusion Barrier	$3.51	sf	2,081,200	$7,305,012	
Air monitoring	$110,250.00	LS		$110,250	
Site preparation	$221,095.00	LS		$221,095	
Subtotal Capital				$7,636,357	
Contractor overhead and profit	25%			$1,909,089	
Subtotal				$9,545,446	
Engineering and construction surveillance	70%			$6,681,812	
Subtotal				$16,227,258	
Contingency	25%			$4,056,815	
TOTAL CAPITAL COSTS				**$20,284,073**	
LONG TERM MAINTENANCE COSTS, PRESENT VALUE					
Biointrusion Barrier maintenance	$0.02	sf/yr	2,081,200	$831,151	
Subtotal long term maintenance costs (net present value)				$831,151	
Contingency	25%			$207,788	
NET PRESENT VALUE COST FOR LONG TERM MAINTENANCE CARE				**$1,038,939**	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				**$21,323,012**	

[a] Costs are for mid-1996.

[b] The sum of capital costs and the net present value for long term maintenance care costs.

ft = feet
sf = square feet
LS = lump sum
ft/yr = feet per year
sf/yr = square feet per year

Table G-12 Cost Estimate for Void Grout (where applicable)/Biointrusion Barrier/ Surveillance and Maintenance for 216-U-14 Ditch/207-U Retention Basins

Item	Unit Cost	Units	Qty	Cost[a]	Notes
CAPITAL COSTS					
Biointrusion Barrier	$3.51	sf	307,800	$1,080,378	
Air monitoring	$110,250.00	LS		$110,250	
Backfill/regrade	$6.91	cy	4,950	$34,205	For the filling of the empty 207-U Retention Basins (1,000,000 gallon total capacity)
Site preparation	$221,095.00	LS		$221,095	
Subtotal Capital				$1,445,928	
Contractor overhead and profit	25%			$361,482	
Subtotal				$1,807,410	
Engineering and construction surveillance	70%			$1,265,187	
Subtotal				$3,072,597	
Contingency	25%			$768,149	
TOTAL CAPITAL COSTS				**$3,840,746**	
LONG TERM MAINTENANCE COSTS, PRESENT VALUE					
Biointrusion Barrier maintenance	$0.02	sf/yr	307,800	$122,924	
Subtotal long term maintenance costs (net present value)				$122,924	
Contingency	25%			$30,731	
NET PRESENT VALUE COST FOR LONG TERM MAINTENANCE CARE				**$153,655**	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE)[b]				**$3,994,400**	

[a] Costs are for mid-1996.

[b] The sum of capital costs and the net present value for long term maintenance care costs.

cy = cubic yard
ft = feet
sf = square feet
LS = lump sum
ft/yr = feet per year
sf/yr = square feet per year

Table G-13 Cost Estimate for Void Grout (where applicable)/Biointrusion Barrier/ Surveillance and Maintenance for 216-Z-1D Ditch/216-Z-11 Ditch/216-Z-19 Ditch

Item	Unit Cost	Units	Qty	Cost[a]	Notes
CAPITAL COSTS					
Biointrusion Barrier	$3.51	sf	430,000	$1,509,300	
Air monitoring	$110,250.00	LS		$110,250	
Site preparation	$221,095.00	LS		$221,095	
Subtotal Capital				$1,840,645	
Contractor overhead and profit	25%			$460,161	
Subtotal				$2,300,806	
Engineering and construction surveillance	70%			$1,610,564	
Subtotal				$3,911,370	
Contingency	25%			$977,843	
TOTAL CAPITAL COSTS				$4,889,213	
LONG TERM MAINTENANCE COSTS, PRESENT VALUE					
Biointrusion Barrier maintenance	$0.02	sf/yr	430,000	$171,726	
Subtotal long term maintenance costs (net present value)				$171,726	
Contingency	25%			$42,931	
NET PRESENT VALUE COST FOR LONG TERM MAINTENANCE CARE				$214,657	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE)[b]				$5,103,870	

[a] Costs are for mid-1996.

[b] The sum of capital costs and the net present value for long term maintenance care costs.

ft = feet
sf = square feet
LS = lump sum
ft/yr = feet per year
sf/yr = square feet per year

Table G-14 Cost Estimate for Void Grout (where applicable)/Biointrusion Barrier/ Surveillance and Maintenance for 216-U-1 Crib/216-U-2 Crib/241-U-361 Settling Tank/ Stainless Steel Pipeline/Vitrified Clay Pipeline

Item	Unit Cost	Units	Qty	Cost[a]	Notes
CAPITAL COSTS					
Biointrusion Barrier	$3.51	sf	101,500	$356,265	
Void Grouting	$229.00	cy	144	$32,976	
Air monitoring	$110,250.00	LS		$110,250	
Pumping, trans. & disposal of liquid material	$12,509.00	LS		$12,509	
Site preparation	$221,095.00	LS		$221,095	
Subtotal Capital				$733,095	
Contractor overhead and profit	25%			$183,274	
Subtotal				$916,369	
Engineering and construction surveillance	70%			$641,458	
Subtotal				$1,557,827	
Contingency	25%			$389,457	
TOTAL CAPITAL COSTS				$1,947,284	
LONG TERM MAINTENANCE COSTS, PRESENT VALUE					
Biointrusion Barrier maintenance	$0.02	sf/yr	101,500	$40,535	
Subtotal long term maintenance costs (net present value)				$40,535	
Contingency	25%			$10,134	
NET PRESENT VALUE COST FOR LONG TERM MAINTENANCE CARE				$50,669	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE)[b]				$1,997,953	

[a] Costs are for mid-1996.

[b] The sum of capital costs and the net present value for long term maintenance care costs.

cy = cubic yard
ft = feet
sf = square feet
LS = lump sum
ft/yr = feet per year
sf/yr = square feet per year

Table G-15 Cost Estimate for Void Grout (where applicable)/Biointrusion Barrier/ Surveillance and Maintenance for 216-U-12 Crib/Vitrified Clay Pipeline

Item	Unit Cost	Units	Qty	Cost[a]	Notes
CAPITAL COSTS					
Biointrusion Barrier	$3.51	sf	22,000	$77,220	
Void Grouting	$229.00	cy	4	$916	
Air monitoring	$110,250.00	LS		$110,250	
Site preparation	$221,095.00	LS		$221,095	
Subtotal Capital				$409,481	
Contractor overhead and profit	25%			$102,370	
Subtotal				$511,851	
Engineering and construction surveillance	70%			$358,296	
Subtotal				$870,147	
Contingency	25%			$217,537	
TOTAL CAPITAL COSTS				**$1,087,684**	
LONG TERM MAINTENANCE COSTS, PRESENT VALUE					
Biointrusion Barrier maintenance	$0.02	sf/yr	22,000	$8,786	
Subtotal long term maintenance costs (net present value)				$8,786	
Contingency	25%			$2,196	
NET PRESENT VALUE COST FOR LONG TERM MAINTENANCE CARE				**$10,982**	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				**$1,098,666**	

[a] Costs are for mid-1996.

[b] The sum of capital costs and the net present value for long term maintenance care costs.

cy = cubic yard
ft = feet
sf = square feet
LS = lump sum
ft/yr = feet per year
sf/yr = square feet per year

Table G-16 Cost Estimate for Excavation and Disposal for 216-U-8 Crib/ Vitrified Clay Pipeline

Item	Unit Cost	Units	Qty	Cost[a]	Notes
CAPITAL COSTS					
Excavate material	$19.50	cy	16,700	$325,650	
Backfill/Regrade	$6.91	cy	4,300	$29,713	
Disposal of contaminated material	$22.29	ton-short	6,948	$154,871	
Void Grouting	$229.00	cy	286	$65,494	Does not include the volume of grout required to fill the pipeline because it would be excavated.
Air monitoring	$110,250.00	LS		$110,250	
Site preparation	$221,095.00	LS		$221,095	
Subtotal Capital				$907,073	
Contractor overhead and profit	25%			$226,768	
Subtotal				$1,133,841	
Engineering and construction surveillance	70%			$793,689	
Subtotal				$1,927,530	
Contingency	25%			$481,882	
TOTAL CAPITAL COSTS				$2,409,412	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				$2,409,412	

[a] Costs are for mid-1996.

[b] The sum of capital costs.

cy = cubic yard

LS = lump sum

Table G-17 Cost Estimate for Excavation and Disposal for 216-U-10 Pond/ 216-U-11 Trench

Item	Unit Cost	Units	Qty	Cost[a]	Notes
CAPITAL COSTS					
Excavate material	$19.50	cy	404,500	$7,887,750	
Backfill/Regrade	$6.91	cy	381,200	$2,634,092	
Disposal of contaminated material	$22.29	ton-short	617,460	$13,763,183	
Air monitoring	$110,250.00	LS		$110,250	
Site preparation	$221,095.00	LS		$221,095	
Subtotal Capital				$24,616,370	
Contractor overhead and profit	25%			$6,154,093	
Subtotal				$30,770,463	
Engineering and construction surveillance	70%			$21,539,324	
Subtotal				$52,309,787	
Contingency	25%			$13,077,447	
TOTAL CAPITAL COSTS				**$65,387,234**	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				**$65,387,234**	

[a] Costs are for mid-1996.

[b] The sum of capital costs.

cy = cubic yard

LS = lump sum

Table G-18 Cost Estimate for Excavation and Disposal for 216-U-14 Ditch/ 207-U Retention Basins

Item	Unit Cost	Units	Qty	Cost[a]	Notes
CAPITAL COSTS					
Excavate material	$19.50	cy	68,200	$1,329,900	
Backfill/Regrade	$6.91	cy	40,550	$280,201	Includes backfilling the empty 207-U Retention Basin (1,000,000 gallon capacity).
Disposal of contaminated material	$22.29	ton-short	57,766	$1,287,604	
Air monitoring	$110,250.00	LS		$110,250	
Site preparation	$221,095.00	LS		$221,095	
Subtotal Capital				$3,229,050	
Contractor overhead and profit	25%			$807,262	
Subtotal				$4,036,312	
Engineering and construction surveillance	70%			$2,825,418	
Subtotal				$6,861,730	
Contingency	25%			$1,715,433	
TOTAL CAPITAL COSTS				$8,577,163	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				$8,577,163	

[a] Costs are for mid-1996.

[b] The sum of capital costs.

cy = cubic yard

LS = lump sum

Table G-19 Cost Estimate for Excavation and Disposal for 216-Z-1D Ditch/216-Z-11 Ditch/216-Z-19 Ditch

Item	Unit Cost	Units	Qty	Cost[a]	Notes
CAPITAL COSTS					
Excavate material	$19.50	cy	53,700	$1,047,150	
Backfill/Regrade	$6.91	cy	41,200	$284,692	
Disposal of contaminated material	$22.29	ton-short	66,704	$1,486,832	
Air monitoring	$110,250.00	LS		$110,250	
Site preparation	$221,095.00	LS		$221,095	
Subtotal Capital				$3,150,019	
Contractor overhead and profit	25%			$787,505	
Subtotal				$3,937,524	
Engineering and construction surveillance	70%			$2,756,267	
Subtotal				$6,693,791	
Contingency	25%			$1,673,448	
TOTAL CAPITAL COSTS				$8,367,239	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				$8,367,239	

[a] Costs are for mid-1996.

