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Rev. 0

100-NR-1 Treatment, Storage, and Disposal Units Corrective Measures Study/Closure Plan

United States
Department of Energy
Richland, Washington

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EXECUTIVE SUMMARY

This *100-NR-1 Treatment, Storage, and Disposal Units Corrective Measures Study/Closure Plan* (TSD CMS) addresses four *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, and disposal (TSD) units along with two non-TSD waste sites located within the 100-NR-1 Operable Unit (OU) at the 100-N Area. The four RCRA TSD units include the 116-N-1 (1301-N) and 116-N-3 (1325-N) Liquid Waste Disposal Facilities, the 120-N-1 Percolation Pond, and the 120-N-2 Surface Impoundment and their associated pipelines (see Figure ES-1). The non-TSD waste sites include the 100-N-58 South Settling Pond and an unplanned release, UPR-100-N-31. The closure plans for the TSD units are included as appendices to this TSD CMS report. The remainder of the waste sites in the 100-NR-1 OU and the contaminated groundwater of the 100-NR-2 OU are addressed in a separate report, *Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units* (DOE-RL 1996c).

PURPOSE AND SCOPE

The purpose of this TSD CMS is to support remedial action alternative selection for each waste unit by focusing on cleanup of vadose zone soils. First, the known characteristics of the waste units and the distribution and extent of the primary contaminants are discussed. The report identifies the applicable or relevant and appropriate requirements associated with remediation of the units and establishes the objectives for remedial actions. The TSD CMS then develops a set of potential remedial alternatives and performs a detailed analysis of these alternatives. Several agreements and strategies have been established to guide the preparation of this document.

The U.S. Department of Energy (DOE), the Washington State Department of Ecology (Ecology), and the U.S. Environmental Protection Agency (EPA) signed the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1996) in 1989, which established the OU designations and provided a framework for effective investigation and cleanup of Hanford waste sites. The signatories of the Tri-Party Agreement also developed a coordinated *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA)/RCRA characterization and remediation strategy known as the *Hanford Past-Practice Strategy* (DOE-RL 1991). As outlined by these documents, waste site remediation at the Hanford Site must address the requirements of CERCLA, RCRA, the Washington State Dangerous Waste Program, and the *National Environmental Policy Act of 1969*. In accordance with these documents, this TSD CMS evaluates appropriate remedial measures for the TSD units and associated pipelines and waste units.

WASTE UNIT DESCRIPTIONS

Radiological Waste Units

The 116-N-1 and 116-N-3 units received radiologically contaminated liquid effluent from the N Reactor. The 116-N-1 Crib was built in 1963, and a zig-zag trench was added in 1965 to increase the unit's disposal capacity. The crib is filled with boulders that are contaminated as a result of the disposal activities. In 1982, the trench was covered with precast concrete panels to minimize wildlife intrusion and airborne contamination. Discharges to the 116-N-1 Crib and Trench ceased in September 1985. The pipelines associated with effluent disposal to 116-N-1 are considered a part of the waste unit.

The 116-N-3 Crib was constructed in 1983. Although the crib was designed as a replacement for 116-N-1, the percolation rates were lower than expected and could not handle the designed capacity. As a result, some of the flow was diverted to 116-N-1 for disposal. Both cribs operated simultaneously until September 1985, when the 116-N-3 straight trench was completed to increase the capacity of the 116-N-3 unit. After the 116-N-3 Trench was added, the 116-N-1 Crib was taken out of service. The 116-N-3 Crib and Trench are both covered with precast concrete panels. Discharges to the 116-N-3 Crib and Trench ceased in April 1991. The pipelines associated with effluent disposal to 116-N-3 are considered a part of the waste unit.

An unplanned release (UPR-100-N-31) of radiologically contaminated liquid occurred on July 22, 1974. The release was associated with the installation of a steel-encased sample line on the west side of the 116-N-1 Crib. An area of approximately 188 m^2 (2,025 ft^2) of surface soil adjacent to the crib was contaminated. Sand and fines were used to stabilize the area. The contaminated soil was excavated and disposed of in the 200 Area. The excavated area was then backfilled to grade with clean material.

The primary radiological contaminants of concern for 116-N-1, 116-N-3, and UPR-100-N-31 include cobalt-60, strontium-90, cesium-137, and plutonium-239/240. Inorganic contaminants of concern include nitrates and mercury at all of the units, and chromium at 116-N-1 and UPR-100-N-31 only. Dangerous wastes discharged to both facilities included methanol, corrosives, cadmium, lead, and mercury.

Nonradiological Waste Units

The 120-N-1 Percolation Pond, 120-N-2 Surface Impoundment, and 100-N-58 South Settling Pond were nonradiological waste sites. Another pond, the North Settling Pond, along with the South Settling Pond and the 120-N-1 Percolation Pond, was an unlined basin constructed in 1977 to receive corrosive effluent from the 163-N Demineralization Plant and the 183-N Filter Backwash Plant. The filter backwash fines dropped out in the settling ponds, and the effluent either percolated into the soil column beneath the settling ponds or overflowed to the 120-N-1 Percolation Pond and then into the soil column. The fines were frequently dredged from the bottom of the settling ponds to improve percolation and prevent flooding.

In 1983, the effluent disposal system was reconfigured. The filter backwash water was rerouted to 130-N-1, a new disposal facility. The North Settling Pond and 100-N-58, no longer needed, were removed from service, and 100-N-58 was backfilled to grade. The North Settling Pond became the site of the 120-N-2 Surface Impoundment. The 120-N-1 Percolation Pond was enlarged and received all effluent from the 163-N facility until 1986, when the 120-N-2 Surface Impoundment began operation.

The 120-N-2 unit is a double-lined pond with a leachate collection system, which received the 163-N plant effluent for treatment before its disposal in the 120-N-1 unit. In 1988, the Elemental Neutralization Unit was installed in the 163-N plant, and the 120-N-2 unit was removed from service. The 120-N-1 Percolation Pond continued to operate, receiving neutralized effluent from 163-N. All discharges were terminated in 1991.

Dangerous wastes discharged to these units, based on the Part A permits, included sulfuric acid and sodium hydroxide. No contaminants of concern have been identified based on soil sampling.

REMEDIAL ACTION OBJECTIVES AND GOALS

The remedial action objectives for soils are based on information presented in the *100 Area Feasibility Study, Phases 1 and 2* (DOE-RL 1994); the *Hanford Site Risk Assessment Methodology* (DOE-RL 1995g); the *100 Area Source Operable Unit Focused Feasibility Study Report* (DOE-RL 1995d); and the *Record of Decision for the U.S. DOE Hanford 100 Area; 100-BC-1, 100-DR-1, 100-HR-1 Operable Units*, Hanford Site, Benton County, Washington (EPA 1995). The remedial action objectives, exposure scenarios, and the preliminary remediation goals (PRGs) developed for this TSD CMS are consistent with those developed for the 100-NR-1/NR-2 CMS.

Future land-use decisions for the Hanford Site continue to be discussed by both the federal and local governments, regulatory agencies, other Hanford Site stakeholders, and interested parties. Because future land use has not been determined, two exposure scenarios are discussed in this TSD CMS report: a rural-residential exposure scenario and a modified Columbia River Comprehensive Impact Assessment (CRCIA) ranger/industrial exposure scenario. These scenarios were developed in workshops with DOE, Richland Operations Office (RL) and Ecology participation. The rural-residential scenario assumes continuous occupancy of the ground surface, consumption of local plants and animals, and the potential for soil excavation as deep as 4.6 m (15 ft). Limited irrigation, using uncontaminated water, is allowed in the

rural-residential scenario. The modified CRCIA ranger/industrial scenario assumes occasional use of the ground surface, no consumption of local plants or animals, and a potential soil intrusion of 3.0 m (10 ft). Irrigation is not allowed in the modified CRCIA ranger/industrial scenario.

The remedial action objectives developed for this TSD CMS are as follows:

- Protect human and ecological receptors, under the rural-residential or modified CRCIA ranger/industrial scenarios, from exposure to radioactive contaminants in surface and subsurface soils, structures, and debris. Exposure routes include ingestion and inhalation as well as external radiation exposure from radionuclides. Protection will be achieved by reducing concentrations of, or limiting exposure pathways to, contaminants in the upper 4.6 m (15 ft) of soil for the rural-residential exposure scenario and the upper 3 m (10 ft) of soil for the modified CRCIA ranger/industrial scenario. The levels of reduction will be such that the total dose does not exceed the EPA draft, radionuclide soil cleanup standard of 15 mrem/yr above Hanford Site background for 1,000 years following remediation. The 1,000-year requirement ensures that the proposed standard accounts for decay of radionuclides to daughter products that are more highly radioactive.

- Protect potential human and ecological receptors under the rural-residential scenario from exposure, by ingestion, to inorganic contaminants present in surface and shallow subsurface soils and debris. Protection will be achieved by reducing concentrations of (or

reducing exposure pathways to) contaminants in the upper 4.6 m (15 ft) of soil to the State of Washington *Model Toxics Control Act* (MTCA) Method B levels.

- Protect potential human and ecological receptors under the modified CRCIA ranger/industrial exposure scenario from exposure, by ingestion, to inorganic contaminants present in surface and shallow subsurface soils and debris. Protection will be achieved by reducing concentrations of, or limiting exposure pathways to, contaminants in the upper 3 m (10 ft) of soil. The concentration will be reduced to levels that correspond to an incremental cancer risk of 1×10^{-5} for carcinogens and a hazard quotient of less than one for noncarcinogens, using exposure parameters and assumptions in the Hanford Site Risk Assessment Methodology (DOE-RL 1995g).

- Protect the unconfined groundwater system from adverse impacts by reducing concentrations of radioactive and inorganic contaminants present in the soil column that could migrate to the groundwater. Contaminant levels will be reduced, or exposure pathways limited, so that concentrations reaching the groundwater do not exceed the State of Washington MTCA Method B levels or maximum contaminant levels.

- Protect the Columbia River from adverse impacts so that current designated beneficial uses are maintained. Protect associated potential human and ecological receptors using and living in the river from exposure to radioactive and inorganic contaminants. Protection will be achieved by reducing concentrations of, or limiting exposure pathways to, contaminants present in the soil column that could migrate to the groundwater and

eventually to the river. Contaminant levels will be reduced so that concentrations reaching the river do not exceed MTCA Method B values; maximum contaminant levels promulgated under the federal *Safe Drinking Water Act*; or the State of Washington's Drinking Water Standards, Ambient Water Quality Criteria, or Surface Water Quality Standards (WAC 173-201-045).

- Prevent destruction of significant cultural resources and sensitive wildlife habitat. Minimize the disruption of cultural resources and wildlife habitat in general and prevent adverse impacts to cultural resources and threatened or endangered species.

The PRGs are numeric expressions of these remedial action objectives. They are contaminant-specific concentrations considered protective of human health and the environment.

REMEDIAL ALTERNATIVES

Four remedial alternatives (of which two were evaluated with different exposure scenarios for a total of six alternatives) were evaluated for these radiological waste sites: 116-N-1 Crib and Trench, 116-N-3 Crib and Trench, and UPR-100-N-31. Two alternatives were evaluated in the detailed and comparative analyses for the rural-residential exposure scenario:

- No Action (RRES-1)
- Removal (RRES-6).

Four alternatives were evaluated in the detailed and comparative analyses for the modified CRCIA ranger/industrial exposure scenario:

- No Action (MCRIS-1)
- Removal (MCRIS-6)
- Capping (MCRIS-7)
- Vitrification (MCRIS-8).

The estimated cost for each alternative is presented in Table ES-1.

Appendix A of this TSD CMS is the closure plan for 116-N-1 and 116-N-3. With the exception of no action, all the alternatives and the closure activities that would be associated with these units are discussed in Appendix A. Presenting all the alternatives provides flexibility in the closure plan, so that modification will not be required when an alternative is ultimately selected.

The nonradiological sites (120-N-1, 120-N-2, and 100-N-58) are on a modified-closure pathway under RCRA as defined in the Closure/Post-Closure Plan (Appendix B). Closure activities will include removing and disposing of the following: surface and underground piping, the pond liner from 120-N-2, a small sampling building, and the perimeter fencing. The ponds will be backfilled, then the area will be recontoured and revegetated.

Figure ES-1. Treatment, Storage, and Disposal Unit Waste Sites at the 100-N Area.

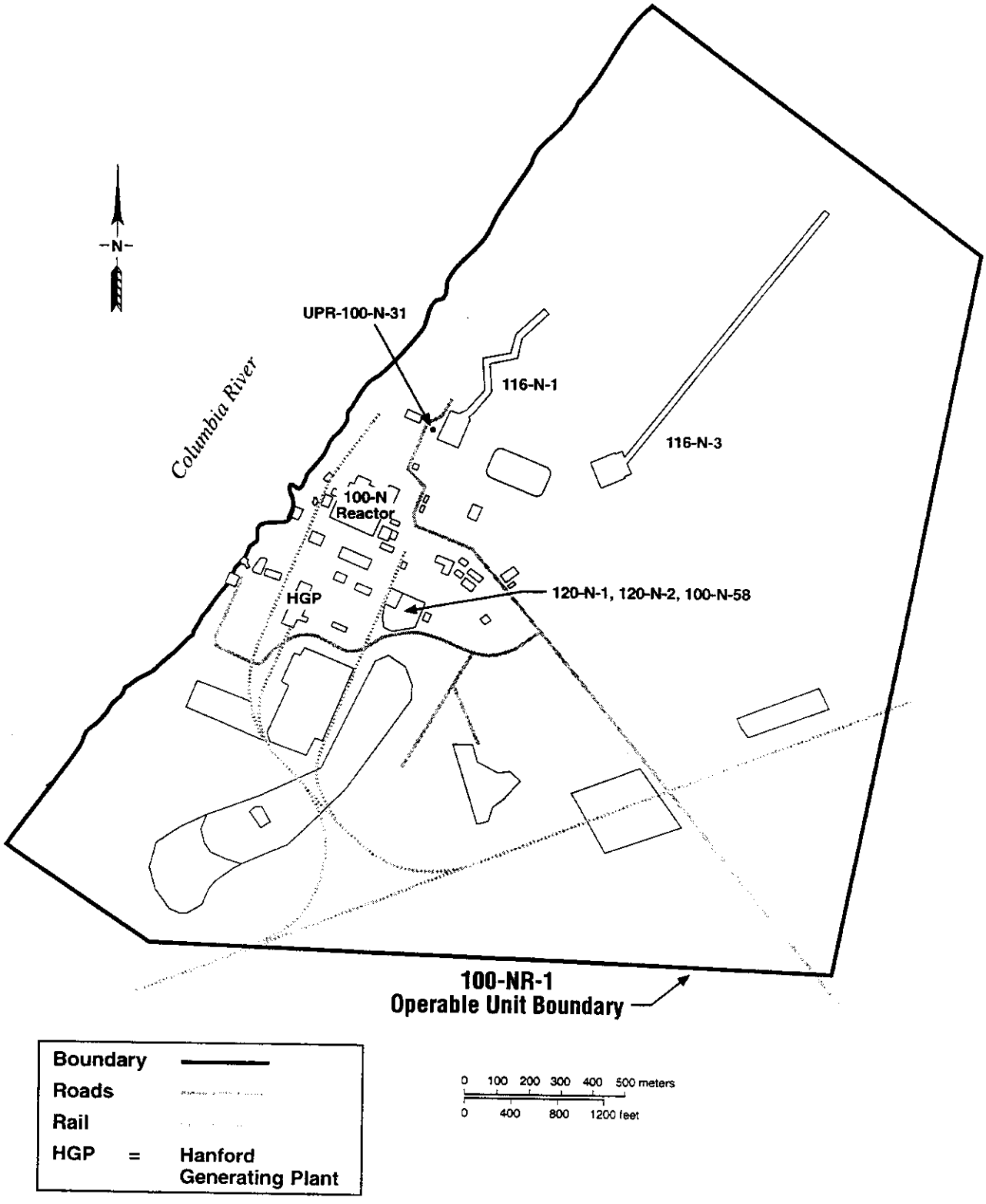

Table ES-1. Summary of Cost Estimates.

Exposure Scenario	Remedial Alternative	Alternative Description	Estimated Cost
Rural-Residential	RRES-1	No Action	$0
	RRES-6	Removal	$17,900,000
Modified CRCIA Ranger/Industrial	MCRIS-1	No Action	$0
	MCRIS-6	Removal	$16,400,000
	MCRIS-7	Capping	$18,200,000
	MCRIS-8	Vitrification	$86,500,000

CRCIA = Columbia River Comprehensive Impact Assessment.