[b] The sum of capital costs.

cy = cubic yard

LS = lump sum

Table G-20 Cost Estimate for Excavation and Disposal for 216-U-1 Crib/216-U-2 Crib/ 241-U-361 Settling Tank/Stainless Steel Pipeline/Vitrified Clay Pipeline

Item	Unit Cost	Units	Qty	Cost[a]	Notes
CAPITAL COSTS					
Excavate material	$19.50	cy	34,500	$672,750	
Backfill/Regrade	$6.91	cy	19,200	$132,672	
Disposal of contaminated material	$22.29	ton-short	31,170	$694,779	
Void Grouting	$229.00	cy	42	$9,618	Does not include volume of grout required to fill pipelines and settling tank because they would be excavated.
Pumping, trans. & disposal of liquid material	$12,509.00	LS		$12,509	
Air monitoring	$110,250.00	LS		$110,250	
Site preparation	$221,095.00	LS		$221,095	
Subtotal Capital				$1,853,673	
Contractor overhead and profit	25%			$463,418	
Subtotal				$2,317,091	
Engineering and construction surveillance	70%			$1,621,964	
Subtotal				$3,939,055	
Contingency	25%			$984,764	
TOTAL CAPITAL COSTS				$4,923,819	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				$4,923,819	

[a] Costs are for mid-1996.

[b] The sum of capital costs.

cy = cubic yard

LS = lump sum

Table G-21 Cost Estimate for Excavation and Disposal for 216-U-12 Crib/ Vitrified Clay Pipeline

Item	Unit Cost	Units	Qty	Cost[a]	Notes
CAPITAL COSTS					
Excavate material	$19.50	cy	8,200	$159,900	
Backfill/Regrade	$6.91	cy	1,900	$13,129	
Disposal of contaminated material	$22.29	ton-short	3,120	$69,545	
Air monitoring	$110,250.00	LS		$110,250	
Site preparation	$221,095.00	LS		$221,095	
Subtotal Capital				$573,919	
Contractor overhead and profit	25%			$143,480	
Subtotal				$717,399	
Engineering and construction surveillance	70%			$502,179	
Subtotal				$1,219,578	
Contingency	25%			$304,894	
TOTAL CAPITAL COSTS				**$1,524,472**	
TOTAL ALTERNATIVE COST (NET PRESENT VALUE) [b]				**$1,524,472**	

[a] Costs are for mid-1996.

[b] The sum of capital costs.

cy = cubic yard

LS = lump sum

APPENDIX H

DETAILED ANALYSIS TABLES

Table H-1 Sites With Short-Lived Radionuclides
No Action

Overall Protection of Human Health and the Environment	
Will risk be at acceptable levels?	No. QRA and RESRAD results are presented below. QRA[a] (ICR) / RESRAD[b] (mrem/yr) 216-U-1/2 Cribs/ Settling Tank: 5×10^{-3} / 740 216-U-8 Crib/ Vitrified Clay Pipeline: $>1 \times 10^{-2}$ / 1464 216-U-12 Crib/ Vitrified Clay Pipeline 216-U-16 VCP (analogous to 216-U-8): $>1 \times 10^{-2}$ / 1464 216-U-14 Ditch/ 207-U Retention Basin (analogous to 216-U-10): 1×10^{-2} / 149 216-U-10 Pond/ 216-U-11: 1×10^{-2} / 149 [a] Calculated using a very conservative industrial exposure scenario [b] Exposure modeling based on less conservative exposure scenario consistent with what was used in 300-FF-1
Timeframe to achieve acceptable levels?	Decay modeling indicates that contaminants will decay to acceptable levels in the following timeframes: Years to Decay to <15 mrem/yr 216-U-1/2 Cribs/ Settling Tank: 170 216-U-8 Crib Vitrified Clay Pipeline: 200 216-U-12 Crib Vitrified Clay Pipeline (analogous to 216-U-8): 200 216-U-14 Ditch 207-U Retention Basin (analogous to 216-U-10): 100 216-U-10 Pond/ 216-U-11: 100
Will the alternative pose any unacceptable short-term or crossmedia impacts?	Because no action is taken, there is no unacceptable exposure to the waste management worker. No crossmedia impacts are anticipated. Impacts to groundwater are evaluated in Appendix B.
Will the alternative impact natural resources?	The sites will be left in their current condition. No additional impacts are anticipated as a result of this alternative.
What restoration actions may be necessary?	No restoration is proposed.
Will residual contamination (following remediation) be a potential problem?	Contamination resulting in exposures above acceptable levels exists at the sites.

Table H-1 Sites With Short-Lived Radionuclides No Action (continued)

Compliance with ARAR	
What are the potential ARAR?	Radioactive 10 CFR 61 Subpart C 10 CFR 20 Nuclear Regulatory Standards for Protection Against Radiation 10 CFR 835 WAC 246-221 Radiation Protection Standards Waste WAC 173-303-070 Designation of Waste WAC 173-303-090 Dangerous Waste Characteristics WAC 173-303-100 Dangerous Waste Criteria WAC 173-340-700 - 760 Model Toxics Control Regulations Air 40 CFR 61 National Emission Standards for Hazardous Air Pollutants (NESHAPS), Subpart H- National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities WAC 246-247 Radiation Protection - Air Emissions
Will the potential ARAR listed above be met? How?	Radioactive protection and management of radioactive material will be accomplished in accordance with current site safety and management procedures. Waste management, including hazardous and mixed waste, will be accomplished by the proper characterization, handling and disposing of the waste using existing facility procedures, or by developing regulatory approved procedures if necessary. Air and water quality will be maintained and monitored using existing site monitoring networks and procedures.
Basis for waivers?	Currently no waiver is being requested under CERCLA for this alternative.
What are the potential TBC?	Radioactive 40 CFR 196 Radiation Site Cleanup Standards
Is the alternative consistent with the TBC listed above?	Yes. Current programs and procedures being used to manage the site today include procedures and standards to ensure compliance is achieved for the requirements listed as TBCs. No changes are expected through the implementation of this alternative.

Table H-1 Sites With Short-Lived Radionuclides No Action (continued)

Long-Term Effectiveness and Permanence			
What is the magnitude of the remaining risk?		<u>ORA[a] (ICR)</u>	<u>RESRAD[b] (mrem/yr)</u>
	216-U-1/2 Cribs/ Settling Tank/ Pipeline/ 216-U-16 VCP	5×10^{-3}	740
	216-U-8 Crib/ Vitrified Clay Pipeline	$>1 \times 10^{-2}$	1464
	216-U-12 Crib/ Vitrified Clay Pipeline (analogous to 216-U-8)	$>1 \times 10^{-2}$	1464
	216-U-14 Ditch/ 207-U Retention Basin (analogous to 216-U-10)	1×10^{-2}	149
	216-U-10 Pond/ 216-U-11	1×10^{-2}	149
	[a] Calculated using a very conservative industrial exposure scenario [b] Exposure modeling based on less conservative exposure scenario consistent with what was used in 300-FF-1		
What remaining sources of risk can be identified?	Existing contaminants in soil remain, and may be accessed by the waste management worker, burrowing animals and deep rooted plants.		
What is the likelihood that the technologies will meet performance needs?	Not Applicable. No technologies are associated with the No Action alternative for this site.		
What type, degree, and requirement of long-term management is required?	None		
What O&M functions must be performed?	None		
What difficulties may be associated with long-term O&M?	Not Applicable.		
What is the potential need for replacement of technical components?	Not Applicable.		
What is the magnitude of risk should the remedial action need replacement?	Not Applicable.		
What is the degree of confidence that controls can adequately handle potential problems?	Not Applicable.		
What are the uncertainties associated with land disposal of residuals and untreated wastes.	Not Applicable.		
Will the alternative provide long-term protection of natural resources?	No. Contamination resulting in an unacceptable exposure currently exists and the alternative provides no restoration or environmental enhancements.		
Will terrestrial habitats be degraded or enhanced?	There will be no change from current terrestrial habitat quality.		
How will the remedial action affect the overall quality of the ecosystem?	Because no action is taken, the quality of the ecosystem will remain in its current condition. Over time, plants and animals may bring contaminants to the surface.		

Table H-1 Sites With Short-Lived Radionuclides No Action (continued)

Reduction of Toxicity, Mobility, or Volume	
Does the treatment process address the principal threats?	Not applicable. No treatment is proposed.
Are there any special requirements for the treatment process?	Not applicable.
What portion of the contaminated material is treated/destroyed?	No treatment is proposed; however, modeling predicts contaminants will naturally decay to acceptable levels.
To what extent is the total mass of toxic contaminants reduced?	No induced mass reduction of contaminants; however, modeling predicts contaminants will naturally decay to acceptable levels.
To what extent is the mobility of contaminants reduced?	None. No treatment is proposed. No impact to groundwater is anticipated as discussed in Appendix B.
To what extent are the effects of the treatment irreversible?	No treatment is proposed; however, natural decay is irreversible.
What are the quantities of residuals and characteristics of the residual risk?	Contaminated materials remain in place. Modeling suggests that unacceptable exposure to the waste management worker will remain until contaminants naturally decay.
What risks do treatment of residuals pose?	None. No treatment of residuals is proposed.
Is treatment used to reduce inherent hazards posed by principal threats at the site?	No treatment is proposed.
How does the proposed treatment impact natural resources?	No treatment is proposed.
Does the alternative result in a gain or loss of quality at the site for natural resources?	No change would result, leaving the site in its current condition.
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, seasonal restrictions on habitat use)?	No impact because no additional action is proposed.
Will the natural resource restoration activities associated with this alternative be easily implemented?	No restoration is proposed.
Will long-term maintenance and monitoring of mitigation/restoration efforts and activities be necessary?	No mitigation/restoration is proposed.

Table H-1 Sites With Short-Lived Radionuclides No Action (continued)

Short-Term Effectiveness	
What are the risks to the community during remedial actions, and how will they be mitigated?	None. No risks to the community exist given the site's isolated location and industrial waste management designation.
What risks remain to the community that cannot be readily controlled?	None.
What are the risks to the workers, and how will they be mitigated?	The only potential exposure to workers results from unabated access to contaminants at the site. Under this alternative, no action will be taken that introduces short-term risk to workers.
What risks remain to the workers that cannot be readily controlled?	None.
What environmental impacts are expected with the construction and implementation of the alternative?	None. No action is taken.
What are the impacts that cannot be avoided should the alternative be implemented?	Not applicable.
How long until remedial response objectives are achieved?	Decay modeling indicates contaminants will decay to acceptable levels in the following timeframes. However, no action is taken to abate the risk of exposure before decay. Years to Decay to <15 mrem/yr) 216-U-1/2 Cribs/ Settling Tank/Pipeline 216-U-16 VCP — 170 216-U-8 Crib/ Vitrified Clay Pipeline — 200 216-U-12 Crib/ Vitrified Clay Pipeline (analogous to 216-U-8) — 200 216-U-14 Ditch/ 207-U Retention Basin (analogous to 216-U-10) — 100 216-U-10 Pond/ 216-U-11 — 100

Table H-1 Sites With Short-Lived Radionuclides No Action (continued)

Implementability	
What difficulties and uncertainties are associated with construction?	None. No construction is proposed.
What is the likelihood that technical problems will lead to schedule delays?	Not applicable.
What likely future remedial actions are anticipated?	Although this interim remedy consists of No Action, other remedial actions may be selected at a later date and documented in the Final ROD for the operable unit. This alternative is completely compatible with any potential future action.
What risks of exposure exist should monitoring be insufficient to detect failure?	No monitoring is proposed.
What activities are proposed which require coordination with other agencies?	None.
Are adequate treatment, storage capacity, and disposal services available?	Not applicable.
Are necessary equipment and specialists available?	Not applicable.
Are technologies under consideration generally available and sufficiently demonstrated or will they require further development before they can be applied at the site?	Not applicable.
Will more than one vendor be available to provide a competitive bid?	Not applicable.

Table H-2 Sites With Short-Lived Contaminants Surveillance and Maintenance

Overall Protection of Human Health and the Environment	
Will risk be at acceptable levels?	Yes. This alternative prevents inadvertent human intrusion through the use of access restrictions. Exposure to contaminants is controlled and any authorized access would require appropriate health and safety measures. Periodic maintenance would include controlling growth of deep-rooted plants and inhabitation of burrowing animals and nesting insects.
Timeframe to achieve acceptable levels?	Exposure pathways will be minimized immediately upon implementing of this alternative. Institutional controls, maintenance, and monitoring will be ongoing for at least 132 years (until 2128). Decay modeling indicates contaminants will decay to acceptable levels in the following timeframes: Years to Decay to <15 mrem/yr 216-U-1/2 Cribs/ Settling Tank/Pipeline/ 216-U-16 VCP — 170 216-U-8 Crib/ Vitrified Clay Pipeline — 200 216-U-12 Crib/ Vitrified Clay Pipeline (analogous to 216-U-8) — 200 216-U-14 Ditch/ 207-U Retention Basin (analogous to 216-U-10) — 100 216-U-10 Pond/ 216-U-11 — 100
Will the alternative pose any unacceptable short-term or crossmedia impacts?	No additional impacts will be introduced by this alternative. Worker and crossmedia impact (i.e., fugitive dust, runon/runoff) can be controlled during surveillance and maintenance through development and implementation of appropriate control measures. An impact to groundwater is not anticipated (Appendix B).
Will the alternative impact natural resources?	The sites will be left in their current condition. No additional impacts are anticipated as a result of this alternative.
What restoration actions may be necessary?	No restoration is proposed.
Will residual contamination (following remediation) be a potential problem?	Contamination resulting in exposures above acceptable levels remain at the site; however, exposure to contaminants will be controlled.

Table H-2 Sites With Short-Lived Contaminants Surveillance and Maintenance (continued)

Compliance with ARAR	
What are the potential ARAR?	Cultural *National Historic Preservation Act of 1966* Title 16 USC 470 Endangered Species Act of 1973 Title 16 USC 1531 et seq Radioactive 10 CFR 20 Nuclear Regulatory Standards for Protection Against Radiation 10 CFR 61 Subpart C 10 CFR 835 WAC 246-221 Radiation Protection Standards Waste WAC 173-303-645 Releases from Regulated Units WAC 173-303-610 Closure and Post-Closure (only applicable for RCRA unit at U12) WAC 173-340-360 Selection of Cleanup Actions WAC 173-340-700 - 760 Model Toxics Control Regulations Air 40 CFR 61 National Emission Standards for Hazardous Air Pollutants (NESHAPS). Subpart H- National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities WAC 173-480 Ambient Air Quality Standards and Emission Limits for Radionuclides WAC 246-247 Radiation Protection - Air Emissions
Will the potential ARAR listed above be met? How?	Yes. Cultural and natural resources will be protected to ensure impacts are minimized and/or mitigated. Current historical records and procedures will be used if discovery of a historical or ecological site is located at a site. Radioactive protection and management of radioactive material will be accomplished in accordance with current site safety and management procedures. Waste management including hazardous and mixed waste, will be accomplished by the proper characterization, handling and disposing of the waste using existing facility procedures, or by developing regulatory approved procedures, if necessary. Air and water quality will be maintained and monitored using existing site monitoring networks and procedures. These requirements are applicable only if implementation actions of the controls at the site cause a disturbance of the current configuration (i.e., additional vegetation cover, installing a fence, moving soil)
Basis for waivers?	Currently no waiver is being requested under CERCLA for this alternative.
What are the potential TBC?	Cultural Washington Natural Heritage Program RCW 79.70 Radioactive 40 CFR 196 Radiation Site Cleanup Standards DOE Order 5480.11 Radiation Protection for Occupational Workers
Is the alternative consistent with the TBC listed above?	Yes. Current programs and procedures being used to manage the site today include procedures and standards to ensure compliance is achieved for the requirements listed as TBCs. No changes are expected through the implementation of this alternative.

Table H-2 Sites With Short-Lived Contaminants Surveillance and Maintenance (continued)

Long-Term Effectiveness and Permanence	
What is the magnitude of the remaining risk?	Although contamination is left in place, this alternative minimizes exposure pathways until contaminants naturally decay to acceptable levels.
What remaining sources of risk can be identified?	Existing contaminants in soil remain; however, the alternative minimizes exposure to contaminants. Biointrusion will be controlled by application of herbicides/pesticides. The 216-U-1/2 Cribs and 216-U-8 Crib present a risk of collapse due to underground crib voids.
What is the likelihood that the technologies will meet performance needs?	Institutional controls and environmental monitoring are proven technologies that have been successfully implemented at the Hanford Site.
What type, degree, and requirement of long-term management is required?	Institutional controls and environmental monitoring will be maintained until contaminants naturally decay to acceptable levels.
What O&M functions must be performed?	Maintenance, monitoring, and institutional controls.
What difficulties may be associated with long-term O&M?	None.
What is the potential need for replacement of technical components?	Maintenance and repair of fencing, signs, existing soil covers, and replacement of monitoring equipment may be necessary. Review of monitoring parameters and frequency will occur at each 5 year review to determine if a change may be appropriate.
What is the magnitude of risk should the remedial action need replacement?	Magnitude of risks will be dependent upon the time remedial action needs replacement since contaminants naturally decay. Without appropriate controls, risks will be at unacceptable levels until contaminants naturally decay.
What is the degree of confidence that controls can adequately handle potential problems?	High degree of confidence. Institutional controls are reliable; however, should institutional controls fail, there is some potential for human and ecological exposure to contaminants. Existing clean soil cover present at most sites would minimize near-term exposure.
What are the uncertainties associated with land disposal of residuals and untreated waste.	Not applicable.
Will the alternative provide long-term protection of natural resources?	Exposure to contamination above acceptable levels will be controlled, but the alternative provides no restoration or environmental enhancements.
Will terrestrial habitats be degraded or enhanced?	There will be no change from current terrestrial habitat quality.
How will the remedial action affect the overall quality of the ecosystem?	The quality of the ecosystem will remain in its current condition.

Table H-2 Sites With Short-Lived Contaminants Surveillance and Maintenance (continued)

Reduction of Toxicity, Mobility, or Volume	
Does the treatment process address the principal threats?	No treatment is proposed. However, exposure to contaminants is controlled by implementing institutional controls.
Are there any special requirements for the treatment process?	Not applicable.
What portion of the contaminated material is treated/destroyed?	Implementing this alternative results in all of the contaminants remaining in place. However, modeling predicts natural decay will reduce contaminants to acceptable levels.
To what extent is the total mass of toxic contaminants reduced?	No induced mass reduction of contaminants; however, modeling predicts contaminants will decay to acceptable levels.
To what extent is the mobility of contaminants reduced?	No treatment is proposed to reduce downward mobility; however, no impact to groundwater is anticipated, as discussed in Appendix B. Mobility from biological processes is controlled.
To what extent are the effects of the treatment irreversible?	No treatment is proposed; however, natural decay is irreversible.
What are the quantities of residuals and characteristics of the residual risk?	Contaminated materials remain in place. Exposure to these contaminants is prevented by implementing institutional controls.
What risks do treatment of residuals pose?	None. No treatment of residuals is proposed.
Is treatment used to reduce inherent hazards posed by principal threats at the site?	No treatment is proposed. However, institutional control will limit exposure to contaminants, thereby reducing threats at the site.
How does the proposed treatment impact natural resources?	No treatment is proposed.
Does the alternative result in a gain or loss of quality at the site for natural resources?	No change would result, leaving the site in its current condition.
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, seasonal restrictions on habitat use)?	No short-term impact to natural resources is anticipated.
Will the natural resource restoration activities associated with this alternative be easily implemented?	No restoration is proposed.
Will long-term maintenance and monitoring of mitigation/restoration efforts and activities be necessary?	No restoration is proposed.

Table H-2 Sites With Short-Lived Contaminants Surveillance and Maintenance (continued)

Short-Term Effectiveness	
What are the risks to the community during remedial actions, and how will they be mitigated?	None. No risks to the community exist given the site's isolated location and waste management designation.
What risks remain to the community that cannot be readily controlled?	None.
What are the risks to the workers, and how will they be mitigated?	Exposure to contaminants via fugitive dust inhalation, ingestion of contaminated soils, and external exposure to radionuclides will be controlled by implementing appropriate health and safety procedures. Sites with underground voids will be monitored for collapse potential.
What risks remain to the workers that cannot be readily controlled?	None.
What environmental impacts are expected with the construction and implementation of the alternative?	None. Potential impacts will be abated by implementing appropriate contamination control measures.
What are the impacts that cannot be avoided should the alternative be implemented?	None.
How long until remedial response objectives are achieved?	The RAOs are achieved immediately upon implementation of the alternative.

Table H-2 Sites With Short-Lived Contaminants Surveillance and Maintenance (continued)

Implementability	
What difficulties and uncertainties are associated with construction?	None.
What is the likelihood that technical problems will lead to schedule delays?	None.
What likely future remedial actions are anticipated?	This interim remedy consists only of institutional controls; other remedial actions may be selected at a later date and documented in the final ROD for the operable unit. This alternative is completely compatible with any potential future action.
What risks of exposure exist should monitoring be insufficient to detect failure?	Should institutional controls fail, there is some potential for human and ecological exposure to contaminants. However existing clean soil cover present at most sites would minimize near-term exposure.
What activities are proposed that require coordination with other agencies?	Long-term DOE waste management activities will require coordination with state groundwater agencies and with local zoning authorities.
Are adequate treatment, storage capacity, and disposal services available?	Not applicable
Are necessary equipment and specialists available?	Yes. Alternative components are established technologies. Equipment and materials are readily obtainable and most materials are available onsite.
Are technologies under consideration generally available and sufficiently demonstrated or will they require further development before they can be applied at the site?	Institutional controls and environmental monitoring are proven technologies that have been successfully implemented at the Hanford Site.
Will more than one vendor be available to provide a competitive bid?	Yes. Several contractors exist locally. Many equipment vendors are available to provide monitoring equipment.

Table H-3 Sites With Short-Lived Contaminants Void Grout (where applicable)/Biointrusion Barrier

Overall Protection of Human Health and the Environment	
Will risk be at acceptable levels?	Yes. This alternative prevents inadvertent intrusion to the site and provides a soil barrier of sufficient thickness to eliminate direct exposure to contaminants, generation of fugitive dust, and ingestion of contaminated soils. The biointrusion layer prevents deep-rooted plants and burrowing animals from bringing contaminants to the surface. Additionally, risks of collapse of the underground voids and migration of contaminants through existing pipelines will be addressed by grouting all crib and pipeline voids.
Timeframe to achieve acceptable levels?	Exposure pathways will be minimized upon implementation of this alternative. Furthermore, modeling suggests contaminants will naturally decay to acceptable levels.
Will the alternative pose any unacceptable short-term or crossmedia impacts?	No additional unacceptable impacts will be introduced by this alternative. Worker exposure and crossmedia impacts (i.e., fugitive dust, runon/runoff) can be controlled during construction through development and implementation of appropriate control measures. An impact to groundwater is not anticipated, as discussed in Appendix B.
Will the alternative impact natural resources?	Construction and transportation activities may present short-term impacts (roads, borrow pits, recontouring) on cultural and natural resources in adjacent areas. However, this alternative will improve existing conditions over the long-term as it isolates waste.
What restoration actions may be necessary?	After contaminants decay to acceptable levels, restoration actions may include revegetation.
Will residual contamination (following remediation) be a potential problem?	Waste will be left in place; however, the barrier will reduce exposure to biological receptors by providing a bio-intrusion layer. Human exposure will also be reduced due to access restrictions and the shielding provided by the cover.