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ABBREVIATIONS AND ACRONYMS

ALARA	as low as reasonably achievable
amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
AWQC	Ambient Water Quality Criteria
Baseline Report	*100-N Area Technical Baseline Report*
bcm	bank cubic meters
bcy	bank cubic yards
bgs	below ground surface
bsg	below surrounding grade
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CMS	corrective measures study
COC	contaminant of concern
COPC	contaminant of potential concern
CRCIA	Columbia River Comprehensive Impact Assessment
DCG	derived concentration guide
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
ENU	elementary neutralization unit
EPA	U.S. Environmental Protection Agency
ERC	Environmental Restoration Contractor
ERDF	Environmental Restoration Disposal Facility
FFS	focused feasibility study
FS	feasibility study
HPPS	*Hanford Past-Practice Strategy*
HSRAM	*Hanford Site Risk Assessment Methodology*
ICR	incremental cancer risk
LDR	land disposal restriction
LFI	limited field investigation
LWDF	liquid waste disposal facility
MCL	maximum contaminant level
MCRIS	Modified CRCIA Ranger/Industrial Scenario
MEI	maximum exposed individual
MRC	maximum representative concentration
MTCA	*Model Toxics Control Act*
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	*National Environmental Policy Act of 1969*
NRC	U.S. Nuclear Regulatory Commission
OU	operable unit

ABBREVIATIONS AND ACRONYMS (continued)

PRG	preliminary remediation goal
QRA	qualitative risk assessment
RAO	remedial action objective
RCOPC	refined contaminant of potential concern
RDR/RAWP	Remedial Design Report/Remedial Action Work Plan
RESRAD	RESidual RADioactivity
RCRA	*Resource Conservation and Recovery Act of 1976*
RL	Richland Operations Office
ROD	record of decision
TBC	to be considered
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
TSD CMS	*100-NR-1 Treatment, Storage, and Disposal Units Corrective Measures Study/Closure Plan*
UPR	unplanned release
WAC	*Washington Administrative Code*
WHC	Westinghouse Hanford Company
WIDS	Waste Information Data System
100-NR-1/NR-2 CMS	*Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units*
1301-N/1325-N LFI	*1301-N and 1325-N Liquid Waste Disposal Facilities Limited Field Investigation (LFI) Report*

1.0 INTRODUCTION

1.1 REGULATORY BACKGROUND

The 100-N Area is one of six areas, collectively referred to as the 100 Area, where nine plutonium production reactors were built along the Columbia River by the U.S. Government during and after World War II. The 100 Area of the Hanford Site, along with the 200, 300, and 1100 Areas (Figure 1-1), was placed on the U.S. Environmental Protection Agency's (EPA) National Priorities List on November 3, 1989, under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). A subset of the Hanford waste sites on the National Priorities List also fall under the jurisdiction of the *Resource Conservation and Recovery Act of 1976* (RCRA).

Under the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1996) signed by the Washington State Department of Ecology (Ecology), the EPA, and the U.S. Department of Energy (DOE), more than 1,000 inactive waste disposal and unplanned release (UPR) sites, and contaminated groundwater on the Hanford Site have been grouped into a number of source and groundwater operable units (OUs). These OUs contain dangerous constituents/wastes, radioactive/dangerous mixed wastes, and other CERCLA hazardous substances. The 100-N Area OUs include the 100-NR-1 OU (source waste sites) and the 100-NR-2 OU (groundwater). The Tri-Party Agreement requires that the waste site remediation programs at the Hanford Site coordinate the requirements of CERCLA, RCRA, the Washington State Dangerous Waste Program (federally authorized state RCRA program), and the *National Environmental Policy Act of 1969* (NEPA). These NEPA values include such issues as cumulative, off-site, ecological, and socioeconomic impacts.

Signatories to the Tri-Party Agreement developed a coordinated CERCLA/RCRA site characterization and remediation strategy to comprehensively and expeditiously address environmental concerns associated with the Hanford Site. This strategy is known as the *Hanford Past-Practice Strategy* (HPPS) (DOE-RL 1991). The HPPS emphasizes integration of the results of ongoing site characterization activities into the decision-making process as soon as practicable (a procedure called the observational approach) and expedites the remedial action process by emphasizing the use of interim actions.

The waste sites in the 100-NR-1 OU addressed in this Corrective Measures Study (CMS) include four RCRA TSD units: the 116-N-1[1] (1301-N) and 116-N-3 (1325-N) Liquid Waste Disposal Facilities (LWDF), the 120-N-1 Percolation Pond (1324-NA), and the 120-N-2 Surface Impoundment (1324-N). The South Settling Pond (100-N-58) is also addressed because of its location (immediately adjacent to 120-N-1 and 120-N-2) and its role in the disposal process

[1]The waste sites have been entered into the Hanford Site Waste Information Data system (WIDS) and redesignated using the WIDS numbering system. Waste sites are generally referred to by their WIDS designation in this report. Table 1-1 provides a listing of the original names or designations and the new WIDS designations for the waste sites in this CMS as well as other 100-N Area facilities that may be referred to. A more detailed listing of the facilities at 100-N Area can be found in the *100-N Area Technical Baseline Report* (Baseline Report) (WHC 1994).

along with 120-N-1, even though it was never permitted as a TSD unit. There was also an unplanned release of effluent from 116-N-1 (UPR-100-N-31) that will be handled as part of the 116-N-1 unit and is addressed in this CMS. The signatories of the Tri-Party Agreement decided to administratively separate the RCRA TSD units from the other waste sites and contaminated groundwater. Therefore, the remainder of the waste sites within the 100-NR-1 OU (including the 100-N shoreline), as well as the groundwater in the 100-NR-2 OU, are addressed in the *Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units* (100-NR-1/NR-2 CMS) (DOE-RL 1996c).

As determined in the Tri-Party Agreement, RCRA is the controlling regulatory statute for the waste sites addressed in this CMS. In addition to these RCRA regulatory authorities, the 100-N Area of the Hanford Site was placed on the EPA National Priorities List on November 3, 1989. Because several authorities apply (RCRA closure, RCRA corrective action, and CERCLA remedial action), the response action at these sites will be combined. For example, certain units are administratively subject to distinct RCRA authorities (such as 116-N-1 for closure and UPR 100-N-31 for corrective action), but are physically located near one another. Thus, it is only natural that the same physical response be applied to the units. Also, RCRA closure and corrective action authorities have clear jurisdiction over waste with chemical constituents (in particular, hazardous waste and hazardous constituents), and mixed wastes (mixtures of hazardous waste and radiological contaminants), but not over waste with radiological contaminants only. By applying CERCLA authority concurrently with RCRA closure and corrective action requirements, all regulatory and environmental obligations at this OU can be addressed as effectively and efficiently as possible. In addition, by applying CERCLA authority jointly with that of RCRA, additional options for disposal of closure, corrective action, and remedial action wastes at Hanford's Environmental Restoration and Disposal Facility are possible. By allowing flexibility in final disposal options, disposal costs can be minimized as much as possible while remaining fully protective of human health and the environment.

Under the provisions of CERCLA, this CMS will result in a proposed plan, which presents the preferred alternatives for remediating the sites. The proposed plan will include a public review and comment period. Based on that review, the remediation alternative will be selected and documented in a Record of Decision (ROD). In accordance with the provisions of RCRA, this CMS will also result in a modification to the Hanford Facility RCRA Permit to include both RCRA TSD closure actions and RCRA corrective actions. It is anticipated that the CERCLA ROD will be issued subsequent to the Hanford Facility RCRA Permit modification. Should the CERCLA ROD contain provisions inconsistent with the approved RCRA modifications, the Hanford Facility RCRA permit will be again modified to reconcile these differences during the next permit modification cycle. Although this CMS addresses both CERCLA and RCRA program authorities, because of the ROD result, the format of this CMS reflects that of a CERCLA feasibility study (FS). This approach will be consistent with the 100 Area ROD for the liquid effluent sites at the 100-BC-1, 100-DR-1, and 100-HR-1 OUs (EPA 1995). In addition, the Tri-Party Agreement details the major components that will make up this TSD CMS as well as the schedule for its submittal (Milestone M-15-12-B). Per the Tri-Party Agreement, Ecology

is the lead authority for this project and signatory of the Hanford Facility RCRA Permit. The EPA will be a signatory to the ROD.

1.2 PURPOSE AND SCOPE

The purpose of this TSD CMS is to provide information to decision makers (signatories to the Tri-Party Agreement) to support selection of a preferred remedial alternative for each waste site to achieve remedial action objectives (RAOs). This report focuses on the development of remediation objectives and goals to remediate the soils in the vadose zone under the waste sites. Applicable technologies were selected and used to develop remedial alternatives that will achieve those objectives and goals. The alternatives were then evaluated to determine the most appropriate alternative.

Information provided in this report will satisfy the CMS data quality objectives (DQOs) identified during the DQO Workshop for 1301-N/1325-N LFI. The DQOs discussed in this report and the sections in which they can be found are listed in Table 1-2.

This CMS presents a detailed analysis of alternatives to remediate wastes at the TSD units in the 100-N Area in accordance with *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988). Wastes consist primarily of radionuclides with a limited number of inorganic and organic contaminants resulting from the operations of the 100-N Reactor and its support facilities from the mid-1960s to the mid-1980s. As part of the analysis of alternatives, this CMS describes the known characteristics of the waste sites, describes the distribution and extent of the primary contaminants, presents RAOs, develops risk reduction goals, and identifies the applicable or relevant and appropriate requirements (ARARs) associated with site conditions and the possible remedial actions.

To evaluate remedial alternatives, information related to future land use, groundwater use, and cleanup goals is necessary. However, this information may not be fully developed prior to the timely consideration of remedial actions. For example, future land-use decisions for the Hanford Site, including the 100-N Area, continue to be discussed by the responsible government agency (DOE), the principal regulatory agencies (EPA and Ecology), the local government agencies, and many other Hanford Site stakeholders and interested parties. Therefore, because a land-use decision has not been made, two exposure scenarios-- rural-residential and modified Columbia River Comprehensive Impact Assessment (CRCIA) ranger/industrial-- were defined for this CMS. These two exposure scenarios represent two general categories of potential land use: unrestricted and restricted.

The 100 Area ROD for the liquid effluent sites at the 100-BC-1, 100-DR-1, and 100-HR-1 OUs (EPA 1995) was used to define a potential rural-residential exposure scenario. The cleanup goals specified in the ROD are based on such a scenario, which provides for continuous occupancy of the ground surface; potential excavation of soils to a depth of 4.6 m (15 ft); and consumption of local plants, animals, and home garden products. The scenario assumes 76 cm (30 in.) of

irrigation per year using uncontaminated water and no use of groundwater for potable water or for irrigation. This is the rural-residential exposure scenario used in this CMS.

The second exposure scenario used in this CMS (i.e., modified CRCIA ranger/industrial), based on recreational land use, estimates human and ecological risks associated with a more restricted use of the land. This exposure scenario assumes occasional use of the ground surface with potential intrusion of soils by humans, animals, and plants to 3.0 m (10 ft). It assumes there will be no consumption of fish, game, and edible vegetation. As explained in Section 3.0, consumption of fish, plants, and animals in any recreational scenario results in cleanup goals similar to those in the rural-residential scenario. This similarity occurs because one of the principal contaminants at the 100-N Area is strontium-90, which is the only radionuclide that transfers through the food chain and bioaccumulates in calcium-containing tissue. Like the rural-residential exposure scenario, the modified CRCIA ranger/industrial scenario assumes that groundwater is not used as a water supply. Unlike the rural-residential exposure scenario, it assumes that no irrigation occurs.

1.3 REPORT ORGANIZATION

This TSD CMS and the 100-NR-1/NR-2 CMS were developed using a CERCLA FS format to be consistent with the FS reports previously published for the 100-BC-1, 100-DR-1, and 100-HR-1 OUs. The CMSs address many of the same issues, concerns, and decisions. Remedial action objectives, action levels, and remedial strategies must be consistent throughout the CMS process. Consequently, the two documents are very similar in structure and content. Rather than repeating material, the TSD CMS refers the reader to the 100-NR-1/NR-2 CMS when practical. The TSD CMS also refers to sections of the 1301-N/1325-N LFI report.

There are, however, some significant differences between the TSD CMS and the 100-NR-1/NR-2 CMS. Considerable information and data exist on the specific waste sites in the TSD CMS. For 116-N-1 and 116-N-3, this information is presented in the 1301-N/1325-N LFI report (DOE-RL 1996b). The TSD CMS can, therefore, present a more detailed description of what is and is not contaminated, avoiding the need to address "what if" contingency plans needed for sites with less data. Having waste-site-specific data helps refine remedial volumes, applicable technologies, alternatives, and cost estimates.

Another difference between the reports is the inclusion as appendices to the TSD CMS of closure/post-closure plans for each of the TSD waste sites. These appendices contain required RCRA information that is not included within the main body of the TSD CMS. Because decisions relative to remedial alternative selection, such as future land use, will impact the final RCRA closure option, the closure plans are written in a manner that ensures flexibility when these decisions are made.

The major sections provided in this report are listed below:

1.0 Introduction
2.0 Site Background
3.0 Remedial Action Objectives and Preliminary Remediation Goals
4.0 Contaminants and Remediation Volumes
5.0 Remedial Technologies and Alternatives
6.0 Detailed Analysis of Alternatives
7.0 Comparative Analysis of Remedial Alternatives
8.0 References

Appendices:

A 1301-N and 1325-N Liquid Waste Disposal Facilities Closure Plan
B 1324-N Surface Impoundment and 1324-NA Percolation Pond Closure Plan
C Applicable or Relevant and Appropriate Requirements
D Volume Estimates
E Cost Estimates
F RESidual RADioactivity Model Input Parameters
G Contaminants of Concern Assessment Process

Figure 1-1. Hanford Site Map.

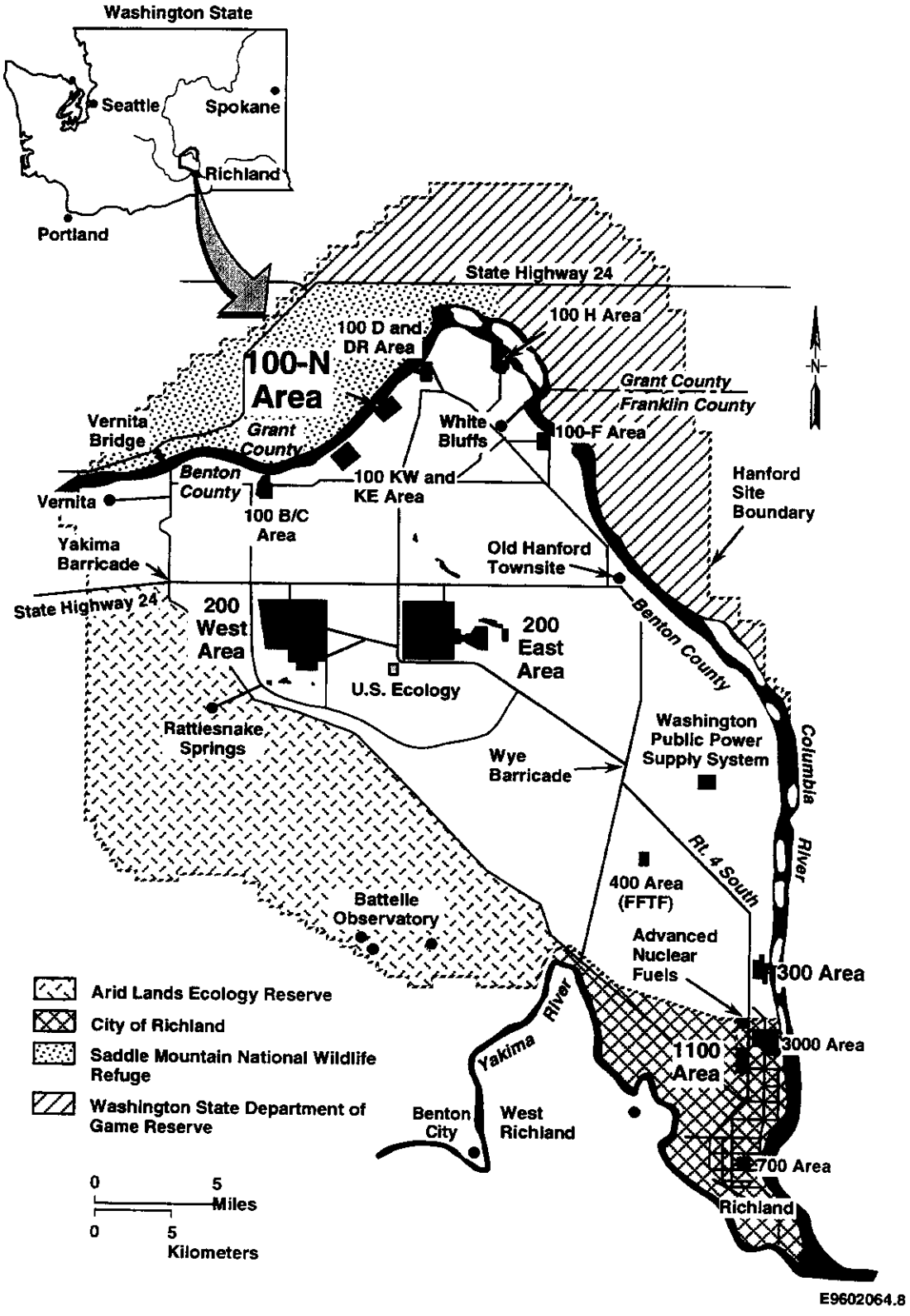


Figure 1-2. Treatment, Storage, and Disposal Unit Waste Sites at the 100-N Area.