Table H-3 Sites With Short-Lived Contaminants Void Grout (where applicable)/Biointrusion Barrier (continued)

Compliance with ARAR	
What are the potential ARAR?	Cultural *Archeological and Historic Preservation Act* Title 16 USC 469a Native American Graves Protection and Repatriation Act Public Law 101-601 as amended *National Historic Preservation Act of 1966* Title 16 USC 470 *Endangered Species Act of 1973* Title 16 USC 1531 et seq Radioactive 10 CFR 61 Subpart C 10 CFR 20 Nuclear Regulatory Standards for Protection Against Radiation 10 CFR 835 WAC 246-221 Radiation Protection Standards Waste WAC 173-303-645 Releases from Regulated Units WAC 173-303-610 Closure and Post-Closure WAC 173-340-360 Selection of Cleanup Actions WAC 173-340-700 - 304-760 Model Toxics Control Regulations Air 40 CFR 61 National Emission Standards for Hazardous Air Pollutants (NESHAPS), Subpart H- National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities WAC 173-480 Ambient Air Quality Standards and Emission Limits for Radionuclides WAC 246-247 Radiation Protection - Air Emissions
Will the potential ARAR listed above be met? How?	Yes. Cultural and natural resources will be protected to ensure impacts are minimized and/or mitigated. Current historical records and procedures will be used if discovery of a historical or ecological site is located at a site. Radioactive protection and management of radioactive material will be accomplished in accordance with current site safety and management procedures. Waste management, including hazardous and mixed waste, will be accomplished by the proper characterization, handling and disposing of the waste using existing facility procedures, or by developing regulatory-approved procedures if necessary. Air and water quality will be maintained and monitored using existing site monitoring networks and procedures.
Basis for waivers?	Currently no waiver is being requested under CERCLA for this alternative.
What are the potential TBC?	Cultural Washington Natural Heritage Program RCW 79.70 Radioactive 40 CFR 196 Radiation Site Cleanup Standards
Is the alternative consistent with the TBC listed above?	Yes. Current programs and procedures being used to manage the site today include procedures and standards to ensure compliance is achieved for the requirements listed as TBCs. No changes are expected through the implementation of this alternative.

Table H-3 Sites With Short-Lived Contaminants Void Grout (where applicable)/Biointrusion Barrier (continued)

Long-Term Effectiveness and Permanence	
What is the magnitude of the remaining risk?	Although contamination is left in place, this alternative minimizes exposure pathways until contaminants naturally decay to acceptable levels.
What remaining sources of risk can be identified?	Existing contaminants in soil remain; however, the alternative minimizes human and biological exposure. Additionally, crib and pipeline voids will be grouted to eliminate risk of collapse and contaminant transport through pipelines.
What is the likelihood that the technologies will meet performance needs?	High likelihood barrier will meet performance needs. The design life (500 years) exceeds necessary decay time. Annual surface monitoring will indicate need for maintenance and/or repair of the barrier. Institutional controls and environmental monitoring are proven technologies that have been successfully implemented at the Hanford Site.
What type, degree, and requirement of long-term management is required?	Long-term maintenance of the barrier and environmental monitoring will be conducted. Additionally, institutional controls will be maintained until contaminants decay to acceptable levels.
What O&M functions must be performed?	Maintenance, monitoring, and institutional controls.
What difficulties may be associated with long-term O&M?	None.
What is the potential need for replacement of technical components?	Maintenance/surveillance of barrier, and replacement of monitoring equipment may be necessary. Review of monitoring parameters and frequency will occur at each 5 year review to determine if a change may be appropriate. The barrier is designed to be free of significant maintenance for 500 years.
What is the magnitude of risk should the remedial action need replacement?	Magnitude of risks will be dependent upon time remedial action needs replacement since contaminants naturally decay. Should the barrier need replacement, risks from intrusion and upward migration will be at unacceptable levels until contaminants decay to acceptable levels. However, replacement is highly unlikely.
What is the degree of confidence that controls can adequately handle potential problems?	High degree of confidence. Control technologies implemented under this alternative are judged to be highly reliable. Furthermore, technological components of this alternative provide some degree of protective redundancy (i.e., the barrier eliminates exposure to contaminants if access restrictions fail to eliminate inadvertent intrusion). Additionally, the biointrusion layer (basalt cobble) indicates to the inadvertent human intruder that a surface barrier exists, and that contamination may be present in the subsurface soils.
What are the uncertainties associated with land disposal of residuals and untreated waste.	Not applicable.
Will the alternative provide long-term protection of natural resources?	The barrier will limit the direct exposure pathways to plants and animals. Limited maintenance/surveillance may be required to retain the integrity of the barrier.
Will terrestrial habitats be degraded or enhanced?	The barrier will be void of vegetation; therefore, enhancements are not anticipated.
How will the remedial action effect overall quality of the ecosystem?	The barrier is maintained free of vegetation and will not provide usable habitat.

Table H-3 Sites With Short-Lived Contaminants Void Grout (where applicable)/Biointrusion Barrier (continued)

Reduction of Toxicity, Mobility, or Volume	
Does the treatment process address the principal threats?	No treatment proposed. However, exposure to the waste management worker and biological receptors are addressed by limiting potential direct exposure pathways. There is no anticipated threat to groundwater (see Appendix B).
Are there any special requirements for the treatment process?	Not applicable.
What portion of the contaminated material is treated/destroyed?	No treatment is proposed.
To what extent is the total mass of toxic contaminants reduced?	No induced mass reduction of contaminants, however, RESRAD modeling predicts contaminants will naturally decay to acceptable levels.
To what extent is the mobility of contaminants reduced?	No treatment is proposed. There is no anticipated impact to groundwater as discussed in Appendix B.
To what extent are the effects of the treatment irreversible?	Components of this alternative are not considered irreversible. The biointrusion layer and soil cover can be removed with standard construction/demolition equipment.
What are the quantities of residuals and characteristics of the residual risk?	Contaminated materials remain in place. Exposure to these contaminants is prevented by application of a biointrusion barrier and implementation of institutional controls.
What risks do treatment of residuals pose?	None. No treatment of residuals is proposed.
Is treatment used to reduce inherent hazards posed by principal threats at the site?	No treatment is proposed.
How does the proposed treatment impact natural resources?	Short-term impacts (roads, borrow pits) would be compensated by long-term gains in natural resource quality. Natural materials are used in the construction of the barrier.
Does the alternative result in a gain or loss of quality at the site for natural resources?	Contaminant migration is limited; however, no ecosystem enhancements are provided.
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, seasonal restrictions on habitat use?	At the present time, the majority of the waste sites are disturbed; therefore, additional impacts as a result of short-term activities will be minimal. Impact abatement efforts will include scheduling activities to reduce intrusion during sensitive life stages, controlling fugitive dust, and establishing buffer zones if needed.
Will the natural resource restoration activities associated with this alternative be easily implemented?	No restoration activities are proposed; however, biointrusion is controlled by the barrier.
Will long-term maintenance and monitoring of mitigation/restoration efforts and activities be necessary?	Maintenance and monitoring will be required to ensure biointrusion control efforts are successful.

Table H-3 Sites With Short-Lived Contaminants Void Grout (where applicable)/Biointrusion Barrier (continued)

Short-Term Effectiveness	
What are the risks to the community during remedial actions, and how will they be mitigated?	None. No risks to the community exist given the site's isolated location and waste management designation.
What risks remain to the community that cannot be readily controlled?	None.
What are the risks to the workers, and how will they be mitigated?	Exposure to contaminants via fugitive dust inhalation, ingestion of contaminated soils, and external exposure to radionuclides will be controlled by implementing appropriate health and safety procedures.
What risks remain to the workers that cannot be readily controlled?	None.
What environmental impacts are expected with the construction and implementation of the alternative?	None. Potential impacts from fugitive dust, etc., will be abated by implementing appropriate contamination control measures.
What are the impacts that cannot be avoided should the alternative be implemented?	Given the presence of the barrier, topographic changes in landscape are inevitable.
How long until remedial response objectives are achieved?	The RAOs are achieved upon construction of the barrier and implementation of institutional controls.

Table H-3 Sites With Short-Lived Contaminants Void Grout (where applicable)/Biointrusion Barrier (continued)

Implementability	
What difficulties and uncertainties are associated with construction?	Lateral extent of contamination is not well defined for most sites. Investigations may be necessary to locate and plan extent of the barrier.
What is the likelihood that technical problems will lead to schedule delays?	None.
What likely future remedial actions are anticipated?	This alternative may constitute final action. However, alternative actions may be selected at a later date and documented in the final ROD for the operable unit. This alternative is compatible with potential future actions; however, the barrier may have to be removed.
What risks of exposure exist should monitoring be insufficient to detect failure?	Should the barrier fail, there is not an immediate potential for human and ecological exposure to contaminants; however, institutional controls should limit intrusion to the site, thereby decreasing potential for exposure.
What activities are proposed that require coordination with other agencies?	Long-term DOE waste management activities will require coordination with state groundwater agencies and with local zoning authorities.
Are adequate treatment, storage capacity, and disposal services available?	Not applicable.
Are necessary equipment and specialists available?	Yes. Alternative components are established technologies. Construction equipment and materials are readily obtainable, and most materials are available onsite.
Are technologies under consideration generally available and sufficiently demonstrated or will they require further development before they can be applied at the site?	Alternative components are established technologies. Surface barriers, institutional controls, and environmental monitoring are proven technologies currently implemented at the Hanford Site.
Will more than one vendor be available to provide a competitive bid?	Yes. Several general earthwork and barrier construction contractors exist locally. Many equipment vendors are available to supply monitoring equipment.

Table H-4 Sites With Short-Lived Contaminants Void Grout (where applicable)/Excavate/Dispose

Overall Protection of Human Health and the Environment	
Will risk be at acceptable levels?	Yes. All contaminants resulting in unacceptable exposure are removed and placed in an engineered disposal facility, and underground voids will be grouted to abate risk of collapse.
Timeframe to achieve acceptable levels?	Acceptable levels will be achieved upon completion of the remedial action, which is expected to be within 1 year for each site. Remediation will need to be coordinated with nearby active unit decommissioning and with site utilities.
Will the alternative pose any unacceptable short-term or crossmedia impacts?	No additional unacceptable impacts will be introduced by this alternative. Worker and crossmedia impact (i.e., fugitive dust, runon/runoff) can be controlled during construction by developing and implementing appropriate control measures.
Will the alternative impact natural resources?	Excavation and transportation activities may present short-term impacts (roads, borrow pits, etc.) on cultural and natural resources in adjacent areas. However, this alternative will improve existing conditions over the long-term as it removes contaminants from the site, and provides for regrading and revegetation.
What restoration actions may be necessary?	Restoration actions would include revegetation and regrading.
Will residual contamination (following remediation) be a potential problem?	There will be no residual waste resulting in an unacceptable exposure during waste management activities.