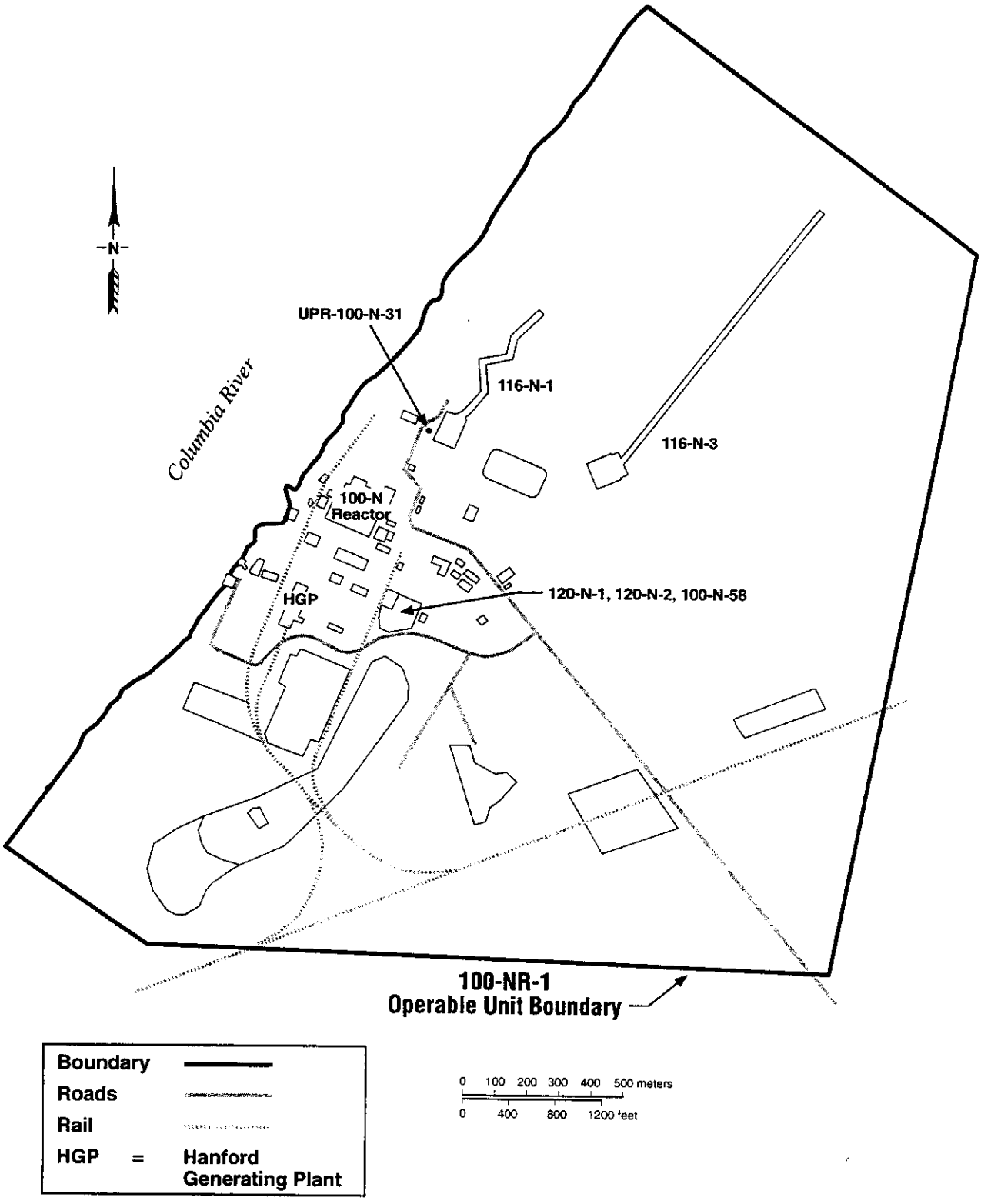


Table 1-1. Facility Names and Numbers.

Original Facility/Unit/Waste Site Name	WIDS Number
105-N Reactor Building	N/A
1301-N Liquid Waste Disposal Facility	116-N-1
1310-N Chemical Waste Storage Tank	116-N-2
1312-N Liquid Effluent Retention Facility	N/A
1315-N Effluent Valve House	N/A
1316-N Valve House	N/A
1322-N Waste Treatment Pilot Plant	N/A
1324-NA Percolation Pond	120-N-1
1324-N Surface Impoundment	120-N-2
1325-N Liquid Waste Disposal Facility	116-N-3
163-N Demineralization Plant	N/A
1722-N Decon Hot Shop	N/A
183-N Water Filtration Plant	N/A
183-N Backwash Discharge Pond	130-N-1
North Settling Pond	N/A
South Settling Pond[a]	100-N-58
Spill at 1301-N	UPR-100-N-31

[a]The number for the South Settling Pond does not appear in previous documents because it was input to WIDS in May 1996.

N/A = not applicable
UPR = unplanned release
WIDS = Waste Information Data System

Table 1-2. Summary of 116-N-1 and 116-N-3 Data Quality Objectives and Criteria.

DQO	Explanation	Addressed in Section(s)
Evaluate remedial alternatives	Evaluate remedial alternatives against the nine CERCLA criteria.	5.2, 6.0, and 7.0
Estimate total inventory	Estimate the amount of strontium-90 in the vadose zone.	2.1.2
Assess lateral distribution	Determine the lateral extent of contamination for use in calculations of volume of soil to be remediated.	4.3
Evaluate dangerous waste	Discuss the presence/absence of dangerous waste in the alternatives evaluation.	Appendix A
Evaluate transuranic waste	Discuss the presence/absence of transuranic waste in the alternatives evaluation.	4.3.1.1

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DQO = data quality objective

2.0 SITE BACKGROUND

This section presents general facility and operations information about the Hanford Site and the 100-N Area. Also included are detailed descriptions and background discussions for the individual waste sites and the associated contaminants of potential concern (COPCs). The waste site descriptions also provide information about the structures and pipelines associated with each waste site. The information was compiled from many different sources including the Baseline Report (WHC 1994), the 100-NR-1 OU Work Plan (DOE-RL 1996g), the 100-NR-1 LFI report (DOE-RL 1995f), the 100-NR-1 Qualitative Risk Assessment (QRA) report (BHI 1995b), and the 1301-N/1325-N LFI report (DOE-RL 1996b).

2.1 FACILITY BACKGROUND

2.1.1 Facility Operations

Nine water-cooled, graphite-moderated plutonium production reactors were constructed along the Columbia River at the Hanford Site between 1943 and 1963. The 100-N Reactor, the last to be built, is situated in the 100 Area in the northern part of the Hanford Site on a broad strip of land along the Columbia River about 48 km (30 mi) northwest of the city of Richland. The 100-N Reactor differs from the other reactors at Hanford, not only because of its closed-loop cooling system, but because it was designed as a dual-purpose reactor capable of producing both special nuclear material and steam generation for electrical power. Although called a "closed-loop cooling system," it actually operated as a bleed-and-feed system where a portion of the cooling waters were constantly bled off and replaced with fresh demineralized water. The cooling effluent removed from the loop eventually made its way to the 116-N-1 and 116-N-3 LWDFs. The 100-N Reactor went into production in December 1963. The Hanford Generating Plant was completed and started producing electrical power in April 1966.

Both the reactor and the generating plant operated continuously, except during periodic shutdowns for maintenance and repairs, until January 7, 1987. The reactor was retired in October 1989 (WHC 1994), and orders were received to shut down the reactor in October 1991. Figure 2-1 shows the facilities in the 100-N Area. The 100-NR-1/NR-2 CMS (Section 2.1.1) provides a general discussion of the operations performed in the 100-N Area. Additional figures included in the 100-NR-1/NR-2 CMS show the N Reactor coolant flow diagram and the location of selected waste sites. Also included are some of the UPRs in the 100-N Area.

2.1.2 Waste Disposal Practices

The 116-N-1 and 116-N-3 units received radioactive liquid wastes containing activation and fission products as well as small quantities of corrosive liquids and laboratory chemicals generated by various N Reactor operations. The units used the vadose zone to remove radioactive and hazardous materials from the reactor operation's effluent. As discharged effluent

percolated through the soil column, most radioactive and chemical constituents were retained in the soil through filtration, absorption, adsorption, and ion exchange. However, some constituents, such as tritium, were not retained in the soil but traveled with the effluent. Eventually the soil's capacity to remove contaminants from the effluent was exceeded, allowing more contaminants to travel to groundwater and on to the Columbia River.

The primary waste sources were the reactor cooling systems and the fuel storage basins. Until December 1984, essentially all the strontium-90 and cesium-137 discharged to 116-N-1 originated in the 100-N Reactor fuel storage basin (WHC 1994). The water was discharged to the LWDFs at an average flow rate of 6,800 L/min (1,800 gal/min) (DOE-RL 1996b). Table 2-1 presents cumulative inventories as of January 1, 1996, for principal radionuclides in effluent discharged to the units.

A listing of dangerous waste solutions disposed in the units is presented in Table 2-2. These wastes resulted mainly from decontamination of the primary coolant system and from possible disposal of chemicals to common floor drains that discharged to the units (WHC 1994). The chemicals that were introduced into the primary coolant system were ammonium hydroxide and hydrazine. Analysis of the primary coolant waste water in 1985 indicated it did not exhibit any of the characteristics of a regulated dangerous waste (WHC 1994). Releases from the periphery cooling systems resulted in small continuous discharges of a variety of chemicals including ammonium hydroxide, morpholine, and hydrazine to the units. Sodium dichromate was used as a corrosion inhibitor in the reactor cooling system and was discharged to the 116-N-1 unit until the early 1970s (BHI 1996). Other discharges include drainage from reactor support facilities, five wet laboratories, and the auxiliary power battery lockers. Additional information on the N Reactor waste generating processes is presented in the Baseline Report (WHC 1994, Sections 2.3.2, 4.7, and 4.8).

The percolation pond system (120-N-1/120-N-2/100-N-58) received nonradioactive liquid wastes from the 163-N Demineralization Plant and the 183-N Water Filter Plant. Before 1977, the effluent from 163-N was discharged to the Columbia River in keeping with the common practice of industry at that time. Beginning in 1977, the effluent was discharged to 120-N-1. The Baseline Report (WHC 1994) summarized the waste treatment practice as the alternate addition of acidic cation regenerate and alkaline anion regenerate to neutralize the pH of 163-N effluent over time. Table 2-3 presents the estimated amounts of dangerous waste discharged to 120-N-1 and 120-N-2. Additional information may be found in the Baseline Report (WHC 1994, Sections 2.4, 4.7, and 4.8).

2.1.3 Spill and Release History

Throughout the operational history of the 100-N Reactor, spills of sufficient quantity to require reporting were documented and are currently identified as UPRs, each with a unique number. All spills within the 100-NR-1 OU are addressed in the 100-NR-1/NR-2 CMS (Section 2.1.3) with the exception of UPR-100-N-31, the only spill associated with the TSD units. The spill occurred on July 22, 1974, while sample lines were being installed in a 15-cm (6-in.) steel casing through

the berm on the west side of the 116-N-1 Crib. During the sample line installation, the water level in the crib was raised from 38 to 46 cm (15 to 18 in.) as a result of an emergency dump tank drawdown test. As a result of the increased water level, approximately 3,785 L (1,000 gal) of effluent water containing fission and activation products flowed through the casing and was released to the soil. An area of approximately 188 m^2 (2,025 ft^2) was contaminated.

2.1.4 Previous Response Actions

There have been no previous response actions that involved or affected the TSD units, except for the actions related to the UPR-100-N-31 spill. Sand and fines were used to stabilize the soil contamination prior to removal of the soil for disposal in the 200 Area. After the soil was removed, clean fill material was used to restore the site.

2.2 PRIOR STUDIES

Pertinent information for this TSD CMS has been developed through previous efforts at Hanford and is documented in a variety of reports. Listed below are some of the reports considered during the preparation of this CMS. Most of these documents are briefly discussed in the 100-NR-1/NR-2 CMS. Refer to the 100-NR-1/NR-2 CMS (DOE-RL 1996c) or the resource cited for further information.

2.2.1 Hanford Site Studies

- *Hanford Reach of the Columbia River, Comprehensive River Conservation Study* and *Environmental Impact Statement* (National Park Service 1994)
- Background Studies
  - *Characterization and Use of Soil and Groundwater Background for the Hanford Site* (WHC 1991)
  - *Hanford Site Background: Evaluation of Existing Soil Radionuclide Data* (DOE-RL 1995a)
  - *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes* (DOE-RL 1995b)
- *Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan* (DOE 1996)
- *Hanford Site National Environmental Policy Act (NEPA) Characterization* (Cushing 1995)

- Hanford Site Annual Reports
  - *Hanford Site Environmental Report for Calendar Year 1994* (Dirkes and Hanf 1994)
  - *Hanford Site Environmental Data for Calendar Year 1994--Surface and Columbia River* (Bisping 1995)
  - *Quarterly Report of RCRA Groundwater Monitoring Data for Periods January 1, 1994, to December 31, 1994* (DOE-RL 1995c).

2.2.2 100 Area Studies

- *100 Area Feasibility Study, Phases 1 and 2* (DOE-RL 1994)
- *100 Area Source Operable Unit Focused Feasibility Study Report* (DOE-RL 1995d)
- Draft *Columbia River Comprehensive Impact Assessment* (scheduled for completion in fiscal year 1997)
- Ecological Studies
  - *Habitat Types on the Hanford Site: Wildlife and Plant Species of Concern* (Downs et al. 1993)
  - *Status of Birds at the Hanford Site in Southeast Washington* (Landeen et al. 1992)
  - *A Synthesis of Ecological Data from the 100 Area of the Hanford Site* (Weiss and Mitchell 1992)
  - *100 Area CERCLA Ecological Investigations* (Landeen et al. 1993).
- Cultural Resource Guidelines and Studies
  - *Hanford Cultural Resources Management Plan* (Chatters 1989)
  - *The Hanford Site 100-N Reactor Buildings Task Identification and Evaluation of Historic Properties* (Stapp and Marceau 1996)
  - *Action Plan for Managing Hanford Cultural Resources 100-N Reactor Area* (Woodruff et al. 1995)
  - Archaeological investigations and surveys conducted within the 100-N Area.

- Pilot Project/Treatability Studies
  - *100-Area Excavation Treatability Test Report* (DOE-RL 1996a)
  - *Soil Washing Pilot Scale Treatability Test for the 100-DR-1 Operable Unit* (DOE-RL 1995e).

2.2.3 100-N Area Studies

- 100-N Area Technical Baseline Report (WHC 1994)
- 100-NR-1 Work Plan (DOE-RL 1996g)
- 100-NR-1 LFI Report (DOE-RL 1995f)
- 100-NR-1 Qualitative Risk Assessment (BHI 1995b)
- 1301-N/1325-N LFI DQO Report (BHI 1996)
- 1301-N/1325-N LFI Report (DOE-RL 1996b)
- N-Springs Expedited Response Action Performance Report (DOE-RL 1996f).

2.3 AREA RESOURCES

2.3.1 Information Presented in the 100-NR-1/100-NR-2 CMS

The Tri-Party Agreement requires the CMS to consider RCRA, CERCLA, and NEPA criteria for assessing the impact of any remedial action measures. Some of the information used to evaluate the impact of remedial action against these criteria include Hanford site-wide information; 100-N Area specific information and physical, cultural, and ecological resources; transportation; and area utilities. Section 2.3 of the 100-NR-1/NR-2 CMS (DOE-RL 1996c) provides details about these topics, which fall under the following general categories:

- Geology at 100-N
- Surface water
- Groundwater
- Meteorology
- Ecology
- Cultural resources
- Other resources.

Geological and hydrogeological factors that are specific to the TSD sites are discussed in the following section.

2.3.2 Site-Specific Geology and Hydrogeology

The site-specific geology and hydrogeology at the TSD units is summarized below from the 100-NR-1 LFI report (DOE-RL 1995f) for 120-N-1, 120-N-2, and 100-N-58, and from the 1301-N/1325-N LFI report (DOE-RL 1996b) for 116-N-1 and 116-N-3.

2.3.2.1 116-N-1 and 116-N-3. Stratigraphic divisions underlying the 100-N Area include the Hanford formation, the Ringold Formation, and Elephant Mountain Member of the Saddle Mountains Basalt. The Hanford formation overlies the Ringold Formation and consists of two gravel-dominated facies: an upper cobble-boulder unit and a lower pebble-cobble unit. The Ringold Formation overlies the Elephant Mountain Member and consists of seven units. Thickness ranges for the Hanford formation and the Ringold Formation are 5.8 to 24.5 m (19 to 77 ft) and 137.2 to 150.6 m (450 to 494 ft), respectively. General stratigraphic relationships of the geologic units are illustrated in the geologic cross section shown in Figure 2-2.

The upper portion of the Hanford formation is composed of unconsolidated basaltic cobble and boulder-sized clasts. Cobbles as large as 15 cm (6 in.) were encountered during drilling in the vicinity of the units, although boulders as large as 0.9 m (3 ft) can be seen around 116-N-1 and 116-N-3. Below the cobble-boulder unit, clast size decreases to pebbles and cobbles with local dominant sand. The gravel and sand are predominantly basaltic in composition. Sometimes significant sand layers are intercepted during drilling. Sand layers from 3 to 4.9 m (10 to 16 ft) thick, consisting of very coarse to fine sand, have been encountered. In the vadose zone, sand layers may have promoted the localized lateral spread of contamination from 116-N-1 and 116-N-3 during operation of the units. The sand zones are discontinuous and cannot, with certainty, be traced between wells.

Extensive grading, excavation, and backfilling of the surficial Hanford formation have occurred within and around 116-N-1 and 116-N-3. Consequently, it is difficult to distinguish undisturbed Hanford formation from anthropogenically disturbed Hanford formation because of similar bulk composition. The zone of disturbed material is up to 6.1 m (20 ft) thick and consists of unconsolidated basaltic cobble- to boulder-sized clasts with sand infilling. Clasts often exhibit white calcium carbonate coatings.

The underlying Ringold Formation is composed of fluvial pebble- to cobble-sized gravels with a silty sandy matrix. The sediments range from well-cemented, with carbonates and/or iron oxides, to uncemented. Cementation is discontinuous but laterally extensive. Basalt content of the gravels is typically less than 50% by volume. Some thin discontinuous sand lenses are found in the areas of 116-N-1 and 116-N-3. The contact between the Hanford formation and the Ringold Formation is sometimes difficult to determine because a transition zone of reworked Ringold Formation is often present. The contact is a potential perching layer in the vadose zone because of the cemented nature of the Ringold Unit E. However, no perched water was observed during the 1995-1996 LFI activities.

Groundwater in the unconfined aquifer flows primarily in a west-northwesterly direction most of the year and discharges to the Columbia River. Fluctuations in river stage, because of dam operations and seasonal variations, can impact the flow direction, hydraulic gradients, and groundwater levels within the unconfined aquifer. The significant stratigraphic divisions at and above the water table at 116-N-1 and 116-N-3 are the Ringold Formation and the Hanford formation. The unconfined aquifer is contained in the gravel-dominated Unit E lithofacies of the Ringold Formation. Detailed descriptions of the Hanford and Ringold formations are found in Hartman and Lindsey (1993).