Table H-4 Sites With Short-Lived Contaminants Void Grout (where applicable)/Excavate/Dispose (continued)

Compliance with ARAR	
What are the potential ARAR?	Cultural *Archeological and Historic Preservation Act* Title 16 USC 469a Native American Graves Protection and Repatriation Act Public Law 101-601 as amended *National Historic Preservation Act of 1966* Title 16 USC 470 *Endangered Species Act of 1973* Title 16 USC 1531 et seq Radioactive 10 CFR 61 Subpart C 10 CFR 20 Nuclear Regulatory Standards for Protection Against Radiation 10 CFR 835 WAC 246-221 Radiation Protection Standards Waste 40 CFR 268 Land Disposal Restrictions WAC 173-303-070 Designation of Waste WAC 173-303-090 Dangerous Waste Characteristics WAC 173-303-100 Dangerous Waste Criteria WAC 173-303-140 Land Disposal Restrictions WAC 173-303-150 Division, Dilution and Accumulation WAC 173-303-160 Containers WAC 173-303-170 Requirements for Generators of Dangerous Waste WAC 173-303-200 Accumulation Dangerous Waste Onsite WAC 173-303-300 General Waste Analysis WAC 173-303-395 Other General Requirements WAC 173-303-630 Use and Management of Containers WAC 173-340-360 Selection of Cleanup Actions WAC 173-340-700 - 760 Model Toxics Control Regulations Air 40 CFR 50 National Ambient Air Quality Standards 40 CFR 61 National Emission Standards for Hazardous Air Pollutants (NESHAPS), Subpart H- National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities WAC 173-400 General Regulations for Air Pollution WAC 173-400-040 General Standards for Maximum Emissions WAC 173-400-075 Emissions Standards for Sources Emitting Hazardous Air Pollutants WAC 173-403 Implementations of Regulations for Air Contaminant Sources WAC 173-460 Controls for Sources of Toxic Air Pollutants WAC 173-470 Ambient Air Quality Standards for Particulate Matter WAC 173-480 Ambient Air Quality Standards and Emission Limits for Radionuclides WAC 246-247 Radiation Protection - Air Emissions
Will the potential ARAR listed above be met? How?	Yes. Cultural and natural resources will be protected to ensure impacts are minimized and/or mitigated. Current historical records and procedures will be used if discovery of a historical or ecological site is located at a site. Radioactive protection and management of radioactive material will be accomplished in accordance with current site safety and management procedures. Waste management including hazardous and mixed waste will be accomplished by the proper characterization, handling and disposing of the waste using existing facility procedures, or by developing regulatory-approved procedures, if necessary. Air and water quality will be maintained and monitored using existing site-monitoring networks and procedures.
Basis for waivers?	Currently no waiver being requested under CERCLA for this alternative.
What are the potential TBC?	Cultural Washington Natural Heritage Program RCW 79.70 Radioactive 40 CFR 196 Radiation Site Cleanup Standards Waste Waste Acceptance Criteria for the Environmental Restoration Disposal Facility, Hanford Site, Washington
Is the alternative consistent with the TBC listed above?	Yes. Current programs and procedures being used to manage the site today include procedures and standards to ensure compliance is achieved for the requirements listed as TBCs. No changes are expected by implementing this alternative.

Table H-4 Sites With Short-Lived Contaminants Void Grout (where applicable)/Excavate/Dispose (continued)

Long-Term Effectiveness and Permanence	
What is the magnitude of the remaining risk?	Contaminated material resulting in an unacceptable exposure is removed from the site and placed in an engineered disposal facility. Voids presenting a risk of collapse will be void grouted. Contaminants remaining at depth are not anticipated to impact groundwater.
What remaining sources of risk can be identified?	None. All sources of risk to the waste management worker resulting from unacceptable exposure to contaminants are removed. However, contaminants may be left in place below depth of excavation, but no impact to groundwater is anticipated as discussed in Appendix B.
What is the likelihood that the technologies will meet performance needs?	Excavation and disposal are established technologies that meet or exceed performance requirements.
What type, degree, and requirement of long-term management is required?	Waste will require long-term management at the disposal facility. No O&M functions will be required at the waste site.
What O&M functions must be performed?	Waste will require long-term O&M at the disposal facility.
What difficulties may be associated with long-term O&M?	None.
What is the potential need for replacement of technical components?	Not applicable.
What is the magnitude of risk should the remedial action need replacement?	The action is permanent; therefore replacement is not anticipated.
What is the degree of confidence that controls can adequately handle potential problems?	Standard earth-moving equipment is well established for use in soil excavations and contamination controls are easily implemented. Technologies will adequately handle potential problems.
What are the uncertainties associated with land disposal of residuals and untreated waste.	The contaminated material is transferred to the disposal facility. Waste-acceptance criteria and design of the disposal facility are being developed in consideration of receiving contaminated material from the Hanford Site; therefore, waste should be readily accepted.
Will the alternative provide long-term protection of natural resources?	Removing the waste from the site and revegetating will allow for reestablishment of a near-natural or natural environment. Short-term maintenance will be required to ensure successful revegetation, but long-term maintenance should not be required.
Will terrestrial habitats be degraded or enhanced?	Removing waste and revegetating the clean fill will enhance terrestrial habitat. Absence of waste at the site should allow the development of an improved (compared to present conditions) or near-natural ecosystems.
How will the remedial action effect overall quality of the ecosystem?	Revegetation will improve the overall quality of the ecosystem. Habitat enhancement at the site will improve the stability and quality of the terrestrial ecosystem in the area.

Table H-4 Sites With Short-Lived Contaminants Void Grout (where applicable)/Excavate/Dispose (continued)

Reduction of Toxicity, Mobility, or Volume	
Does the treatment process address the principal threats?	No treatment is proposed; however, contaminated material resulting in unacceptable exposure is removed and placed at an engineered disposal facility.
Are there any special requirements for the treatment process?	Not applicable.
What portion of the contaminated material is treated/destroyed?	No treatment is proposed; however, all contaminated material is disposed of in an engineered facility. Contaminants will naturally decay to acceptable levels.
To what extent is the total mass of toxic contaminants reduced?	None. No mass reduction is proposed.
To what extent is the mobility of contaminants reduced?	Although no treatment is proposed, contaminant mobility will be reduced by placement in an engineered disposal facility.
To what extent are the effects of the treatment irreversible?	Disposal of the waste in an engineered facility is considered irreversible.
What are the quantities of residuals and characteristics of the residual risk?	Contaminants may be left in place below the excavation; however, no impact to groundwater is anticipated, as discussed in Appendix B.
What risks do treatment of residuals pose?	None. No treatment of residuals is proposed.
Is treatment used to reduce inherent hazards posed by principal threats at the site?	No treatment is proposed.
How does the proposed treatment impact natural resources?	No treatment is proposed. Construction activities would have an immediate effect (roads, borrow pits, etc.) on natural resources; however, short-term effects would be outweighed by long-term gains in natural resource quality.
Does the alternative result in a gain or loss of quality at the site for natural resources?	The alternative would improve natural resource quality.
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, seasonal restrictions on habitat use)?	No treatment is proposed. Construction activities would have an immediate effect (roads, borrow pits, etc.) on natural resources; however, short-term effects would be outweighed by long-term gains in natural resource quality. Impact abatement efforts will include scheduling activities to reduce intrusion during sensitive life stages, controlling fugitive dust, and establishing buffer zones, if needed.
Will the natural resource restoration activities associated with this alternative be easily implemented?	Revegetation and restoration techniques are available and can be implemented.
Will long-term maintenance and monitoring of mitigation/restoration efforts and activities be necessary?	Maintenance and monitoring will be required to ensure that revegetation and restoration efforts are successful.

Table H-4 Sites With Short-Lived Contaminants Void Grout (where applicable)/Excavate/Dispose (continued)

Short-Term Effectiveness	
What are the risks to the community during remedial actions, and how will they be mitigated?	None. No risks to the community exist given the site's isolated location and waste management designation.
What risks remain to the community that cannot be readily controlled?	None.
What are the risks to the workers, and how will they be mitigated?	Exposure to contaminants via fugitive dust inhalation, ingestion of contaminated soils and external exposure to radionuclides will be controlled through the implementation of appropriate health and safety procedures.
What risks remain to the workers that cannot be readily controlled?	None.
What environmental impacts are expected with the construction and implementation of the alternative?	None. Potential impacts will be abated by implementing appropriate contamination control measures.
What are the impacts that cannot be avoided should the alternative be implemented?	Soils would be placed at the site as backfill. Backfill soils would be obtained from an onsite borrow area.
How long until remedial response objectives are achieved?	The RAOs are achieved upon completion of the remedial action.

Table H-4 Sites With Short-Lived Contaminants Void Grout (where applicable)/Excavate/Dispose (continued)

Implementability	
What difficulties and uncertainties are associated with construction?	The lateral extent of contamination has not been adequately defined; however, the actual extent will be delineated during excavation.
What is the likelihood that technical problems will lead to schedule delays?	None.
What likely future remedial actions are anticipated?	Although this interim action will likely constitute final action for the site, additional remedial actions may be selected at a later date and documented in the final ROD for the operable unit. This alternative is compatible with potential future actions.
What risks of exposure exist should monitoring be insufficient to detect failure?	None. No monitoring is associated with alternative.
What activities are proposed which require coordination with other agencies?	None.
Are adequate treatment, storage capacity, and disposal services available?	Yes. The ERDF will be available in 1996.
Are necessary equipment and specialists available?	Yes. Alternative components are established technologies. Construction equipment and materials are readily obtainable and most materials are available onsite.
Are technologies under consideration generally available and sufficiently demonstrated or will they require further development before they can be applied at the site?	Alternative components are established technologies and have been demonstrated at the Hanford Site.
Will more than one vendor be available to provide a competitive bid?	Yes. Several general earthwork and construction contractors exist locally. Analytical equipment is available from equipment vendors.

Table H-5 Sites With Long-Lived Radionuclides No Action

Overall Protection of Human Health and the Environment	
Will risk be at acceptable levels?	Because of the plutonium-239 and americium-241 (long-lived radionuclides) present in the Z-Ditches, decay is not a factor in the remedial action evaluation. Therefore, the high concentrations of these COPCs could represent unacceptable risk to workers if the existing covers were breached or eroded. This possibility exists because no actions are taken to maintain protection. The RESRAD modeling suggests a dose of 138 mrem/yr for americium-241 and 52,000 mrem/yr for plutonium-239/240.
Timeframe to achieve acceptable levels?	Long half-lives of contaminants result in long-term unacceptable exposure.
Will the alternative pose any unacceptable short-term or crossmedia impacts?	Yes. No action results in unacceptable exposure to the waste management worker. No crossmedia impacts are anticipated. An impact to groundwater is not anticipated (see Appendix B).
Will the alternative impact natural resources?	The site will be left in its current condition. No additional impacts are anticipated as a result of this alternative.
What restoration actions may be necessary?	No restoration is proposed.
Will residual contamination (following remediation) be a potential problem?	Contamination resulting in exposures above acceptable levels exists at the site.

Table H-5 Sites With Long-Lived Radionuclides No Action (continued)

Compliance with ARAR	
What are the potential ARAR?	Radioactive 10 CFR 61 Subpart C 10 CFR 20 Nuclear Regulatory Standards for Protection Against Radiation 10 CFR 835 WAC 246-221 Radiation Protection Standards Waste WAC 173-303-070 Designation of Waste WAC 173-303-090 Dangerous Waste Characteristics WAC 173-303-100 Dangerous Waste Criteria WAC 173-340-700 - 760 Model Toxics Control Regulations Air 40 CFR 61 National Emission Standards for Hazardous Air Pollutants (NESHAPS), Subpart H- National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities WAC 246-247 Radiation Protection - Air Emissions
Will the potential ARAR listed above be met? How?	Radioactive protection and management of radioactive material will be accomplished in accordance with current site safety and management procedures. Waste management including hazardous and mixed waste, will be accomplished by the proper characterization, handling and disposing of the waste using existing facility procedures, or by developing regulatory-approved procedures, if necessary. Air and water quality will be maintained and monitored using existing site monitoring networks and procedures.
Basis for waivers?	Currently no waiver is being requested under CERCLA for this alternative.
What are the potential TBC?	Radioactive 40 CFR 196 Radiation Site Cleanup Standards
Is the alternative consistent with the TBC listed above?	Yes. Current programs and procedures being used to manage the site today include procedures and standards to ensure compliance is achieved for the requirements listed as TBCs. No changes are expected by implementing this alternative.

Table H-5 Sites With Long-Lived Radionuclides No Action (continued)

Long-Term Effectiveness and Permanence	
What is the magnitude of the remaining risk?	Results of QRA for the 216-U-10 Pond (analogue site) indicate total ICR = 1×10^{-2}. RESRAD modeling suggests dose of 138 mrem/yr for americium-241 and 52,000 mrem/yr for plutonium-239/240.
What remaining sources of risk can be identified?	Existing contaminants in soil remain and may be accessed by the waste management worker, burrowing animals and deep rooted plants.
What is the likelihood that the technologies will meet performance needs?	Not applicable. No technologies are associated with the No Action alternative for this site.
What type, degree, and requirement of long-term management is required?	None.
What O&M functions must be performed?	None.
What difficulties may be associated with long-term O&M?	Not applicable.
What is the potential need for replacement of technical components?	Not applicable.
What is the magnitude of risk should the remedial action need replacement?	Not applicable.
What is the degree of confidence that controls can adequately handle potential problems?	Not applicable.
What are the uncertainties associated with land disposal of residuals and untreated waste.	Not applicable.
Will the alternative provide long-term protection of natural resources?	No. Contamination resulting in an unacceptable exposure currently exists, and the alternative provides no restoration or environmental enhancements.
Will terrestrial habitats be degraded or enhanced?	There will be no change from current terrestrial habitat quality.
How will the remedial action affect the overall quality of the ecosystem?	Because no action is taken, the quality of the ecosystem will remain in its current condition. Over time, plants and animals may bring contaminants to the surface.

Table H-5 Sites With Long-Lived Radionuclides No Action (continued)

Reduction of Toxicity, Mobility, or Volume	
Does the treatment process address the principal threats?	Not applicable. No treatment is proposed.
Are there any special requirements for the treatment process?	Not applicable.
What portion of the contaminated material is treated/destroyed?	No treatment is proposed.
To what extent is the total mass of toxic contaminants reduced?	No induced mass reduction of contaminants.
To what extent is the mobility of contaminants reduced?	None. No treatment is proposed. No impact to groundwater is anticipated (Appendix B).
To what extent are the effects of the treatment irreversible?	No treatment is proposed.
What are the quantities of residuals and characteristics of the residual risk?	Contaminated materials remain in place. Risks are unacceptable because of the potential for unprotected workers to be exposed to the waste through intrusion or erosion of existing cover or through biological processes.
What risks do treatment of residuals pose?	None. No treatment of residuals is proposed.
Is treatment used to reduce inherent hazards posed by principal threats at the site?	No treatment is proposed.
How does the proposed treatment impact natural resources?	No treatment is proposed.
Does the alternative result in a gain or loss of quality at the site for natural resources?	No change would result, leaving the site in its current condition.
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, seasonal restrictions on habitat use)?	No impact because no additional action is proposed.
Will the natural resource restoration activities associated with this alternative be easily implemented?	No restoration proposed.
Will long-term maintenance and monitoring of mitigation/restoration efforts and activities be necessary?	No mitigation/restoration proposed.

Table H-5 Sites With Long-Lived Radionuclides
No Action (continued)

Short-Term Effectiveness	
What are the risks to the community during remedial actions, and how will they be mitigated?	None. No risks to the community exist given the site's isolated location and waste management designation.
What risks remain to the community that cannot be readily controlled?	None.
What are the risks to the workers, and how will they be mitigated?	The only potential exposure of workers results from unabated access to contaminants at the site. Under this alternative, no action will be taken that introduce short-term risk to workers.
What risks remain to the workers that cannot be readily controlled?	None.
What environmental impacts are expected with the construction and implementation of the alternative?	None. No action is taken.
What are the impacts that cannot be avoided should the alternative be implemented?	Not applicable.
How long until remedial response objectives are achieved?	Contaminants will not decay to acceptable levels in the foreseeable future.

Table H-5 Sites With Long-Lived Radionuclides No Action (continued)

Implementability	
What difficulties and uncertainties are associated with construction?	None. No construction is proposed.
What is the likelihood that technical problems will lead to schedule delays?	Not applicable.
What likely future remedial actions are anticipated?	Although this interim remedy consists of No Action, other remedial actions may be selected at a later date and documented in the final ROD for the operable unit. This alternative is completely compatible with any potential future action.
What risks of exposure exist should monitoring be insufficient to detect failure?	No monitoring is proposed.
What activities are proposed which require coordination with other agencies?	None.
Are adequate treatment, storage capacity, and disposal services available?	Not applicable.
Are necessary equipment and specialists available?	Not applicable.
Are technologies under consideration generally available and sufficiently demonstrated or will they require further development before they can be applied at the site?	Not applicable.
Will more than one vendor be available to provide a competitive bid?	Not applicable.

Table H-6 Sites With Long-Lived Radionuclides Surveillance and Maintenance

Overall Protection of Human Health and the Environment	
Will risk be at acceptable levels?	Yes. This alternative prevents inadvertent human intrusion by using access restrictions in the short-term. Exposure to contaminants is controlled, and any authorized access would require appropriate health and safety measures. Periodic maintenance would include controlling growth of deep-rooted plants and inhabitation of burrowing animals and nesting insects. Because of the long-lived COPC additional future actions beyond the scope of the IRM are anticipated.
Timeframe to achieve acceptable levels?	Exposure pathways will be minimized immediately upon implementation of this alternative. Contamination resulting in unacceptable exposure will be present for many years due to long-lived radionuclides.
Will the alternative pose any unacceptable short-term or crossmedia impacts?	No additional unacceptable impacts will be introduced by this alternative. Worker and crossmedia impact (i.e., fugitive dust, runon/runoff) can be controlled during monitoring and maintenance by developing and implementing appropriate control measures. An impact to groundwater is not anticipated (Appendix B).
Will the alternative impact natural resources?	The site will be left in its current condition. No additional impacts are anticipated as a result of this alternative.
What restoration actions may be necessary?	No restoration is proposed.
Will residual contamination (following remediation) be a potential problem?	Contamination resulting in exposures above acceptable levels remain at the site; however, exposure to contaminants will be controlled in the short-term. Contaminants will remain for many years due to long-lived radionuclides.

Table H-6 Sites With Long-Lived Radionuclides Surveillance and Maintenance (continued)

Compliance with ARAR	
What are the potential ARAR?	Cultural *National Historic Preservation Act of 1966* Title 16 USC 470 *Endangered Species Act of 1973* Title 16 USC 1531 et seq Radioactive 10 CFR 20 Nuclear Regulatory Standards for Protection Against Radiation 10 CFR 61 Subpart C 10 CFR 835 WAC 246-221 Radiation Protection Standards Waste WAC 173-303-645 Releases from Regulated Units WAC 173-303-610 Closure and Post-Closure (only applicable for RCRA unit at U12) WAC 173-340-700 - 304-760 Model Toxics Control Regulations Air 40 CFR 61 National Emission Standards for Hazardous Air Pollutants (NESHAPS), Subpart H- National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities WAC 173-480 Ambient Air Quality Standards and Emission Limits for Radionuclides WAC 246-247 Radiation Protection - Air Emissions
Will the potential ARAR listed above be met? How?	Yes. Cultural and natural resources will be protected to ensure impacts are minimized and/or mitigated. Current historical records and procedures will be used if discovery of a historical or ecological site is located at a site. Radioactive protection and management of radioactive material will be accomplished in accordance with current site safety and management procedures. Waste management including hazardous and mixed waste, will be accomplished by the proper characterization, handling and disposing of the waste using existing facility procedures, or be developing regulatory-approved procedures if necessary. Air and water quality will be maintained and monitored using existing site monitoring networks and procedures. These requirements are applicable only if implementation actions of the controls at the site cause a disturbance of the current configuration (i.e., additional vegetation cover, installing a fence, moving soil)
Basis for waivers?	Currently no waiver is being requested under CERCLA for this alternative.
What are the potential TBC?	Cultural Washington Natural Heritage Program RCW 79.70 Radioactive 40 CFR 196 Radiation Site Cleanup Standards
Is the alternative consistent with the TBC listed above?	Yes. Current programs and procedures being used to manage the site today include procedures and standards to ensure compliance is achieved for the requirements listed as TBCs. No changes are expected by implementing this alternative.

Table H-6 Sites With Long-Lived Radionuclides Surveillance and Maintenance (continued)

Long-Term Effectiveness and Permanence	
What is the magnitude of the remaining risk?	Long-lived radionuclides will remain onsite for thousands of years. The interim action will minimize exposure to below acceptable levels.
What remaining sources of risk can be identified?	Existing contaminants in soil remain; however, the alternative minimizes human exposure to contaminants in the short-term. Ecological exposure may occur, but application of herbicides/pesticides should minimize spread of contamination by biological intruders.
What is the likelihood that the technologies will meet performance needs?	Institutional controls and environmental monitoring are proven technologies that have been successfully implemented at the Hanford Site.
What type, degree, and requirement of long-term management is required?	Institutional controls and environmental monitoring would be required indefinitely or until final action.
What O&M functions must be performed?	Maintenance, monitoring, and institutional controls.
What difficulties may be associated with long-term O&M?	None.
What is the potential need for replacement of technical components?	Maintenance and repair of fencing, signs, existing soil covers, and replacement of monitoring equipment may be necessary. Review of monitoring parameters and frequency will occur at each 5 year review to determine if a change may be appropriate.
What is the magnitude of risk should the remedial action need replacement?	Magnitude of risks will be dependent upon the time remedial action needs replacement since contaminants naturally decay. Without appropriate controls, risks will be at unacceptable levels for many years because of long-lived radionuclides.
What is the degree of confidence that controls can adequately handle potential problems?	High degree of confidence in the near-term. Institutional controls are reliable; however, should institutional controls fail, there is some potential for human and ecological exposure to contaminants. Existing clean soil cover present at most sites would minimize near-term exposure.
What are the uncertainties associated with land disposal of residuals and untreated waste.	Not applicable.
Will the alternative provide long-term protection of natural resources?	Exposure to contamination above acceptable levels will be controlled, but the alternative provides no restoration or environmental enhancements.
Will terrestrial habitats be degraded or enhanced?	There will be no change from current terrestrial habitat quality.
How will the remedial action affect the overall quality of the ecosystem?	Because no action is taken, the quality of the ecosystem will remain in its current condition.

Table H-6 Sites With Long-Lived Radionuclides Surveillance and Maintenance (continued)

Reduction of Toxicity, Mobility, or Volume	
Does the treatment process address the principal threats?	No treatment is proposed. However, exposure to contaminants is controlled by implementing institutional controls.
Are there any special requirements for the treatment process?	Not applicable.
What portion of the contaminated material is treated/destroyed?	Implementation of this alternative results in all of the contaminants remaining in place.
To what extent is the total mass of toxic contaminants reduced?	No induced mass reduction of contaminants.
To what extent is the mobility of contaminants reduced?	No treatment is proposed to reduce mobility; however, no impact to groundwater is anticipated (Appendix B).
To what extent are the effects of the treatment irreversible?	No treatment is proposed.
What are the quantities of residuals and characteristics of the residual risk?	Contaminated materials remain in place. Exposure to these contaminants is prevented by implementing institutional controls.
What risks do treatment of residuals pose?	None. No treatment of residuals is proposed.
Is treatment used to reduce inherent hazards posed by principal threats at the site?	No treatment is proposed. However, institutional control will limit exposure to contaminants, thereby reducing threats at the site.
How does the proposed treatment impact natural resources?	No treatment is proposed.
Does the alternative result in a gain or loss of quality at the site for natural resources?	No change would result, leaving the site in its current condition.
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, seasonal restrictions on habitat use)?	No short-term impact on natural resources.
Will the natural resource restoration activities associated with this alternative be easily implemented?	No restoration is proposed.
Will long-term maintenance and monitoring of mitigation/restoration efforts and activities be necessary?	No restoration is proposed.

Table H-6 Sites With Long-Lived Radionuclides Surveillance and Maintenance (continued)

Short-Term Effectiveness	
What are the risks to the community during remedial actions, and how will they be mitigated?	None. No risks to the community exist given the site's isolated location and waste management designation.
What risks remain to the community that cannot be readily controlled?	None.
What are the risks to the workers, and how will they be mitigated?	Exposure to contaminants via fugitive dust inhalation ingestion of contaminated soils, and external exposure to radionuclides will be controlled by implementing appropriate health and safety procedures.
What risks remain to the workers that cannot be readily controlled?	None.
What environmental impacts are expected with the construction and implementation of the alternative?	None. Potential impacts will be abated by implementing appropriate contamination control measures.
What are the impacts that cannot be avoided should the alternative be implemented?	None.
How long until remedial response objectives are achieved?	The RAOs are achieved immediately upon implementation of the alternative.