2.3.2.2 120-N-1, 120-N-2, and 100-N-58. The same stratigraphic divisions underlie 120-N-1, 120-N-2, and 100-N-58 as those which underlie 116-N-1 and 116-N-3. They include the Hanford formation, the Ringold Formation, and the Elephant Mountain Member of the Saddle Mountains Basalt. Previous drilling in the 120-N-1 area penetrated the Hanford formation, Unit E of the Ringold Formation, and the upper mud of the Ringold Formation (Figure 2-3). The Hanford formation ranges from 13.7 to 21.3 m (45 to 70 ft) thick. Unit E of the Ringold Formation is 15.6 m (52 ft) thick based on well 199-N-77. The thickness of the upper mud of the Ringold Formation has not been determined.

The Hanford formation is composed of unconsolidated basaltic pebbles and boulders with sand filling the interstices. The overall grain size generally decreases downward in the Hanford formation. Discontinuous sand layers are occasionally encountered.

The underlying Unit E of the Ringold Formation is composed of fluvial pebble- to cobble-sized gravels with a silty sandy matrix. The sediments range from well-cemented, with carbonates and/or iron oxides, to uncemented. Basalt content of the gravels is typically less than 50% by volume. The upper mud consists primarily of consolidated silt and clay with minor sand. Calcium carbonate content of the top of the mud is high and represents a paleosol.

The groundwater system under 120-N-1, 120-N-2, and 100-N-58 is part of the same system that is under 116-N-1 and 116-N-3. It flows primarily in a northwesterly direction and discharges to the Columbia River. Fluctuations in river stage, caused by dam operations, and seasonal variations have the same general impacts on flow direction, hydraulic gradients, and groundwater levels throughout the 100-N Area. The significant stratigraphic divisions at and above the water table are the Ringold Formation and the Hanford formation. The unconfined aquifer is contained in the gravel-dominated Unit E lithofacies of the Ringold Formation.

2.4 WASTE SITE DESCRIPTIONS

2.4.1 116-N-1: 1301-N Liquid Waste Disposal Unit

2.4.1.1 Unit Description and Operating History. N Reactor achieved initial criticality in December 1963. The 116-N-1 LWDF began operating that year as N Reactor's primary LWDF. It operated until September 1985 and received an average flow rate of 6,800 L/min

(1,800 gal/min). Table 2-4 summarizes the major events that occurred during the operational history of 116-N-1 and 116-N-3. The 116-N-1 unit is located approximately 240 m (800 ft) from the Columbia River. Figure 2-4 shows the general location of 116-N-1 in relation to N Reactor, the Columbia River, and 116-N-3.

The 116-N-1 unit is composed of three distinct parts: the crib, the zig-zag trench, and the pipelines. The crib area is approximately 88 m (290 ft) long by 38 m (125 ft) wide and about 1.5 m (5 ft) deep. The elevation of the bottom of the crib is 137.2 (450 ft) above mean sea level (amsl), and the surrounding grade is approximately 138.7 m (455 ft) amsl. A sloped soil and gravel embankment forms the walls of the crib. Design drawings, numbered H-1-30581 and H-1-30589 Sheet 4, show a 122-m- (400-ft) long compacted impervious barrier built into the south wall, running all along the south side of the crib and extending beyond the crib another 61 m (200 ft) to the southeast. The barrier is 3 m (10 ft) wide at the top at an elevation of 138 m (454 ft). It is 3.7 m (12 ft) wide at the bottom, where the elevation is 130 m (428 ft). This same impervious cutoff is shown in Figure 4-1 of the Baseline Report (WHC 1994). Figure 2-5 depicts a three-dimensional view of the crib cut away to help visualize these features.

An underground 91-cm- (36-in.) diameter main effluent line from the 105-N lift station discharged into the crib through a 16-m by 3.7-m (52-ft by 12-ft) concrete weir box, which was initially open on top. The weir box, commonly referred to as the "horse trough," was designed to simply fill and overflow into the crib (Figure 2-6a). Also discharging into the crib was an underground 30-cm- (12-in.) diameter effluent drain line from the N Reactor basin floor drains. Details about all feeds to the unit are provided later in this section.

Initially, the bottom of the crib was filled with a 0.9-m (3-ft) layer of large boulders. In early 1981, an additional 0.6-m (2-ft) layer of smaller boulders was added to the top of the large boulders to cover surface contamination on the boulders. This layer started in the area around the weir box and extended northeast approximately 31 m (100 ft) along the length of the crib. During the months of August and September 1988, the entire crib was covered with cobble-sized material to an additional depth of 1.2 to 1.5 m (4 to 5 ft) (BHI 1996). Consequently, for remedial design purposes, the actual depth of the rocks and boulders may vary throughout the crib from as little as 2.1 m (7 ft) to as much as 3.4 m (11 ft). Figure 2-7 is a cross section through the crib that illustrates the crib's construction.

The 116-N-1 zig-zag trench was constructed in 1965 and is 490 m (1,600 ft) long by 15 m (50 ft) wide at the top and 3.7 m (12 ft) deep with sloped side walls. Water spilled over the weir in the dike on the north side of the crib into the trench. Boulders and cobbles were not placed in the trench as they were in the crib. Wooden poles laid across the trench were used to support wire screening to keep birds out. Figure 2-8, a photograph of the crib and trench taken in September 1981, shows the area where the crib and trench connect and the poles and screening over the trench.

In 1975, modifications were made so that the water could be diverted to the 1312-N disposal basin. Two 91.4-cm (36-in.) pipelines connect the east end of the 116-N-1 weir box with the

1315-N valve pit. Opening the valves in 1315-N would allow the water to flow from the 116-N-1 weir box through the pipe and then into the 1312-N disposal basin. Additionally, an open ditch connected the southeast corner of the 116-N-1 Trench with the northwest corner of 1312-N. However, an earthen berm on the 116-N-1 end of the ditch prevented wastewater from entering the ditch. Consequently, wastewater was never diverted to 1312-N.

In early 1982, precast concrete panels were installed to cover the entire trench to minimize wildlife intrusion and airborne contamination. These panels created a 15-m- (50-ft) wide cover over the top of the trench. First, concrete foundations were constructed (Figure 2-9) to support concrete beams that spanned the trench (Figure 2-10). Next, pre-cast concrete panels were placed on top of the support beams leaving all wooden poles and wire mesh in place (Figure 2-11). The open void between the cover panel and the ground, which ran parallel to the trench, was backfilled to prevent wildlife intrusion (Figure 2-12). The long sides between the concrete panels were not grouted. However, the spaces between the ends of the panels, extending across the trench along the support beams, were grouted together. After backfilling, the side slopes outside the cover were sprayed with a layer of shotcrete to prevent erosion and rodent intrusion (Figure 2-13).

As mentioned, the existing cover of wooden beams and wildlife netting was not removed during installation of the cover panels. It will be necessary to address the beams and netting during remediation.

During 1982, routine sampling of the riverbank springs indicated an increase in radionuclide concentrations reaching the river. This condition pointed to a decrease in the effectiveness of the 116-N-1 unit to retain radionuclides in the soil column. This led to the construction of the 116-N-3 Crib. In order to transfer effluent to 116-N-3, the 116-N-1 weir box was modified slightly, adding two 91-cm- (36-in.) diameter discharge pipelines (opposite the inlet lines) and a cover.

The quantity of effluent discharged to 116-N-1 from N Reactor operations began to decrease with the completion of the 116-N-3 Crib in October 1983. The 116-N-3 Crib, however, was not capable of handling the full effluent capacity from N Reactor, and 116-N-1 continued to receive effluent to prevent 116-N-3 from overflowing. Routine discharges to 116-N-1 were terminated in September 1985, when construction of the 116-N-3 straight extension trench was completed. The 116-N-1 Trench continued to be available as an emergency overflow discharge unit until approximately June 1987. The top of the 116-N-1 weir box was sealed at this time, and no further discharges occurred to 116-N-1. Figure 2-6b shows the present configuration of the weir box.

2.4.1.2 Associated Pipelines. Six pipelines feed effluent to the 116-N-1 unit (Table 2-5). The pipelines include two lines that come from the 1722-N Building (adjacent to 105-N Building), pass through the 1322-N Building, and end at the 116-N-1 weir box. One is labeled as a contaminated drain pipe; the other is a radioactive drain pipe. There are two lines from the 116-N-2 facility (1310-N Golf Ball); one is a contaminated drain and the other is a radioactive

drain. Also coming from the 116-N-2 facility directly to the 116-N-1 Crib is a chemical waste pipe. The final pipeline addressed in the CMS is a radioactive drain line from the 1322-N Building to the 116-N-1 Crib. More details about these pipelines and the maps used to define them can be found in Appendix D. Figure 2-14 shows the pipelines expected to be encountered during remediation of the crib. It is possible that additional pipelines will be encountered during remediation. There is an exposed pipeline of unknown origin that can be seen in the southwest corner of the crib. Other such pipelines will likely exist. No pipelines are known to enter or exit the trench.

Two additional pipelines that need to be mentioned are the 91-cm (36-in.) discharge lines going from the weir box to 116-N-3. These lines feed the 116-N-3 Crib and are addressed as part of that unit.

2.4.1.3 Current Site Conditions. Currently, 116-N-1 is enclosed in an area with a chain link fence topped with barbed wire and posted with signs reading "Danger - Unauthorized Personnel Keep Out," "Caution, Radiation Area," "Radiologically Controlled Area," "Underground Radioactive Material," "No Trespassing," and "Surface Contamination." Access is controlled by a lock and key, with the keys held by the Environmental Restoration Contractor (ERC). There are two access roads inside the fence; one provides access to the crib, and the other provides access to the trench. These features can be seen in Figure 2-15. The current general topography of the surrounding area is shown in Figure 2-16.

The radiological conditions at 116-N-1 require special consideration when evaluating alternatives for remediation of the unit. The following information was taken from the 1301-N/1325-N LFI (DOE-RL 1996b) and from copies of the *Westinghouse Hanford Company Operational Environmental Monitoring Annual Report* for calendar years 1994 (WHC 1995) and 1995 (WHC 1996).

At 116-N-1, the radiation measurements are decreasing slightly through the years, reflecting the continuing decay of radionuclide inventory in 116-N-1. Dose rates measured near the unit in 1995 showed an annual average decrease of approximately 18% from 1994 levels. In a 1995 survey, radiation measurements taken at 1 m (3 ft) above the 116-N-1 Trench concrete panels (at the portion closest to the crib) were about 300 mrem/hr.

During drilling performed from late 1995 to early 1996 for the 1301-N/1325-N LFI, the background at the 199-N-108A drill pad (next to the 116-N-1 Trench) ranged from 1 to 3 mrem. Drums filled with water were placed between the trench (source) and the workers on the drill pad to provide shielding from radiation.

The 116-N-1 Crib boulders are suspected of having soils on them with the highest radionuclide concentrations. During the recent 1301-N/1325-N LFI, the highest radiation readings (up to 350 mrem/hr) and highest concentrations of cobalt-60, cesium-137, strontium-90, and plutonium-239/240 were detected on the soil removed from the crib boulders.

Special consideration should also be given to the removal of the concrete panels on the 116-N-1 Trench. It is assumed that the concrete panels have fixed and removable contamination present, especially on the side exposed to the soil. It is not known at this time whether cutting and removing the panels in one piece is feasible because rebar may be present. Breaking these panels for removal may create airborne contamination concerns. These concerns can be mitigated by spraying water on the panels during their removal. These concerns will need to be resolved during the remedial design phase, and the as low as reasonably achievable (ALARA) principle will need to be employed to protect the workers and prevent any spread of contamination.

2.4.2 UPR-100-N-31

The UPR-100-N-31 spill occurred on July 22, 1974, while sample lines were being installed in a 15-cm (6-in.) steel casing through the berm on the west side of the 116-N-1 Crib. During the sample line installation, the water level in the crib was raised from 38 to 46 cm (15 to 18 in.) as a result of an emergency dump tank drawdown test. Due to the increased water level, approximately 3,785 L (1,000 gal) of effluent water containing fission and activation products flowed through the casing and was released to the soil.

An area of approximately 188 m^2 (2,025 ft^2) was contaminated. Figure 2-4 shows the location of the spill in relation to the 116-N-1 unit, the N Reactor, and the Columbia River. The spill is located at Washington State Plane coordinates E571411, N149699.

Sand and fines were used to stabilize the soil contamination prior to its removal to the 200 Area for disposal. After the contaminated soil was removed, clean fill material was used to restore the site. There are no structures such as concrete foundations or pipelines associated with this waste site. Currently the site has no postings, fences, or access restrictions associated with the waste site itself since the contaminated soils have been removed and disposed of. However, no known confirmatory sampling exists; therefore, it is unknown if the site meets current cleanup standards.

2.4.3 116-N-3: 1325-N Liquid Waste Disposal Facility

2.4.3.1 Unit Description and Operating History. The 116-N-3 unit is composed of three distinct parts: the crib, the straight trench, and the pipelines. The 116-N-3 Crib was constructed and put into operation in October 1983 as a replacement for 116-N-1, which exceeded its disposal capacity. The 116-N-3 unit operated until April 1991, receiving an average flow of 1,700 L/min (450 gal/min), and was shut down in 1993. Table 2-4 summarizes the major events that occurred during the operational history of 116-N-1 and 116-N-3. The 116-N-3 unit is located approximately 300 m (1,000 ft) east and 61 m (200 ft) north of 116-N-1 (away from the Columbia River). Figure 2-4 shows the general location of 116-N-3 in relation to N Reactor, the Columbia River, and 116-N-1.

The 116-N-3 Crib is 76 m (250 ft) by 73 m (240 ft) and has a concrete cover positioned about 1.3 m (4 ft) below the surrounding surface grade, which is at about 137.5 m (451 ft) amsl. The cover is made of precast concrete panels completely sealed with grout. The crib's soil

percolation surface is 2 m (6 ft) below the cover at an elevation of 134 m (441 ft). Figure 2-17 depicts a three-dimensional view of the crib cut away to help visualize these features.

Effluent was delivered to the 116-N-3 Crib through a 366-m- (1,200-ft) long by 91-cm- (36-in.) diameter pipeline. A reinforced concrete header box-and-trough system distributed the effluent in the 116-N-3 Crib. Figure 2-18 illustrates this distribution system and how it worked. Effluent entered from the 91-cm (36-in.) pipeline into the main distribution trough that runs down the center of the crib. The effluent flowed through holes in the sides of the main distribution trough into the distribution laterals. Similar holes in the sides of the distribution laterals allowed the effluent to evenly discharge out to the soil column.

Because of low percolation rates in the soil column, the 116-N-3 Crib was not able to achieve its designed flow capacity. Consequently, between 1983 and September 1985, both 116-N-1 and the 116-N-3 Crib were in service. The 116-N-1 unit was used as an alternate discharge point to prevent the 116-N-3 Crib from overflowing, which, according to personnel interviews, did occur (BHI 1996). These interviews reveal that within the first couple of months of crib operation (October and November 1983), the capacity of the crib was exceeded two or three times, causing it to overflow. Each of the overflows traveled no more than 6.1 to 9.1 m (20 to 30 ft) from the concrete cover on the crib. All contamination stayed within the fenced boundary, and each overflow was covered with a 15- to 20-cm (6- to 8-in.) layer of clean 2.5- to 5- cm (1- to 2- in.) river rock. After these initial incidents, the flow to 116-N-3 was controlled to prevent any further overflows.

Construction of the 116-N-3 straight extension trench started 3 months after operation of the crib began (BHI 1996). The 116-N-3 straight extension trench was put in full service in September 1985. It is 914 m (3,000 ft) by 17 m (55 ft) and is 3 m (10 ft) deep from the bottom of the concrete panels to the soil percolation surface, which is at an elevation of 133 m (437 ft) amsl. This trench is also covered with precast concrete panels that have been placed close together but left unsealed. The panels have lifting lugs. Centracore concrete panels measuring 0.6 m (2 ft) by 20.3 cm (8 in.) were placed, unsealed, along the sides of the trench. The sides of the trench were then backfilled, thus creating a minimum barrier distance of 0.9 m (3 ft) for burrowing animals.

The trench is divided into four equal sections by three dams. Only the first 226 m (740 ft) of the 116-N-3 Trench was used because effluent levels never rose high enough to cross the first dam. The dams are composed of structural fill and concrete. A layer of riprap was added on the downstream side of each dam to prevent scouring. The top 0.6 m (2 ft) of the trench bottom was screened to remove the fines to enhance percolation and reduce plugging. Figure 2-19 shows a typical cross section through the trench at one of the dams to illustrate the details of the trench construction.

The trench ties into the crib at two points (from the crib's northern and eastern corners) with the effluent from these points combining in a common weir box. The tie-in is composed of rubber-gasket-joined, precast, reinforced concrete box sections. Figure 2-20 shows a three-dimensional view of the tie-in weir box. Effluent flowing through the weir discharges into

the trench through an overflow gate in the weir box. Figure 2-20 also shows a cutaway drawing of the overflow gate in the weir box. From the weir box, the trench extends about 914 m (3,000 ft) in a north-northeasterly direction.

In September 1985, 116-N-3 became the primary LWDF at 100-N, and 116-N-1 was used only as an emergency discharge point in case of an accident. In January 1987, N Reactor was placed on standdown status for an extended maintenance and safety upgrade period. Discharges to 116-N-3 decreased significantly at that time and ceased in April 1991.

During an inspection of the 116-N-3 Crib in June 1995, standing water was observed in the main (center) concrete distribution trough. No standing water was observed on the soil surface of the crib. During a second inspection in June 1996, the level of water in the trough had dropped approximately 51 cm (20 in.).

2.4.3.2 Associated Pipelines. Two pipelines come from the 116-N-1 weir box. One pipeline feeds directly to the 116-N-3 unit, and the other pipeline ends in the 1312-N Liquid Effluent Retention Facility, a lined emergency storage pond that was never used. These lines are both 91 cm (36 in.) in diameter, and the total combined length is 632 m (2,073 ft). More detail about these pipelines and the maps used to define them can be found in Table 2-5 and in Appendix D.