Table H-6 Sites With Long-Lived Radionuclides Surveillance and Maintenance (continued)

Implementability	
What difficulties and uncertainties are associated with construction?	None.
What is the likelihood that technical problems will lead to schedule delays?	None.
What likely future remedial actions are anticipated?	This interim remedy consists only of institutional controls, other remedial actions will likely be selected at a later date and documented in the final ROD for the operable unit. This alternative is completely compatible with any potential future action.
What risks of exposure exist should monitoring be insufficient to detect failure?	Should institutional controls fail, there is some potential for direct human and ecological exposure in the short-term to contaminants. However, existing clean soil cover present at most sites would minimize near-term exposure.
What activities are proposed that require coordination with other agencies?	Long-term deed restrictions and DOE waste management activities will require coordination with state groundwater agencies and with local zoning authorities.
Are adequate treatment, storage capacity, and disposal services available?	Not applicable.
Are necessary equipment and specialists available?	Yes. Alternative components are established technologies. Equipment and materials are readily obtainable and most materials are available onsite.
Are technologies under consideration generally available and sufficiently demonstrated or will they require further development before they can be applied at the site?	Institutional controls and environmental monitoring are proven technologies that have been successfully implemented at the Hanford Site.
Will more than one vendor be available to provide a competitive bid?	Yes. Several contractors exist locally. Many equipment vendors are available to provide monitoring equipment.

Table H-7 Sites With Long-Lived Radionuclides Void Grout (where applicable)/Biointrusion Barrier

Overall Protection of Human Health and the Environment	
Will risk be at acceptable levels?	Yes. This alternative prevents inadvertent intrusion to the site and provides a soil barrier of sufficient thickness to eliminate direct exposure to contaminants, generation of fugitive dust, and ingestion of contaminated soils. The biointrusion layer prevents deep-rooted plants and burrowing animals from bringing contaminants to the surface.
Timeframe to achieve acceptable levels?	Exposure pathways will be minimized upon implementation of this alternative. Institutional controls, maintenance, and monitoring will be conducted long-term or until final action.
Will the alternative pose any unacceptable short-term or crossmedia impacts?	No additional unacceptable impacts will be introduced by this alternative. Worker exposure and crossmedia impacts (i.e., fugitive dust, runon/runoff) can be controlled during construction by developing and implementing appropriate control measures. An impact to groundwater is not anticipated (Appendix B).
Will the alternative impact natural resources?	Construction and transportation activities may present short-term impacts (roads, borrow pits, recontouring) on cultural and natural resources in adjacent areas. However, this alternative will improve existing conditions over the long-term as it isolates waste.
What restoration actions may be necessary?	No restoration is anticipated.
Will residual contamination (following remediation) be a potential problem?	Waste will be left in place; however, the barrier will eliminate exposure to biological receptors by providing a bio-intrusion layer. Human exposure will also be eliminated due to access restrictions and the shielding provided by the cover.

Table H-7 Sites With Long-Lived Radionuclides Void Group (where applicable)/Biointrusion Barrier (continued)

Compliance with ARAR	
What are the potential ARAR?	Cultural *Archeological and Historic Preservation Act* Title 16 USC 469a *Native American Graves Protection and Repatriation Act* Public Law 101-601 as amended *National Historic Preservation Act* of 1966 Title 16 USC 470 *Endangered Species Act of 1973* Title 16 USC 1531 et seq Radioactive 10 CFR 61 Subpart C 10 CFR 20 Nuclear Regulatory Standards for Protection Against Radiation 10 CFR 835 WAC 246-221 Radiation Protection Standards Waste WAC 173-340-360 Selection of Cleanup Actions WAC 173-303-645 Releases from Regulated Units WAC 173-303-610 Closure and Post-Closure WAC 173-340-700 - 304-760 Model Toxics Control Regulations Air 40 CFR 61 National Emission Standards for Hazardous Air Pollutants (NESHAPS), Subpart H- National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities WAC 173-480 Ambient Air Quality Standards and Emission Limits for Radionuclides WAC 246-247 Radiation Protection - Air Emissions
Will the potential ARAR listed above be met? How?	Yes. Cultural and natural resources will be protected to ensure impacts are minimized and/or mitigated. Current historical records and procedures will be used if discovery of a historical or ecological site is located at a site. Radioactive protection and management of radioactive material will be accomplished in accordance with current site safety and management procedures. Waste management including hazardous and mixed waste will be accomplished by the proper characterization, handling and disposing of the waste using existing facility procedures, or be developing regulatory approved procedures if necessary. Air and water quality will be maintained and monitored using existing site monitoring networks and procedures.
Basis for waivers?	Currently no waiver is being requested under CERCLA for this alternative.
What are the potential TBC?	Cultural Washington Natural Heritage Program RCW 79.70 Radioactive 40 CFR 196 Radiation Site Cleanup Standards
Is the alternative consistent with the TBC listed above?	Yes. Current programs and procedures being used to manage the site today include procedures and standards to ensure compliance is achieved for the requirements listed as TBCs. No changes are expected by implementing this alternative.

Table H-7 Sites With Long-Lived Radionuclides Void Group (where applicable)/Biointrusion Barrier (continued)

Long-Term Effectiveness and Permanence	
What is the magnitude of the remaining risk?	The barrier minimizes exposure in the short-term; however, long-lived radionuclides at high concentration are left on site beyond the 500 year design life.
What remaining sources of risk can be identified?	Existing contaminants in soil remain, however, the alternative minimizes human and biological exposure.
What is the likelihood that the technologies will meet performance needs?	High likelihood barrier will meet performance needs in the near-term (up to 500 years). Annual surface monitoring will indicate need for maintenance and surveillance of the barrier. Institutional controls and environmental monitoring are proven technologies that have been successfully implemented at the Hanford Site. Due to the presence of long-lived radionuclides, future actions are anticipated.
What type, degree, and requirement of long-term management is required?	Long-term maintenance of the barrier and environmental monitoring will be conducted until final action.
What O&M functions must be performed?	Maintenance, monitoring, and institutional controls.
What difficulties may be associated with long-term O&M?	None.
What is the potential need for replacement of technical components?	Maintenance/repair of barrier, and replacement of monitoring equipment may be necessary. Review of monitoring parameters and frequency will occur at each 5 year review to determine if a change may be appropriate.
What is the magnitude of risk should the remedial action need replacement?	Magnitude of risks will be dependent upon time remedial action needs replacement.
What is the degree of confidence that controls can adequately handle potential problems?	High degree of confidence in the near-term. Control technologies implemented under this alternative are judged to be highly reliable. Furthermore, technological components of this alternative provide some degree of protective redundancy (i.e., the barrier eliminates exposure to contaminants if access restrictions fail to eliminate inadvertent intrusion). Additionally, the biointrusion layer (basalt cobble) indicates to the inadvertent human intruder that a surface barrier exists, and that contamination may be present in the subsurface soils.
What are the uncertainties associated with land disposal of residuals and untreated waste.	Not applicable.
Will the alternative provide long-term protection of natural resources?	The barrier will limit the direct exposure pathways to plants and animals. Maintenance may be required to retain the integrity of the barrier.
Will terrestrial habitats be degraded or enhanced?	The barrier will be void of vegetation. Future changes in barrier integrity should have only limited influence on the terrestrial ecosystem.
How will the remedial action effect overall quality of the ecosystem?	The barrier is maintained free of vegetation and will not provide usable habitat.

Table H-7 Sites With Long-Lived Radionuclides Void Group (where applicable)/Biointrusion Barrier (continued)

Reduction of Toxicity, Mobility, or Volume	
Does the treatment process address the principal threats?	No treatment is proposed. However, exposure to a waste management worker and biological receptors are addressed by limiting potential direct exposure pathways. There is no anticipated threat to groundwater (see Appendix B).
Are there any special requirements for the treatment process?	Not applicable.
What portion of the contaminated material is treated/destroyed?	No treatment is proposed.
To what extent is the total mass of toxic contaminants reduced?	No induced mass reduction of contaminants.
To what extent is the mobility of contaminants reduced?	No treatment is proposed. There is no anticipated impact to groundwater (Appendix B).
To what extent are the effects of the treatment irreversible?	Components of this alternative are not considered irreversible. The biointrusion layer and soil cover can be removed with standard construction/demolition equipment.
What are the quantities of residuals and characteristics of the residual risk?	Contaminated materials remain in place. Exposure to these contaminants is prevented by application of a biointrusion barrier and implementing institutional controls.
What risks do treatment of residuals pose?	None. No treatment of residuals is proposed.
Is treatment used to reduce inherent hazards posed by principal threats at the site?	No treatment proposed.
How does the proposed treatment impact natural resources?	Short-term impacts (roads, borrow pits, etc.) would be compensated by long-term gains in natural resource quality. Natural materials are used in the construction of the barrier.
Does the alternative result in a gain or loss of quality at the site for natural resources?	Contaminant migration is limited; however, no ecosystem enhancements are provided.
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, seasonal restrictions on habitat use)?	At the present time, the majority of the waste sites are disturbed, therefore, additional impacts as a result of short-term activities will be minimal. Impact abatement efforts will include scheduling activities to reduce intrusion during sensitive life stages, controlling fugitive dust, and establishing buffer zones if needed.
Will the natural resource restoration activities associated with this alternative be easily implemented?	No restoration activities are proposed; however, biointrusion is controlled by the barrier.
Will long-term maintenance and monitoring of mitigation/restoration efforts and activities be necessary?	Maintenance and monitoring will be required to ensure that biointrusion control efforts are successful.

Table H-7 Sites With Long-Lived Radionuclides Void Group (where applicable)/Biointrusion Barrier (continued)

Short-Term Effectiveness	
What are the risks to the community during remedial actions, and how will they be mitigated?	None. No risks to the community exist given the site's isolated location and waste management designation.
What risks remain to the community that cannot be readily controlled?	None.
What are the risks to the workers, and how will they be mitigated?	Exposure to contaminants via fugitive dust inhalation, ingestion of contaminated soils and external exposure to radionuclides will be controlled by implementing appropriate health and safety procedures.
What risks remain to the workers that cannot be readily controlled?	None.
What environmental impacts are expected with the construction and implementation of the alternative?	None. Potential impacts from fugitive dust, etc., will be abated by implementing appropriate contamination control measures.
What are the impacts that cannot be avoided should the alternative be implemented?	Given the presence of the barrier, topographic changes in landscape are inevitable.
How long until remedial response objectives are achieved?	The RAOs are achieved upon construction of the barrier and implementation of institutional controls.

Table H-7 Sites With Long-Lived Radionuclides Void Group (where applicable)/Biointrusion Barrier (continued)

Implementability	
What difficulties and uncertainties are associated with construction?	Lateral extent of contamination is not well defined. Investigations may be necessary to locate and plan extent of the barrier.
What is the likelihood that technical problems will lead to schedule delays?	None.
What likely future remedial actions are anticipated?	This alternative will not likely constitute final action due to long-lived COPC. Alternative actions may be selected at a later date and documented in the Final ROD for the operable unit. This alternative is compatible with potential future actions; however, the barrier may have to be removed for some actions.
What risks of exposure exist should monitoring be insufficient to detect failure?	Should the barrier fail, there is some potential for human and ecological exposure to contaminants; however, institutional controls should limit intrusion to the site, thereby decreasing potential for exposure.
What activities are proposed that require coordination with other agencies?	Long-term deed restrictions will require coordination with state groundwater agencies and with local zoning authorities.
Are adequate treatment, storage capacity, and disposal services available?	Not Applicable.
Are necessary equipment and specialists available?	Yes. Alternative components are established technologies. Construction equipment and materials are readily obtainable and most materials are available onsite.
Are technologies under consideration generally available and sufficiently demonstrated or will they require further development before they can be applied at the site?	Alternative components are established technologies. Surface barriers, institutional controls, and environmental monitoring are proven technologies currently implemented at the Hanford Site.
Will more than one vendor be available to provide a competitive bid?	Yes. Several general earthwork and barrier construction contractors exist locally. Many equipment vendors are available to supply monitoring equipment.

Table H-8 Sites With Long-Lived Radionuclides
Void Grout (where applicable)/Excavate/Dispose

Overall Protection of Human Health and the Environment	
Will risk be at acceptable levels?	Yes. All contaminants resulting in unacceptable exposure are removed and placed in an engineered disposal facility.
Timeframe to achieve acceptable levels?	Acceptable levels will be achieved upon completion of the alternative.
Will the alternative pose any unacceptable short-term or crossmedia impacts?	No additional unacceptable impacts will be introduced by this alternative. Worker and crossmedia impact; (i.e., fugitive dust, runon/runoff) can be controlled during construction by developing and implementing appropriate control measures. Presence of TRU waste may require specialized waste-handling equipment.
Will the alternative impact natural resources?	Excavation and transportation activities may present short-term impacts (roads, borrow pits, etc.) on cultural and natural resources in adjacent areas. However, this alternative will improve existing conditions over the long-term, as it removes contaminants from the site and provides for regrading and revegetation.
What restoration actions may be necessary?	Restoration actions would include revegetation and regrading.
Will residual contamination (following remediation) be a potential problem?	There will be no residual waste resulting in an unacceptable exposure during waste management activities.

Table H-8 Sites With Long-Lived Radionuclides Void Grout (where applicable)/Excavate/Dispose (continued)

Compliance with ARAR	
What are the potential ARAR?	Cultural *Archeological and Historic Preservation Act* Title 16 USC 469a *Native American Graves Protection and Repatriation Act* Public Law 101-601 as amended *National Historic Preservation Act* of 1966 Title 16 USC 470 *Endangered Species Act* of 1973 Title 16 USC 1531 et seq Radioactive 10 CFR 61 Subpart C 10 CFR 20 Nuclear Regulatory Standards for Protection Against Radiation 10 CFR 835 WAC 246-221 Radiation Protection Standards Waste 40 CFR 268 Land Disposal Restrictions WAC 173-340-360 Selection of Cleanup Actions WAC 173-303-070 Designation of Waste WAC 173-303-100 Dangerous Waste Characteristics WAC 173-303-140 Land Disposal Restrictions WAC 173-303-150 Division, Dilution and Accumulation WAC 173-303-160 Containers WAC 173-303-170 Requirements for Generators of Dangerous Waste WAC 173-303-200 Accumulation Dangerous Waste Onsite WAC 173-303-395 Other General Requirements WAC 173-303-630 Use and Management of Containers WAC 173-340-700 - 304-760 Model Toxics Control Regulations Air 40 CFR 50 National Ambient Air Quality Standards 40 CFR 61 National Emission Standards for Hazardous Air Pollutants (NESHAPS), Subpart H- National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities WAC 246-247 Radiation Protection - Air Emissions WAC 173-400 General Regulations for Air Pollution WAC 173-400-040 General Standards for Maximum Emissions WAC 173-400-075 Emissions Standards for Sources Emitting Hazardous Air Pollutants WAC 173-403 Implementations of Regulations for Air Contaminant Sources WAC 173-460 Controls for sources of Air Pollution 173-460 WAC 173-470 Ambient Air Quality Standards for Particulate Matter WAC 173-480 Ambient Air Quality Standards and Emission Limits for Radionuclides WAC 246-247 Radiation Protection - Air Emissions
Will the potential ARAR listed above be met? How?	Yes. Cultural and natural resources will be protected to ensure impacts are minimized and/or mitigated. Current historical records and procedures will be used if discovery of a historical or ecological site is located at a site. Radioactive protection and management of radioactive material will be accomplished in accordance with current site safety and management procedures. Waste management, including hazardous and mixed waste will be accomplished by the proper characterization, handling and disposing of the waste using existing facility procedures, or be developing regulatory-approved procedures, if necessary. Air and water quality will be maintained and monitored using existing site-monitoring networks and procedures.
Basis for waivers?	Currently no waiver is being requested under CERCLA for this alternative.
What are the potential TBC?	Cultural Washington Natural Heritage Program RCW 79.70(TBC) Radioactive 40 CFR 196 Radiation Site Cleanup Standards Waste Waste Acceptance Criteria for the Environmental Restoration Disposal Facility, Hanford Site, Washington
Is the alternative consistent with the TBC listed above?	Yes. Current programs and procedures being used to manage the site today include procedures and standards to ensure compliance is achieved for the requirements listed as TBCs. No changes are expected by implementing this alternative.

Table H-8 Sites With Long-Lived Radionuclides Void Grout (where applicable)/Excavate/Dispose (continued)

Long-Term Effectiveness and Permanence	
What is the magnitude of the remaining risk?	Contaminated material resulting in an unacceptable exposure is removed from the site and placed in an engineered disposal facility. Contaminants remaining at depth are not anticipated to impact groundwater.
What remaining sources of risk can be identified?	None. All sources of risk to the waste management worker resulting from unacceptable exposure to contaminants are removed. However, contaminants may be left in place below depth of excavation, but no impact to groundwater is anticipated (Appendix B).
What is the likelihood that the technologies will meet performance needs?	Excavation and disposal are established technologies that meet or exceed performance requirements. Presence of TRU waste would require disposal in a geologic repository, however no such disposal facility is currently available.
What type, degree, and requirement of long-term management is required?	Waste will require long term management at the disposal facility. No O&M functions will be required at the waste site.
What O&M functions must be performed?	Waste will require long term O&M at the disposal facility.
What difficulties may be associated with long-term O&M?	None.
What is the potential need for replacement of technical components?	Not applicable.
What is the magnitude of risk should the remedial action need replacement?	The action is permanent; therefore replacement is not anticipated.
What is the degree of confidence that controls can adequately handle potential problems?	Standard earth moving equipment are well established for use in soil excavations and contamination controls are easily implemented. Technologies will adequately handle potential problems. Specialized handling equipment may be necessary if TRU waste is encountered.
What are the uncertainties associated with land disposal of residuals and untreated waste.	The contaminated material is transferred to the disposal facility. Waste acceptance criteria and design of the low-level waste disposal facility are being developed in consideration of receiving contaminated material from the Hanford Site, therefore waste should be readily accepted. A geologic repository for TRU waste currently is not available.
Will the alternative provide long-term protection of natural resources?	Removal of the waste from the site and revegetation will allow for reestablishment of a near-natural or natural environment. Short-term maintenance will be required to ensure successful revegetation, but long-term maintenance should not be required.
Will terrestrial habitats be degraded or enhanced?	Removal of wastes and revegetation of the clean fill will enhance terrestrial habitat. Absence of wastes at the site should allow the development of an improved (compared to present conditions) or near-natural ecosystems.
How will the remedial action effect overall quality of the ecosystem?	Revegetation will improve the overall quality of the ecosystem. Habitat enhancement at the site will improve the stability and quality of the terrestrial ecosystem in the area.

Table H-8 Sites With Long-Lived Radionuclides Void Grout (where applicable)/Excavate/Dispose (continued)

Reduction of Toxicity, Mobility, or Volume	
Does the treatment process address the principal threats?	No treatment is proposed; however, contaminated material resulting in unacceptable exposure is removed and placed at an engineered disposal facility.
Are there any special requirements for the treatment process?	Not applicable.
What portion of the contaminated material is treated/destroyed?	No treatment is proposed; however, all contaminated material is disposed of in an engineered facility.
To what extent is the total mass of toxic contaminants reduced?	None. No mass reduction is proposed.
To what extent is the mobility of contaminants reduced?	Although no treatment is proposed, contaminant mobility will be reduced by placement in an engineered disposal facility.
To what extent are the effects of the treatment irreversible?	Disposal of the waste in an engineered facility is considered irreversible.
What are the quantities of residuals and characteristics of the residual risk?	Contaminants may be left in place below the excavation; however, no impact to groundwater is anticipated (Appendix B).
What risks do treatment of residuals pose?	None. No treatment of residuals is proposed.
Is treatment used to reduce inherent hazards posed by principal threats at the site?	No treatment is proposed.
How does the proposed treatment impact natural resources?	No treatment is proposed. Construction activities would have an immediate effect (roads, borrow pits, etc.) on natural resources; however, short-term effects would be outweighed by long-term gains in natural resource quality.
Does the alternative result in a gain or loss of quality at the site for natural resources?	The alternative would improve natural resource quality.
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, seasonal restrictions on habitat use)?	No treatment is proposed. Construction activities would have an immediate effect (roads, borrow pits, etc.) on natural resources; however, short-term effects would be outweighed by long-term gains in natural resource quality. Impact abatement efforts will include scheduling activities to reduce intrusion during sensitive life stages, controlling fugitive dust, and establishing buffer zones, if needed.
Will the natural resource restoration activities associated with this alternative be easily implemented?	Revegetation and restoration techniques are available and can be implemented.
Will long-term maintenance and monitoring of mitigation/restoration efforts and activities be necessary?	Maintenance and monitoring will be required to ensure that revegetation and restoration efforts are successful.

Table H-8 Sites With Long-Lived Radionuclides Void Grout (where applicable)/Excavate/Dispose (continued)

Short-Term Effectiveness	
What are the risks to the community during remedial actions, and how will they be mitigated?	None. No risks to the community exist given the site's isolated location and waste management designation.
What risks remain to the community that cannot be readily controlled?	None.
What are the risks to the workers, and how will they be mitigated?	Exposure to contaminants via fugitive dust inhalation, ingestion of contaminated soils, and external exposure to radionuclides will be controlled by implementing appropriate health and safety procedures. Specialized handling practices may be required if TRU waste is encountered.
What risks remain to the workers that cannot be readily controlled?	None.
What environmental impacts are expected with the construction and implementation of the alternative?	None. Potential impacts will be abated by implementing appropriate contamination control measures.
What are the impacts that cannot be avoided should the alternative be implemented?	Soils would be placed at the site as backfill. Backfill soils would be obtained from an onsite borrow area.
How long until remedial response objectives are achieved?	The RAOs are achieved upon completion of the remedial action.

Table H-8 Sites With Long-Lived Radionuclides Void Grout (where applicable)/Excavate/Dispose (continued)

Implementability	
What difficulties and uncertainties are associated with construction?	Lateral extent of contamination is not well defined; however, the extent will be delineated during excavation. Additionally, there is a potential to encounter TRU waste; therefore, waste must be segregated as appropriate during removal. Removal and handling techniques for TRU waste may need to be tested before excavation.
What is the likelihood that technical problems will lead to schedule delays?	Presence of TRU waste may slow the process due to specialized handling requirements. Additionally a geologic repository for TRU waste is not currently available.
What likely future remedial actions are anticipated?	Although this interim action will likely constitute final action for the site, other remedial actions may be selected at a later date and documented in the final ROD for the operable unit. This alternative is compatible with potential future actions.
What risks of exposure exist should monitoring be insufficient to detect failure?	None. No monitoring is associated with the alternative.
What activities are proposed that require coordination with other agencies?	None.
Are adequate treatment, storage capacity, and disposal services available?	Yes. The ERDF will be available in 1996. The TRU waste requires disposal in a geologic repository. Currently there are no repositories available for TRU waste.
Are necessary equipment and specialists available?	Yes. Alternative components are established technologies. Construction equipment and materials are readily obtainable and most materials are available onsite. Specialized equipment and personnel may be required if TRU waste is encountered.
Are technologies under consideration generally available and sufficiently demonstrated or will they require further development before they can be applied at the site?	Alternative components are established technologies and have been demonstrated at the Hanford Site. Handling of TRU waste may require specialized training.
Will more than one vendor be available to provide a competitive bid?	Yes. Several general earthwork and construction contractors exist locally. Analytical equipment is available from equipment vendors.