During the construction of the 1312-N Liquid Effluent Retention Facility, a concrete-covered bypass trench was built to allow effluent to be transferred between 1312-N and 116-N-3. Like 1312-N, it was never used. Because it is considered to be part of 1312-N and has never been used, this trench will not be addressed in this TSD CMS.

Drawings (H-1-48891, H-1-48892, and H-1-48895) indicate two additional pipelines that will be encountered during remediation: a 30-cm- (12-in.) diameter underground export water line that was rerouted over the top of the trench cover during trench construction, and an abandoned pipeline of an unknown diameter that was cut and plugged with concrete during trench construction. Figure 2-21 shows the location of all known pipelines.

2.4.3.3 Current Site Conditions. Currently, 116-N-3 is surrounded by a chain link fence and is locked. Access is controlled by the ERC radiological controls organization. The fence line is posted with "Caution, Contamination Area," "Caution, Radiation Area," and "Danger - Unauthorized Personnel Keep Out" warning signs. There is a drill pad located on the west side (toward the river) of the crib inside the fence. A new access road was constructed on the west side of the crib near the 100-N Springs Pump-and-Treat facility that allowed heavy equipment such as drill rigs easier access to the TSD unit. Figure 2-22 is a photograph showing some of these features. Figure 2-23 shows the general topography of the surrounding area.

The radiological conditions at 116-N-3 require special consideration when evaluating alternatives for remediation of the unit. The following information was taken from the 1301-N/1325-N LFI (DOE-RL 1996b) and from copies of the *Westinghouse Hanford Company Operational*

Environmental Monitoring Annual Report for calendar years 1994 (WHC 1995) and 1995 (WHC 1996).

In 1995, radiation measurements at 116-N-3 decreased by approximately 22% from 1994 levels. During a site inspection at 116-N-3 in 1994, the dose rate was more than 1,000 mrem at the crib soil surface (probe access was obtained through a manhole) and about 125 mrem/hr at 1 m (3 ft) above the crib concrete panels.

Regardless of the alternative selected for remediation of 116-N-3, special consideration must be given to the removal of the concrete panels on the 116-N-3 Crib and Trench. It is assumed that the concrete panels have fixed and removable contamination present, especially on the side exposed to the soil. It is not known at this time whether cutting and removing them in one piece is feasible because rebar may be present. Breaking these panels for removal may create airborne contamination concerns. These concerns can be mitigated by spraying water on the panels during their removal. These concerns will need to be resolved during the remedial design phase and the ALARA principal will need to be employed to protect the workers and prevent any spread of contamination.

2.4.4 Nonradioactive Sites

Three of the waste sites in this CMS never received radioactive contaminants: 120-N-1, 120-N-2, and 100-N-58. Because these sites collectively define a single disposal process and because a thorough discussion of one waste site cannot be made without inclusion of the other sites, all three sites are discussed together in this section. It is also appropriate to group them together because they are immediately adjacent to each other and any remediation performed on one site would likely impact the other sites.

2.4.4.1 Unit Description and Operating History. The 120-N-1 Percolation Pond, the 120-N-2 Surface Impoundment, and 100-N-58, along with the associated pipelines, make up the disposal system for effluent from the 163-N Demineralized Water Treatment Plant. Figure 2-4 shows the location of these sites in relation to some of the 100-N facilities and the Columbia River. This system took on various configurations during its operating life, which began in 1977. Prior to startup of this system, these effluents were discharged directly to the Columbia River. During various operating modes, the system neutralized and disposed of effluent from 163-N and received and disposed of filter backwash water from the 183-N Water Filter Plant. The average flow rate to this disposal system was 1,200 L/min (310 gal/min). Table 2-6 summarizes the major events that occurred during the operational history of 120-N-1, 120-N-2, and 100-N-58.

From August 1977 until spring 1983, the system included the North Settling Pond, 100-N-58, and the 120-N-1 Percolation Pond. The unlined settling ponds each measured approximately 34 m by 15 m (110 ft by 50 ft) at the surface with sides sloping to a bottom measuring approximately 24 m by 3 m (70 ft by 10 ft). The estimated depth of each pond was 4.5 m (15 ft) (DOE-RL 1995f). The percolation pond had a bottom area of approximately 850 m^2 (9,200 ft^2) and an estimated capacity of 4.5 million L (1.2 million gal) (DOE-RL 1995f). Figure 2-24 shows

the system's configuration during this period and the general flow of effluent through the system and into the soil column.

Corrosive wastes from the 163-N Demineralization Plant were produced during regeneration of acidic cation columns and alkaline anion columns, which were alternately discharged to the disposal system. Regeneration of the cation column was performed using a 2% to 4% sulfuric acid solution. Regeneration of the anion column used a 4% solution of sodium hydroxide. Each column was regenerated about twice per day under normal operating conditions and as often as eight times per day during reactor refueling and maintenance periods.

This alternate discharge of high and low pH wastes served to neutralize the wastes in the 120-N-1 Percolation Pond. The percolation pond also made use of the buffering capacity and calcareous nature of the soil column to neutralize the corrosive wastes. There is no record of radionuclides from 100-N Area operations being discharged to this disposal system. Westinghouse Hanford Company (WHC) personnel have indicated that low levels of naturally occurring thorium may be present in the system as a result of using alum in the water treatment process (DOE-RL 1995f). No other radionuclides were detected in soil samples taken from beneath the pond (DOE-RL 1995f).

Effluent from 163-N was combined with the 183-N filter backwash water and then piped to the North Settling Pond and 100-N-58. The filter backwash fines settled out in these two ponds. The remaining effluent either discharged directly to the soil column through the bottom of the settling pond or overflowed to the percolation pond via two 0.3-m (12-in.) polyvinyl chloride drain lines. It was then discharged to the soil column.

By 1978, the fines had plugged the bottoms of the settling ponds, and the ponds had to be dredged to prevent flooding. If flooding did occur, it is likely that the overflow went toward the northern side of the units where the surrounding surface grade drops slightly. The dredging was performed at least once per year and sometimes as often as monthly. The more frequent dredging occurred when water usage was at its peak, which occurred during reactor refueling and maintenance periods. The dredging operation consisted of a clam-shell bucket being pulled across the bottom of the pond by a crane. The crane dumped the fines on the surrounding ground surface within reach of the crane's boom. Based on personnel interviews, the fines were never hauled or removed from the site and were pushed around and mixed with native soils during different phases of construction. Currently, there is no visible evidence of dredging spoil piles at the TSD units.

In the spring of 1983, the system underwent its first major reconfiguration. The filter backwash water was rerouted through a new pipeline to the newly constructed 130-N-1 Filter Backwash Disposal Pond dedicated solely to that effluent. The settling ponds were no longer needed for fines removal and were removed from service. For the 120-N-1 Percolation Pond to operate on its own, the pond capacity had to be enlarged from 4.5 million L (1.2 million gal) to 11.4 million L (3 million gal) and the bottom area increased from 850 m^2 (9,200 ft^2) to approximately 2,700 m^2 (29,000 ft^2). A new pipeline to handle only 163-N effluent was put into service, and the

original line was abandoned in place. During this construction period, 100-N-58 was backfilled to grade (DOE-RL 1995f).

Figure 2-25 shows the system during this phase of operation. The corrosive wastes from 163-N were disposed of and treated in the percolation pond. The effluent was then discharged to the soil column. The system operated in this manner until May 13, 1986, when the 120-N-2 Surface Impoundment was put into service to treat the corrosive waste before it was discharged to the percolation pond.

The 120-N-2 Surface Impoundment is a double-lined pond (two 45-mil Hypalon™ liners) with a leachate collection system. A sampling shed is located in the northeast corner of the 120-N-2 surface impoundment. The pond was built in the location of the old North Settling Pond. The surface impoundment measures approximately 43 m by 23 m (140 ft by 75 ft) at the surface. Its sides slope down to the bottom and measure approximately 24 m by 4.6 m (80 ft by 15 ft). The pond is approximately 4.6 m (15 ft) deep and has a designed capacity of 1.6 million L (424,000 gal). After treatment in the surface impoundment, neutralized waste waters were transferred to the percolation pond via a 30-cm (12-in.) polyvinyl chloride drain line and a 30-cm (12-in.) polyvinyl chloride overflow line (DOE-RL 1995f). The neutralized effluent then discharged to the soil column. Figure 2-26 shows how the system operated in this configuration.

The 120-N-2 Surface Impoundment was operated in conjunction with the percolation pond until November 1988, when the elementary neutralization unit (ENU) was installed in the 163-N facility. The surface impoundment was no longer needed for treatment of corrosive wastes and was removed from service. No leaks were detected in this unit (DOE-RL 1995f). The percolation pond received only neutralized effluents from November 1988, when the ENU became operational, to May 1991 when all effluent discharges to this system were terminated. The system's configuration during this period is shown in Figure 2-27. Although conflicting dates for the termination of discharges to 120-N-1 are given in different reports, personnel interviews indicate that discharges ceased in May 1991.

2.4.4.2 Associated Pipelines. Two pipelines feeding these units are shown on piping drawings (H-1-45007, Sheets 7, 8, 14, 15, and 16). The original line, which carried both 163-N effluent and 183-N filter backwash effluent, was abandoned in 1983 when the 130-N-1 pond was put into service. The second line carried only 163-N neutralized effluent and no dangerous waste constituents from November 1988 until May 1991. The first line, which was abandoned, is addressed in the CMS; the second is not. Also shown on the drawings and included in the CMS are the overflow lines between ponds. These lines are all less than or equal to 30 cm (12 in.) in diameter. More detail about these pipelines and the maps used to define them can be found in Table 2-7 and Appendix D.

Some pipelines can be seen coming into the percolation pond from the direction of the settling ponds and the surface impoundment. Pipelines that were taken out of service during the evolution of the disposal process were likely abandoned in place and are expected to be

encountered during remediation. Figure 2-28 shows the locations of known pipelines that may be encountered during remediation.

2.4.4.3 Current Site Conditions. The site is currently surrounded by a 2-m (8-ft) chain link fence with locked gates and topped with barbed wire. The site is currently posted with "No Trespassing" and "Danger - Unauthorized Personnel Keep Out" signs. Figure 2-29 is a photograph showing the site as it is today. Figure 2-30 shows the general topography of the surrounding area.

2.5 IDENTIFICATION OF CONTAMINANTS OF POTENTIAL CONCERN

The list of COPCs at the TSD units is compiled from lists of COPCs identified in previous reports and agreed to by the Tri-Parties. This list of contaminants is the starting point for defining the "refined" COPCs, and finally the contaminants of concern (COCs) for the units. The refinement process is presented in Figure 2-31. The COCs are the contaminants used to determine the remedial volumes (Section 4.0). They are addressed in the remedial alternatives (Section 5.0). The following sections present the methodology and results of determining the list of contaminants and the COPCs.

The COPC list does not include methanol which will need to be evaluated in order to close the units under *Washington Administrative Code* (WAC) 173-303-610. Methanol is currently defined as a listed waste (dangerous waste code F003), but has not been defined as a potential risk to human health and the environment in the 100-NR-1 QRA (BHI 1995b). No organic vapors (including methanol) were detected with an organic vapor monitor during the 1301-N/1325-N LFI activities. Therefore, methanol is not carried through as a COPC for the purposes of remedial action. However, methanol is discussed in the context of dangerous waste closure in Appendix A. Because samples within 116-N-1 and 116-N-3 have not been collected and analyzed for methanol, sample analysis and collection would be required to verify its absence before final closure of the units.

The sulfate plume that is present in groundwater beneath 120-N-1, 120-N-2, and 100-N-58 is being evaluated in the 100-NR-1/NR-2 CMS (DOE-RL 1996c) as a part of the groundwater OU.

2.5.1 Identification of the List of Contaminants

The list of contaminants at the TSD units was compiled from COPC lists in three previous reports:

- 100-NR-1 Qualitative Risk Assessment (BHI 1995b)
- DQO Workshop Results for 1301-N/1325-N (BHI 1996)
- 100-NR-1/NR-2 CMS (DOE-RL 1996c).

The COPCs in the 100-NR-1 QRA are those contaminants that exceed an incremental cancer risk (ICR) of 1 x 10^{-5} or exceed an environmental hazard quotient of one. The COPCs in the 1301-N/1325-N DQO report are those contaminants that were considered primary risk drivers or were discharged to the units in considerable amounts. The 100-NR-1/NR-2 CMS provides a list of contaminants in groundwater plumes that are attributable to 116-N-1 and/or 116-N-3. The list of contaminants compiled from the three sources is presented in Table 2-8 for contaminants in the surface soils (0 to 3.0 m [0 to 10 ft] below surrounding grade [bsg] and 0 to 4.6 m [0 to 15 ft] bsg) at 116-N-1/116-N-3; in Table 2-9 for subsurface soils (greater than 3.0 m [10 ft] bsg and 4.6 m [15 ft] bsg) at 116-N-1/116-N-3; and in Table 2-10 for surface soils at 120-N-1, 120-N-2, and 100-N-58. The list of contaminants has been separated into surface and subsurface soils to facilitate comparisons with preliminary remediation goals (PRGs).

2.5.2 Selection of Maximum Representative Concentrations

The next step in the COPC selection process is to select the maximum representative concentration (MRC) for each constituent on the list of contaminants. The MRC is then compared to background values for the compiled COPC list.

The MRCs were obtained from the quantitative soil data from boreholes located in the vicinity of, and between, the TSD units and from sediment samples collected from within the TSD units:

- **116-N-1/116-N-3:** boreholes 199-N-75, 199-N-76, 199-N-80, 199-N-103A, 199-N-104A, 199-N-105A, 199-N-106A, 199-N-107A, 199-N-108A, 199-N-109A; RW#1, RW#2, RW#3; and sediment samples TS-01, TS-02, TS-03, TS-04, TS-05, TS-06, TS-07, TS-08, TS-09, CS-01, CS-02, CS-03, CS-04, CS-05, CS-06, CS-07, CS-08, CS-09, CS-10, CS-11, CS-12.

- **120-N-1/120-N-2/100-N-58:** boreholes 199-N-88 and 199-N-89, and test pit samples.

The location of the boreholes is presented in Figure 2-32. Samples from the surface to the water table were used because the RAOs include protecting humans and animals exposed to contaminants near the surface and protecting the groundwater, which may be impacted by contaminants deeper in the vadose zone. Samples along the 100-N shoreline were not used in MRC selection because the shoreline is being evaluated in the 100-NR-1/NR-2 CMS.

The MRCs for surface and subsurface soils were combined, and the highest representative concentration detected was selected for this screening process. This results in the most comprehensive list of COPCs given the amount of data available.

The data screening process used to select the MRC consisted of the following simplified steps:

1. Selecting the maximum detected concentration for the analyte being considered.

2. Comparing the maximum concentration to the concentrations in other samples from the same borehole and to concentrations in other nearby boreholes by measuring the same media, such as soils, within the facilities. Determining whether the maximum concentration is consistent with the other data. The following criteria were used to assist in evaluating consistency:

   - Was the analyte detected in other samples from the same borehole or nearby locations or from other sediment samples or sampling rounds?

   - Was the maximum concentration within an order of magnitude of the concentrations observed in the other samples?

   This evaluation is intended to identify outlier data that may not be representative of site conditions.

3. Evaluating the maximum concentration with respect to the distribution of the data.

   - If the maximum concentration follows the distribution of the rest of the data, that maximum concentration is designated as the MRC.

   - If the maximum concentration does not follow the distribution of the data and is approximately an order of magnitude above the next highest value, the maximum concentration will be further evaluated for representativeness. If this evaluation indicates that the maximum concentration is not representative of the site, the next highest value will be designated as the MRC.

At 120-N-1, 120-N-2, and 100-N-58, the highest concentration of nickel was 135 mg/kg. The next highest concentration was 17.6 mg/kg. There is no source of nickel at these TSD units, and the lower nickel concentrations are considered representative of background. The high nickel concentration detected was not verified by other samples collected at the TSD units and is not considered representative of nickel concentrations in soil at these TSD units.

2.5.3 Comparison of MRC to Background

The MRC is compared to the 90th percentile of lognormal distribution Hanford Site background concentration for each analyte. The Hanford Site background concentrations for radioactive nuclides and nonradioactive analytes in soil are presented in DOE-RL (1996e) and DOE-RL (1995b), respectively. If the MRC exceeds the background value, the analyte is retained. If there is no background value for the analyte, the analyte is retained by default. If the MRC is less than or equal to background, the analyte is removed from consideration as a COPC.

Table 2-11 (116-N-1/116-N-3) and Table 2-12 (120-N-1/120-N-2/100-N-58) present the MRC and the background value for each contaminant.

2.5.4 Rationale for Selection of Contaminants of Potential Concern

Several of the analytes retained in the previous step of comparison-to-background were not retained as COPCs for the following reasons:

1. The radionuclide was naturally occurring; concentrations were less than, equal to, or within the range of background values; and the N Reactor operations did not contribute to accumulations of these constituents.

   Radium-226 was detected at 116-N-1 and 116-N-3 at concentrations within the range of background and was eliminated from the COPC list. Potassium-40 is a naturally occurring radionuclide, and the N Reactor operations did not contribute to its accumulation.

2. Low-activity radionuclides with short half-lives, known from process knowledge to have been present in low concentrations, are eliminated as COPCs if they have decayed for at least five half-lives (EPA 1995). A decay time of five half-lives is sufficient for decay of 96.9% of the radionuclide activity and results in a reduced level of potential risk.

   Cerium-144 (half-life of 285 days), manganese-54 (half-life of 312 days), and ruthenium-106 (half-life of 1 year) were eliminated from the COPC list because they are low-activity radionuclides, known from process knowledge, and have decayed at least five half-lives. Additionally, at 116-N-1, thorium-228 (half-life of 1.9 years) was eliminated from the COPC list because of its half-life (five have occurred since discharges ceased in 1985). However, at 116-N-3, five half-lives have not elapsed since discharges ceased in 1991; therefore, thorium-228 has been kept as a COPC for 116-N-3.

3. When two radionuclides accompany each other and the risk of one is significantly less than the other, the one with the smaller risk will be removed from the COPC list. By addressing the radionuclide with the higher risk, the radionuclide with the lower risk will always be addressed.

   At 116-N-1 and 116-N-3, cesium-134, and pultonium-238, because of their high activity, were eliminated from the COPC list because they accompany cesium-137 and plutonium-239, the primary risk drivers. Even though the concentration of plutonium-238 is higher, the risk because of plutonium-239 is higher because the activity of plutonium-238 is a small fraction of the plutonium-239 activity.

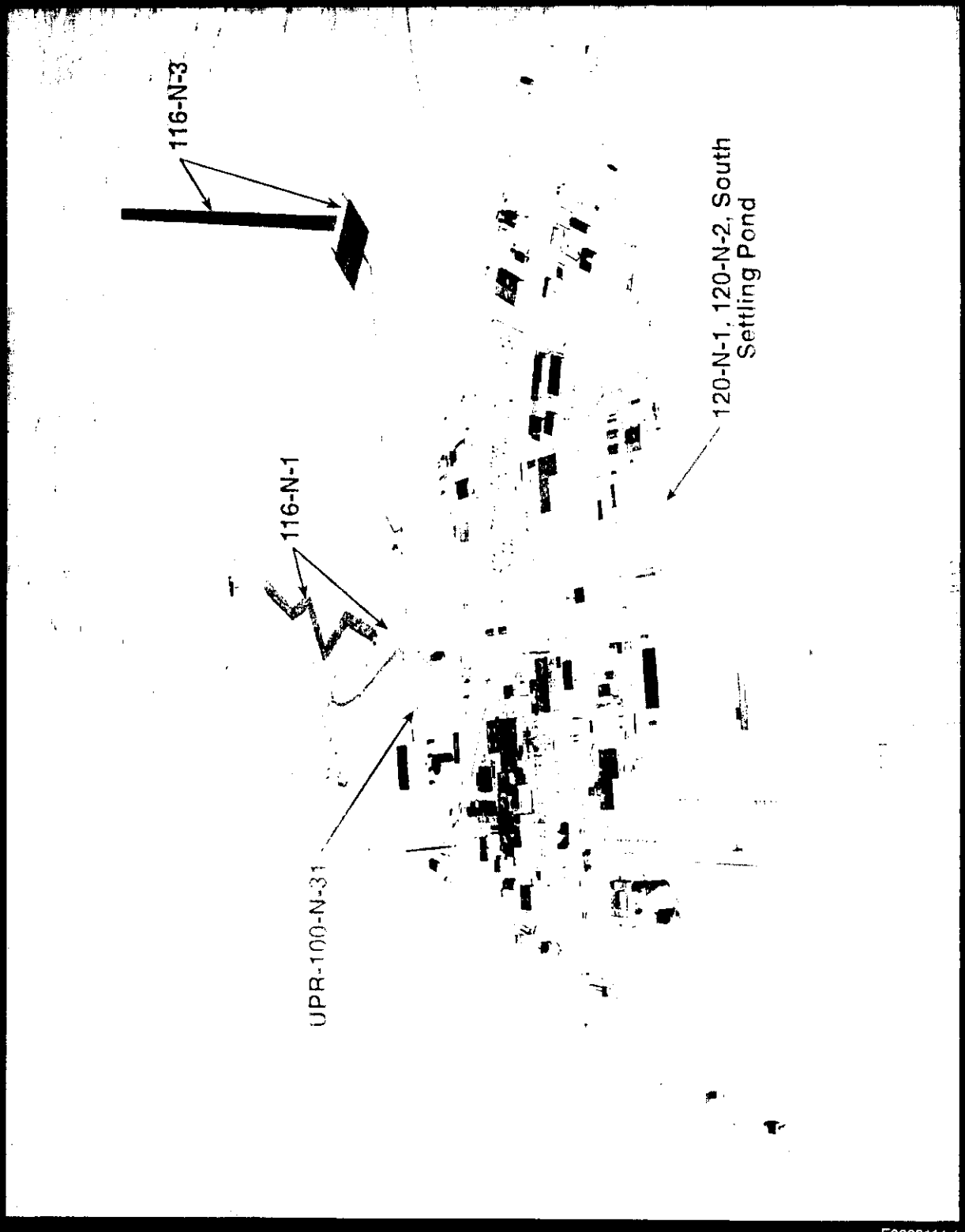
The rationale for COPC selection for surface soils and subsurface soils at 116-N-1 is presented in Table 2-13. The rationale for COPC selection at 116-N-3 is presented in Table 2-14, and for 120-N-1, 120-N-2, and 100-N-58 in Table 2-15.

2.5.5 Conclusions for Soil Contaminants of Potential Concern

The final lists of radionuclide and nonradionuclide COPCs for soil are presented in Tables 2-16 and 2-17 for 116-N-1 and 116-N-3, respectively. The COPCs at 116-N-1, 116-N-3, and UPR-N-31 will be further evaluated in Section 4.0 and compared to the PRGs developed and identified in Section 3.0.

The 120-N-1, 120-N-2, and 100-N-58 Percolation Pond system never received radioactive contaminants. This system received corrosive waste from water treatment plants. Soil samples from the vadose zone at 120-N-1 Percolation Pond, 120-N-2 Surface Impoundment, and the 100-N-58 South Settling Pond were collected in late 1992 and early 1993. Samples were collected from the surface to as deep as 23 m. The soil samples were analyzed for heavy metals, organics, cyanide, pH, and anions. Organic constituents were not detected. The concentrations of other constituents that were detected were compared to background levels for the Hanford Site. Background is allowed as a default cleanup level in most environmental regulations (e.g., WAC 173-303, and 173-340), which recognize that background levels are rarely detrimental to human health or the environment and that remediating to levels below background concentrations is futile. The comparison with background values follows the methodology recommended by Ecology (Ecology 1992). Using this comparison, the data are below background for all analytes so there are no contaminants of concern associated with these sites. Since there are no COPCs for 120-N-1, 120-N-2, and 100-N-58, the following sections do not include information pertinent to these waste sites. However, because these units are TSDs, closure plans and post-closure plans have been prepared and are included in Appendix B.

Figure 2-1. Aerial View of 100-N Area.



E9608114.1

Figure 2-2. General Stratigraphic Cross Section for 116-N-1 and 116-N-3.

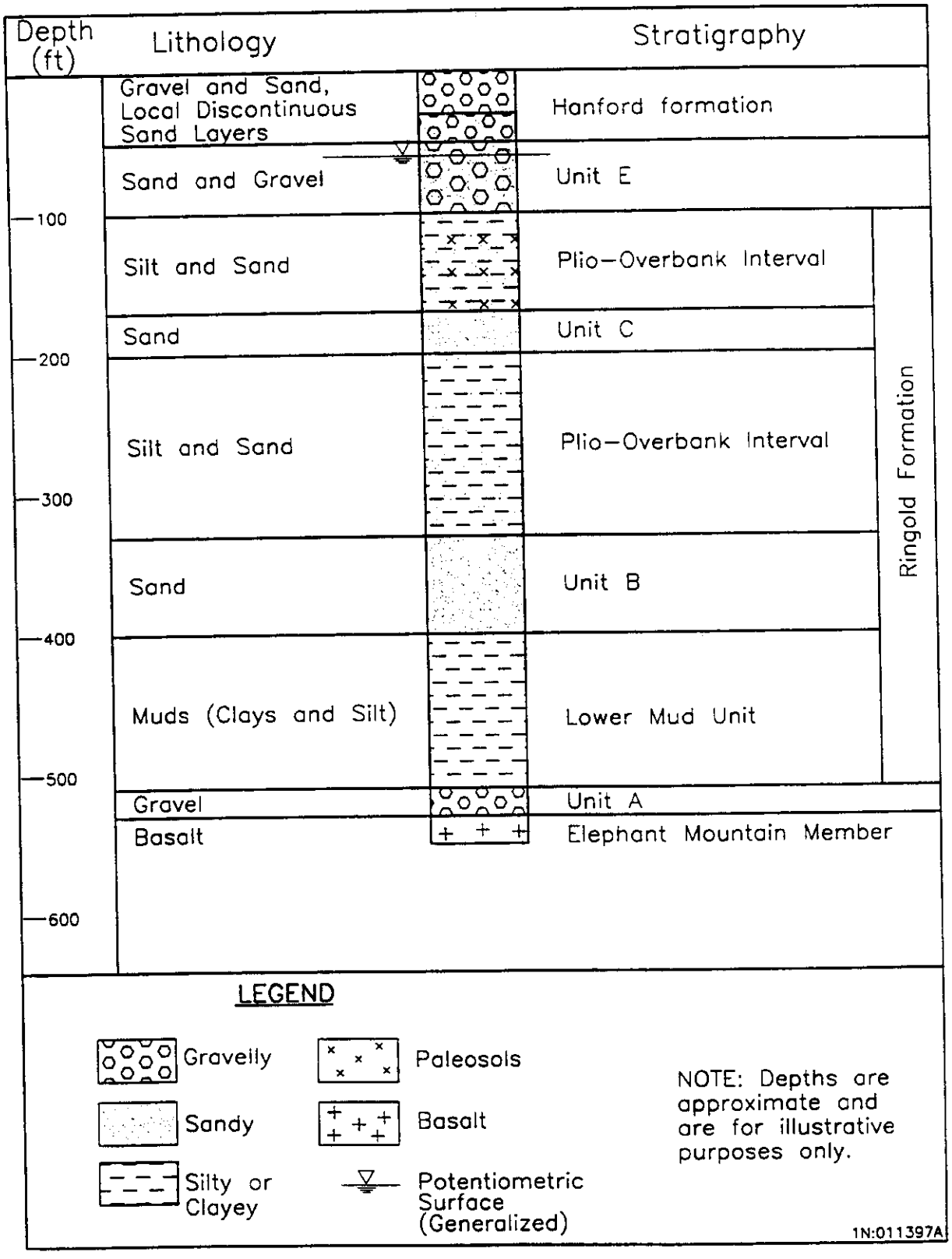


Figure 2-3. General Stratigraphic Cross Section for 120-N-1, 120-N-2, and 100-N-58.

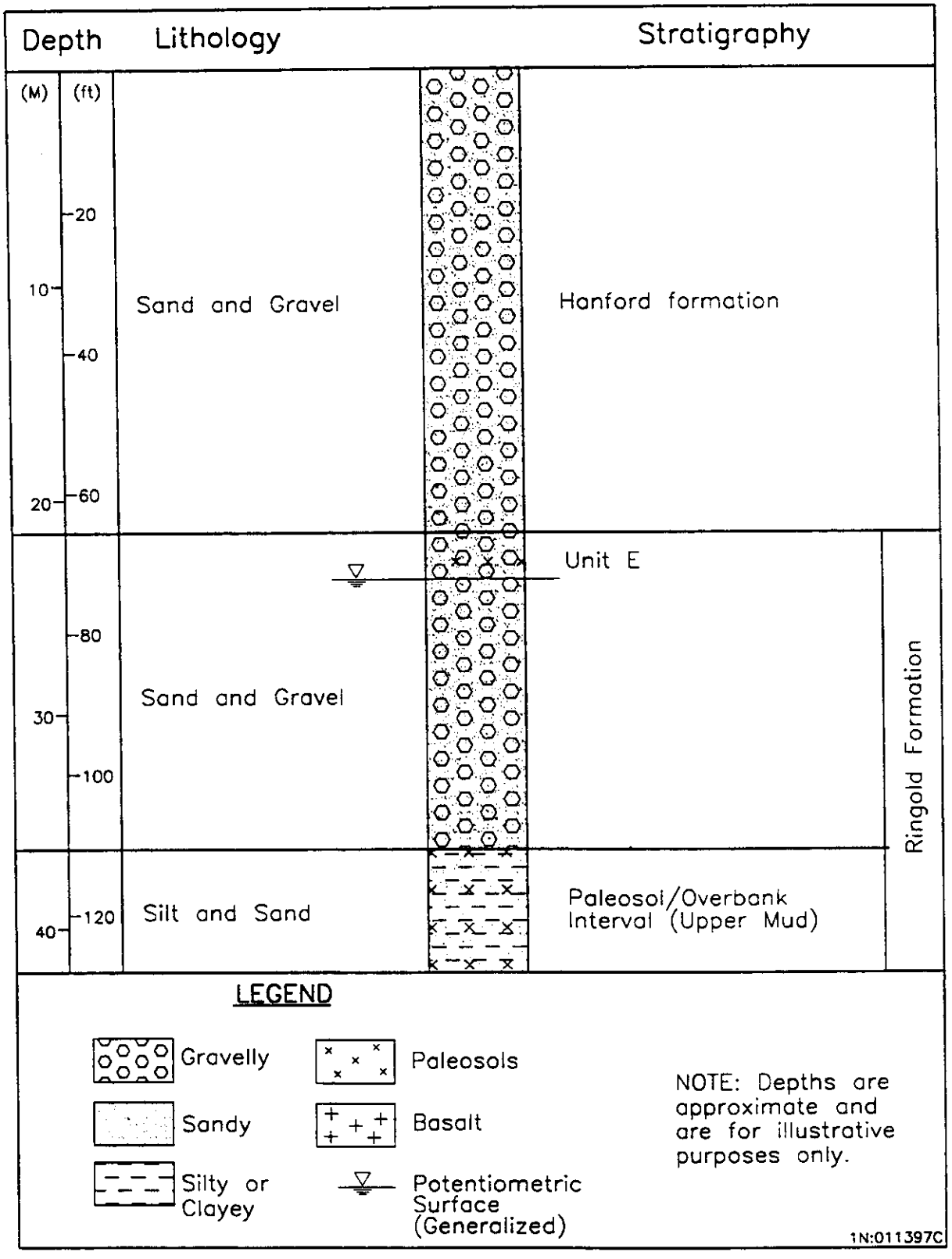
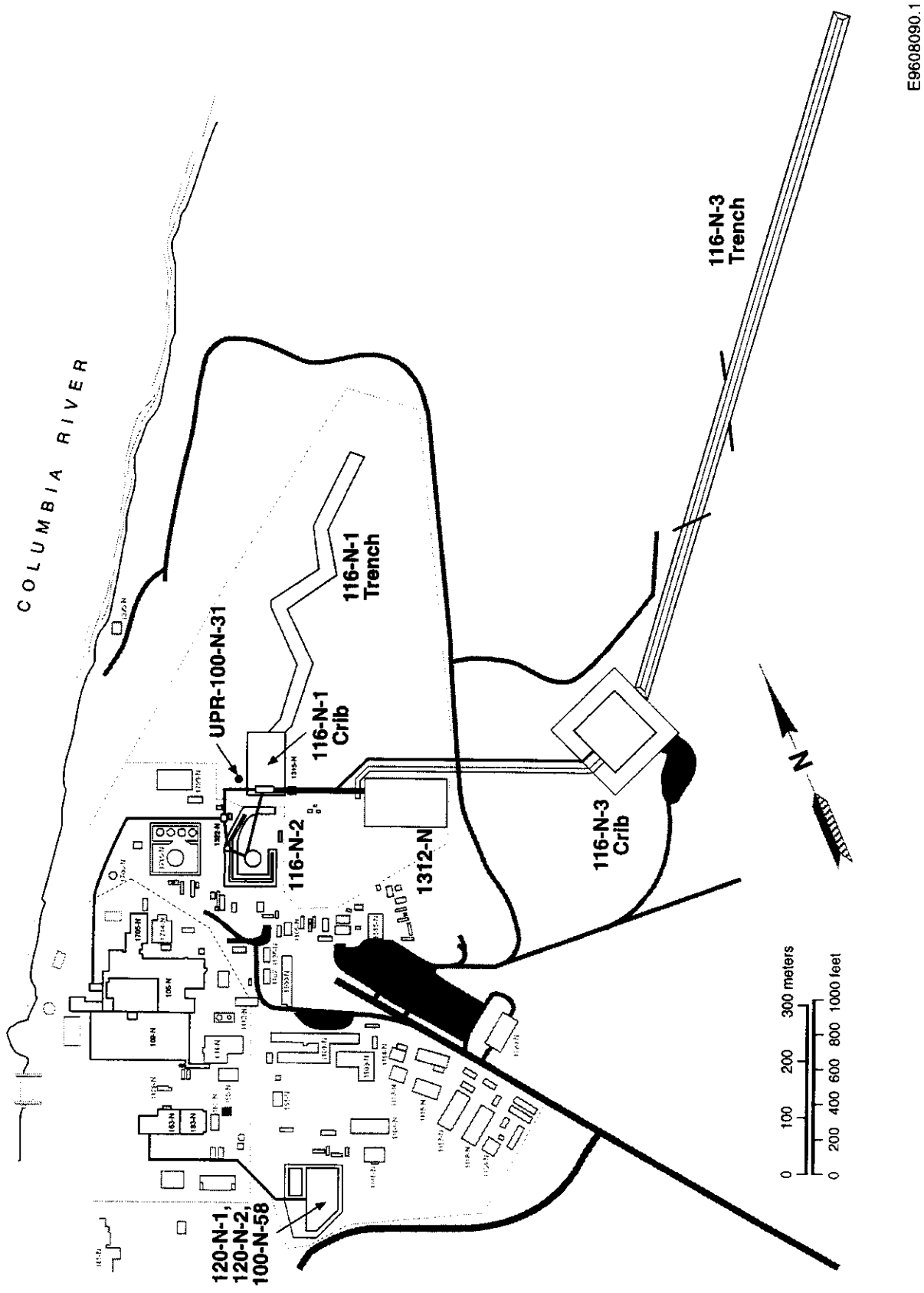


Figure 2-4. Selected Waste Sites at 100-N Area.



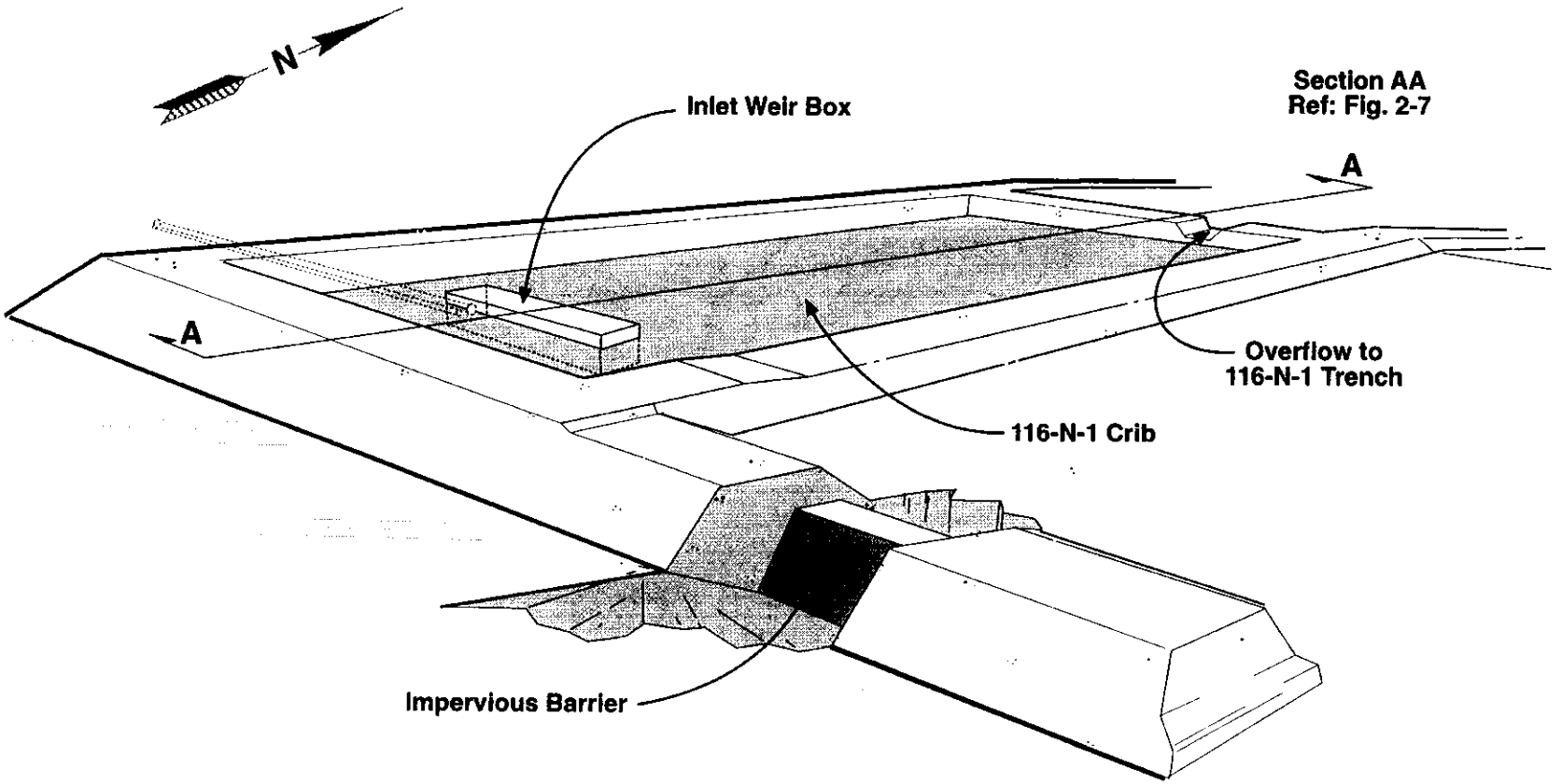


Figure 2-5. 116-N-1 Crib Construction.

E9608090.2

Figure 2-6a. Original Configuration of 116-N-1 Weir Box.

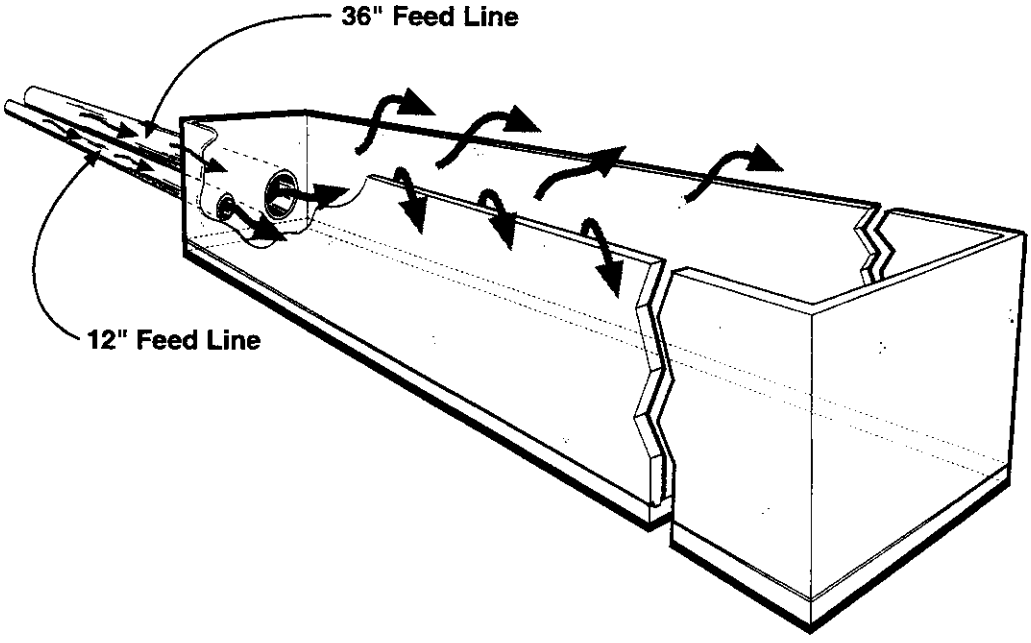
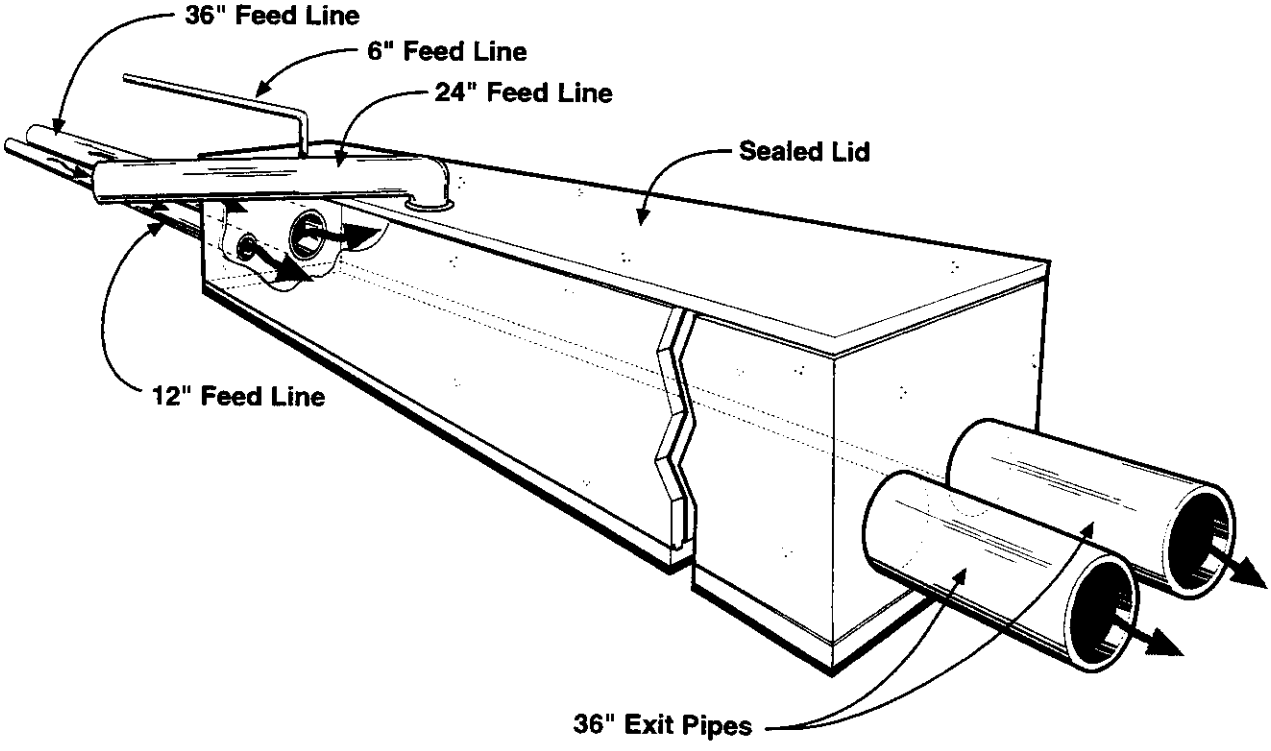
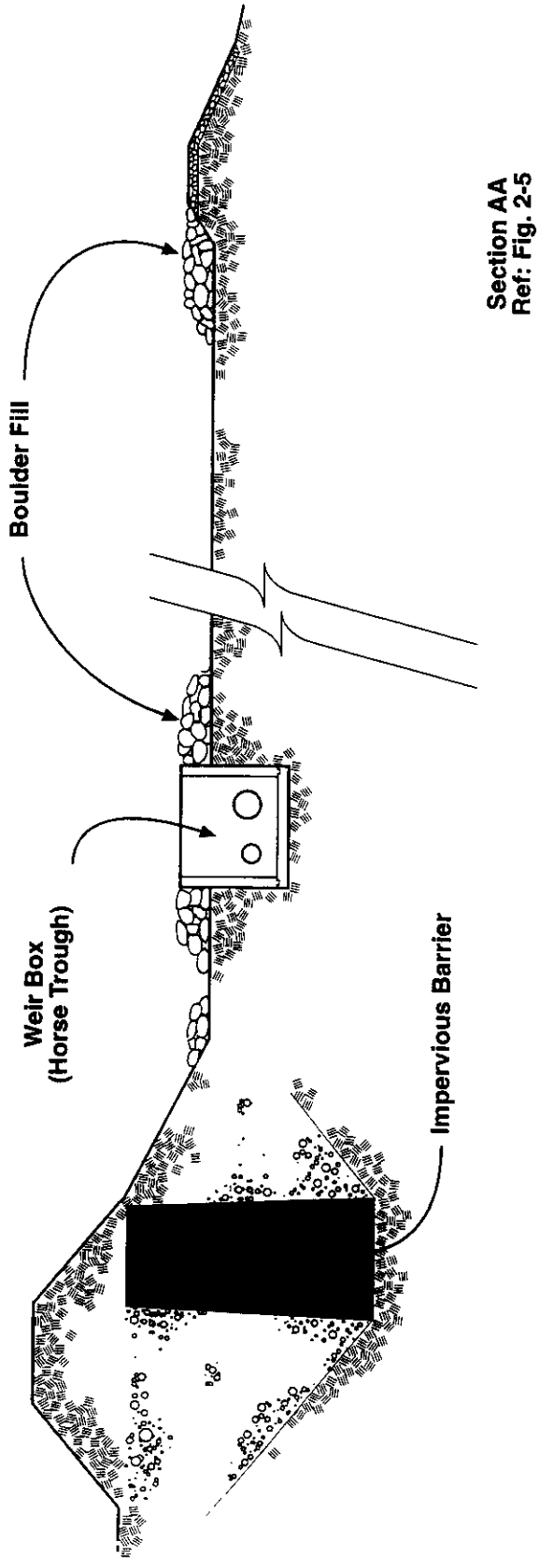


Figure 2-6b. Final Configuration of 116-N-1 Weir Box.



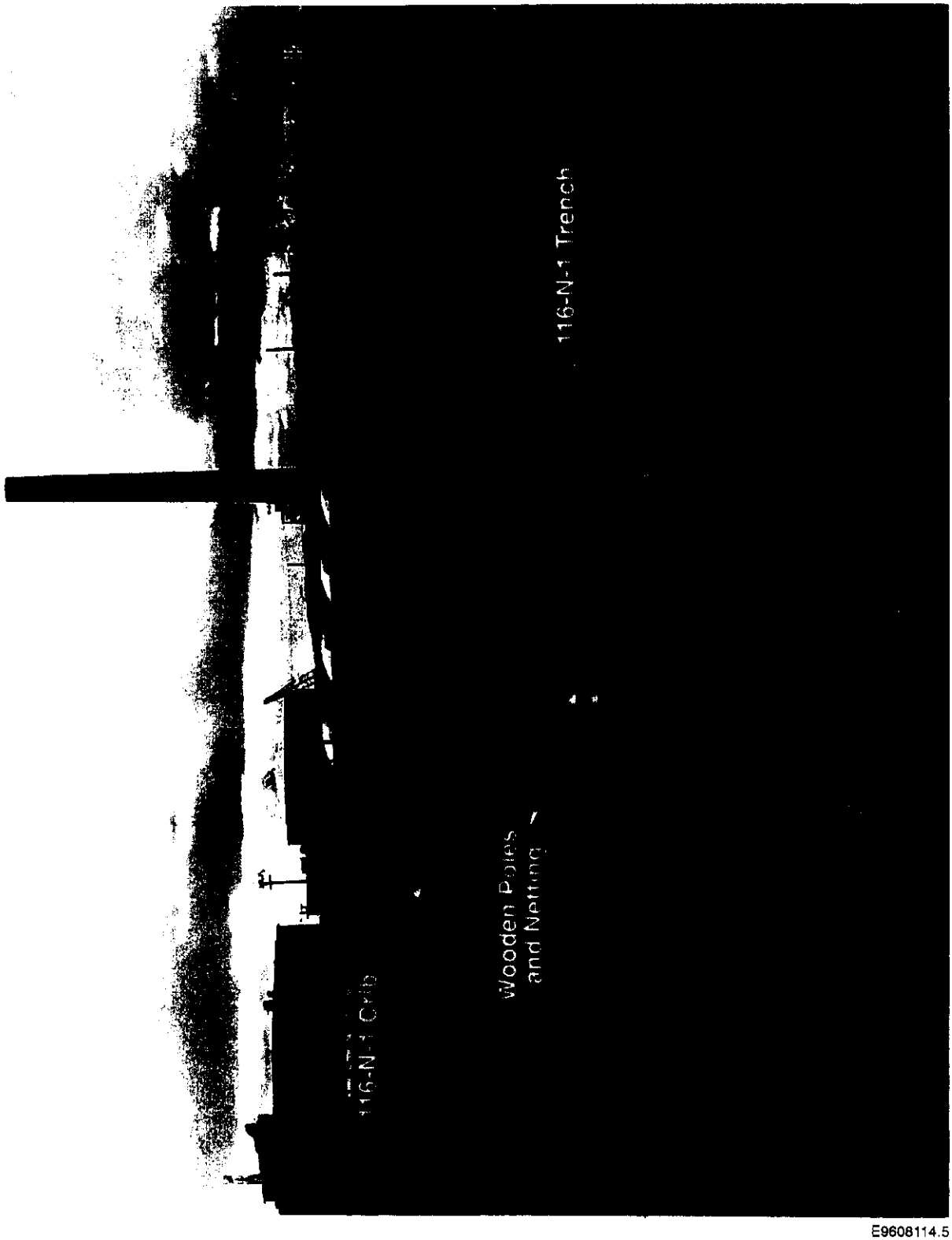
E9608090.3

Figure 2-7. 116-N-1 Crib Cross-Section A-A.



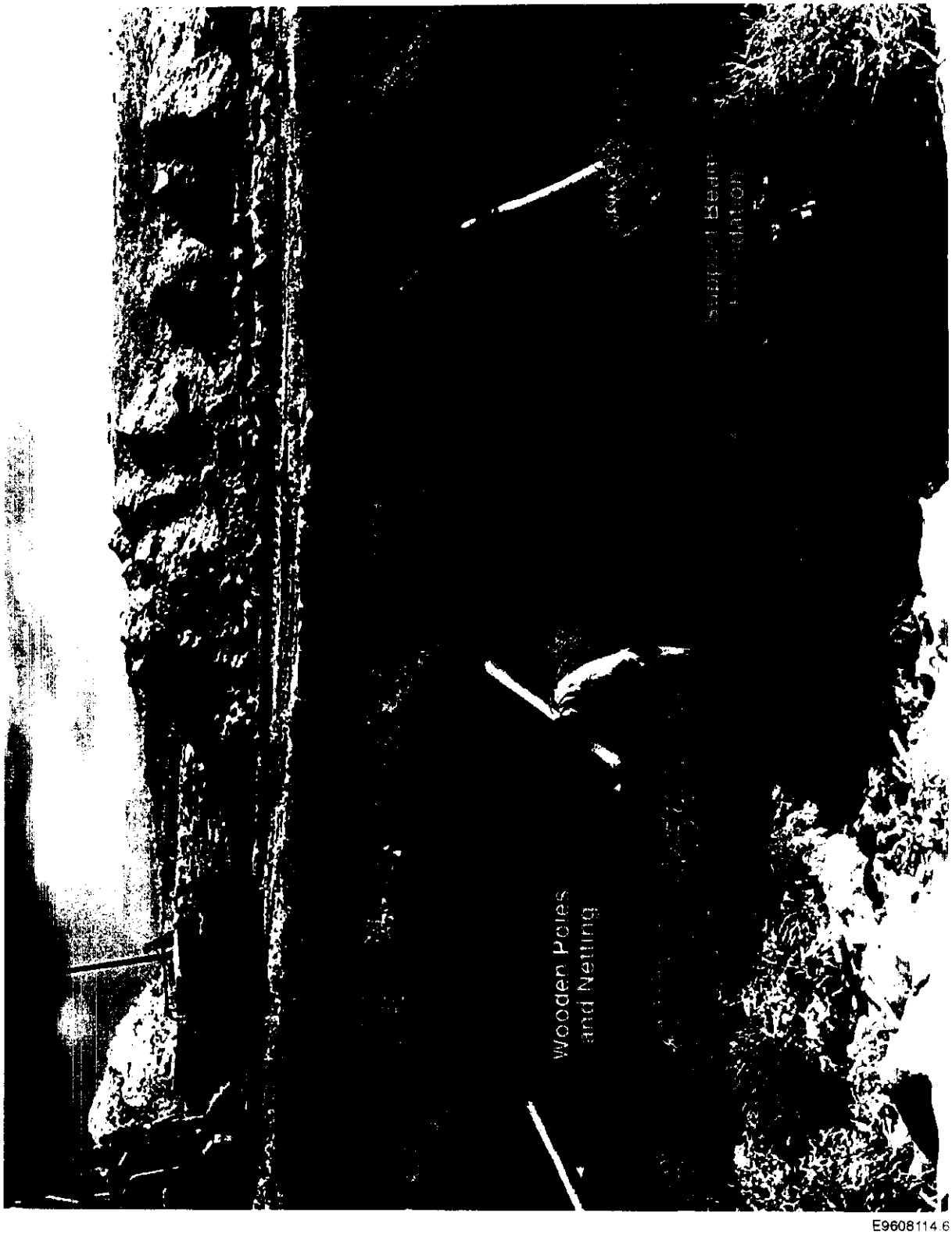
E9608090.4

Figure 2-8. 116-N-1 Crib and Trench (September 1981).



E9608114.5

Figure 2-9. 116-N-1 Trench During Cover Installation.

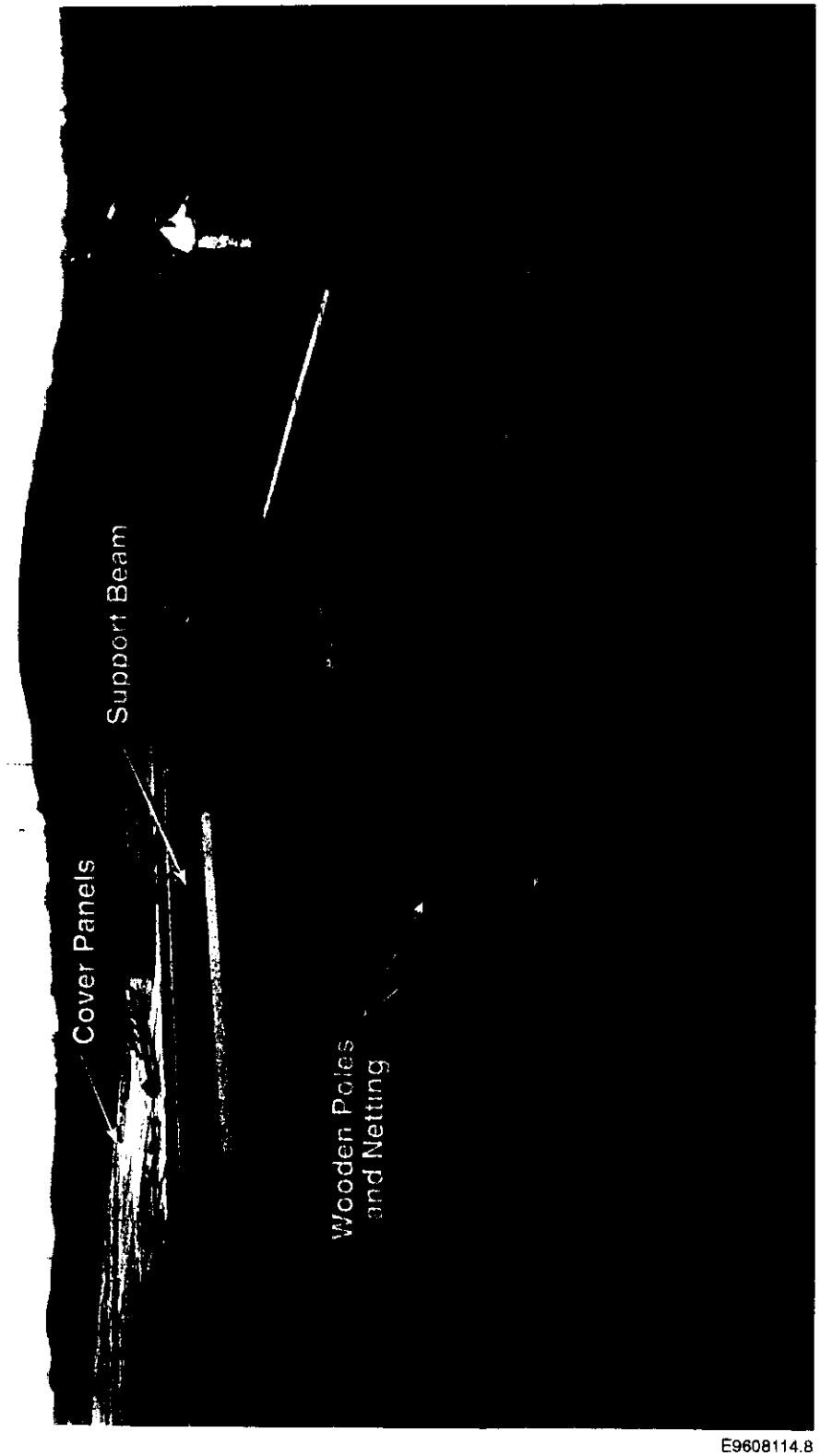


E9608114.6

Figure 2-10. Support Beams for 116-N-1 Trench Cover.

E9608114.7

Figure 2-11. Support Beam and Cover Panel Installation at 116-N-1 Trench.



E9608114.8

Figure 2-12. Cover Panels and Side-Slope Backfilling at 116-N-1 Trench.

E9608114.9

Figure 2-13. Grouted Cover Panels and Shotcrete Side Slopes at the 116-N-1 Trench.

E9608114.10

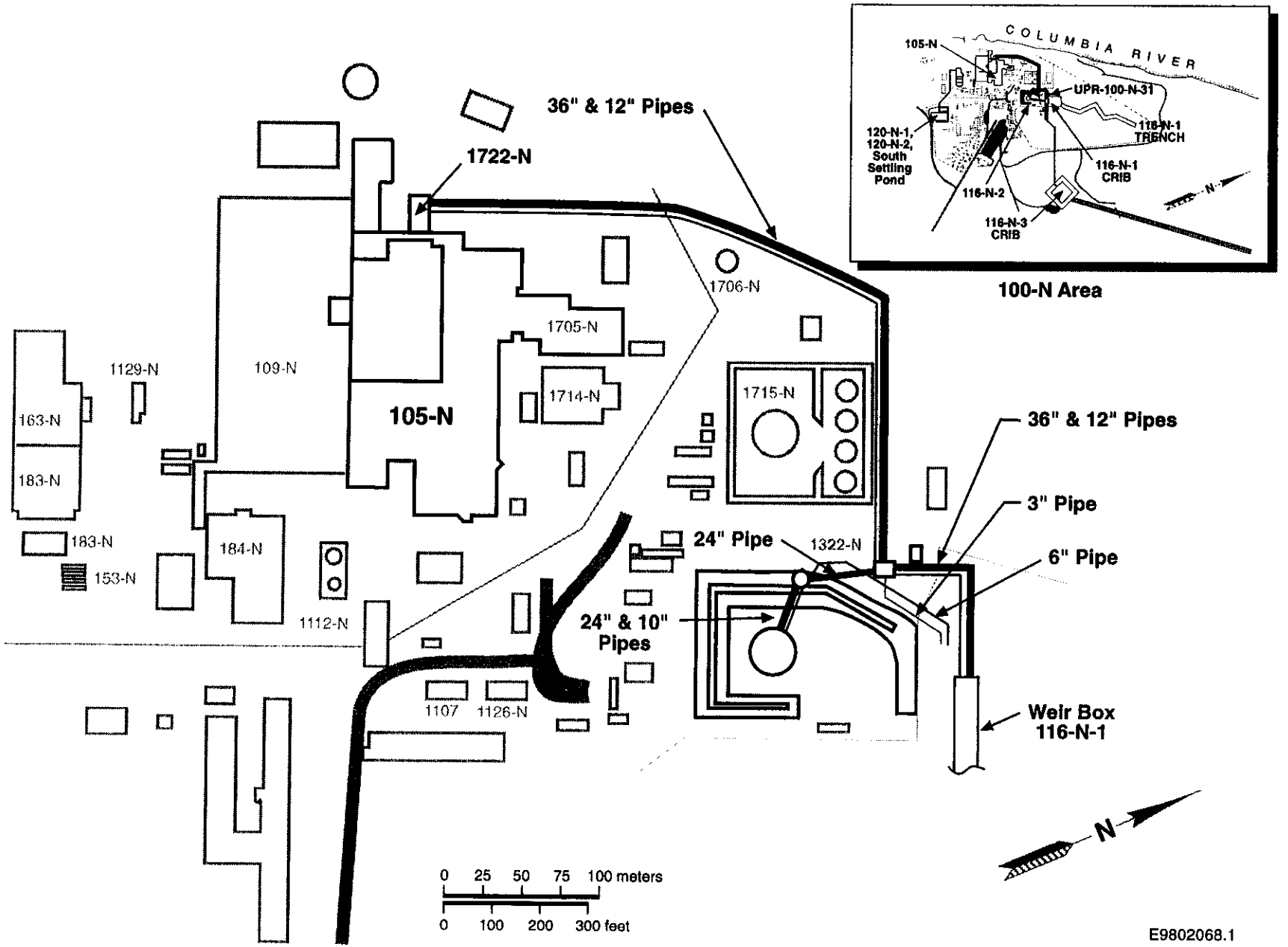
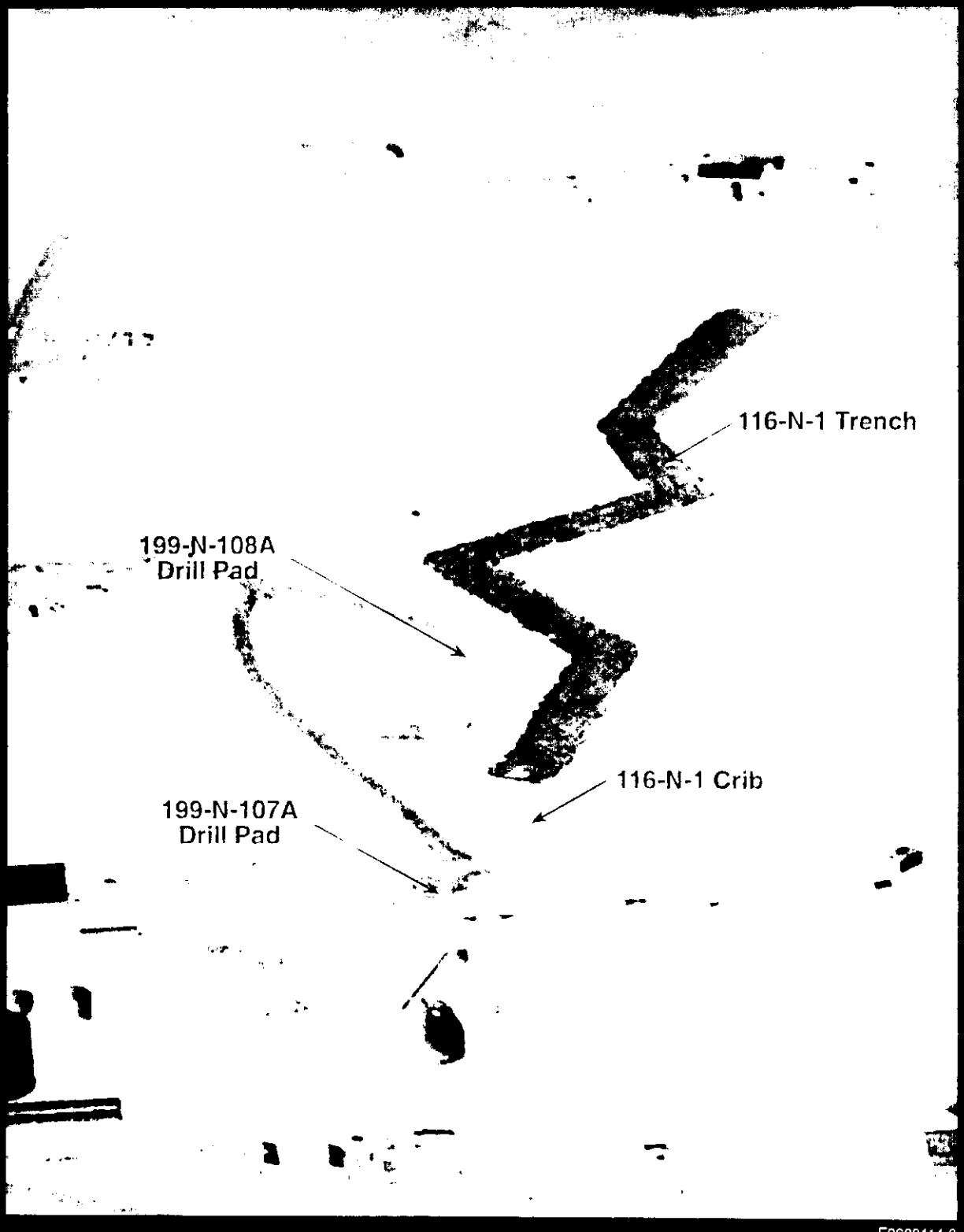


Figure 2-14. 116-N-1 Pipelines.

Figure 2-15. September 1995 Aerial View of 116-N-1.



E9608114.2

Figure 2-16. General Topography at 116-N-1.

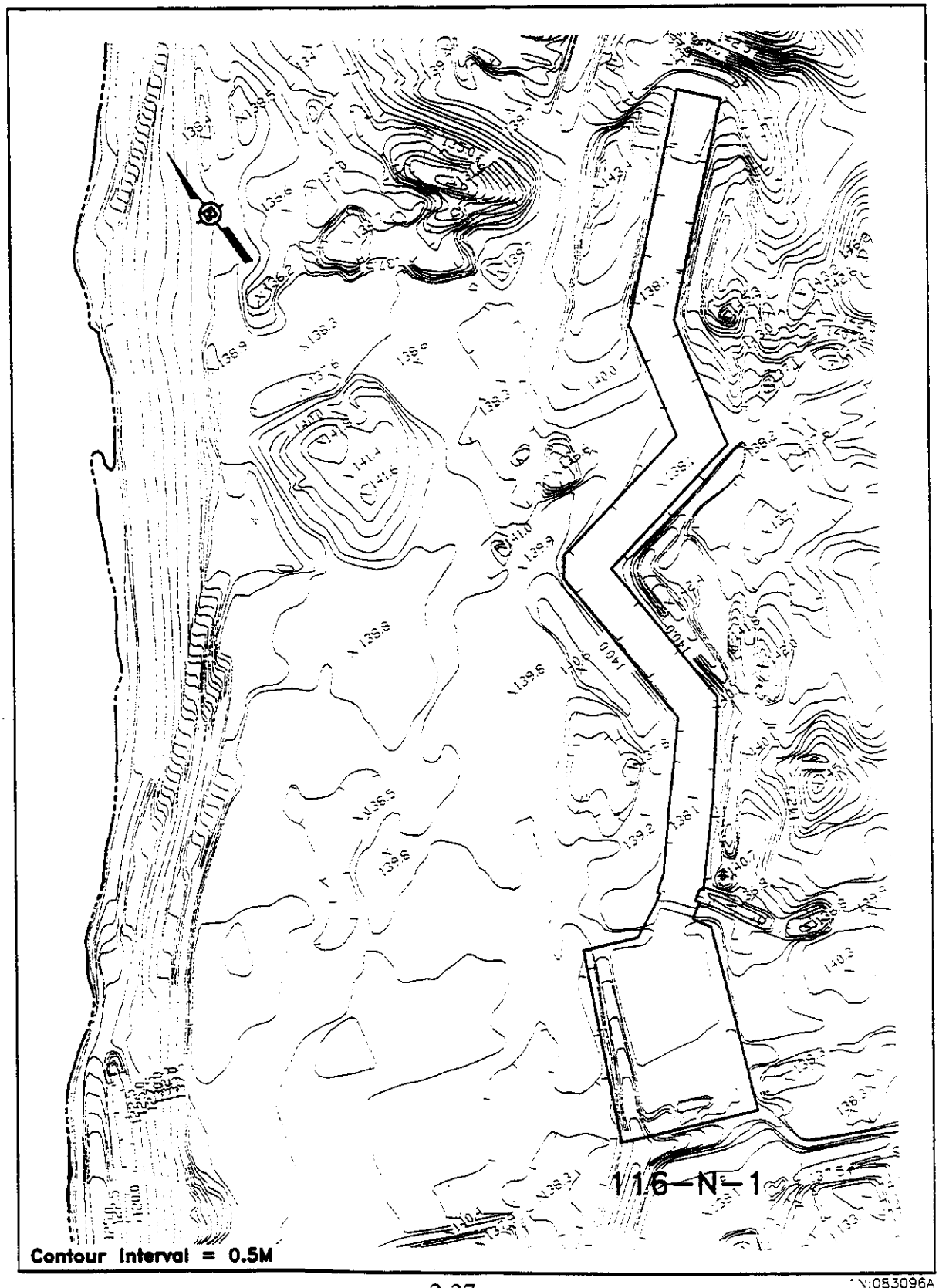


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Figure 2-17. 116-N-3 Crib Construction.

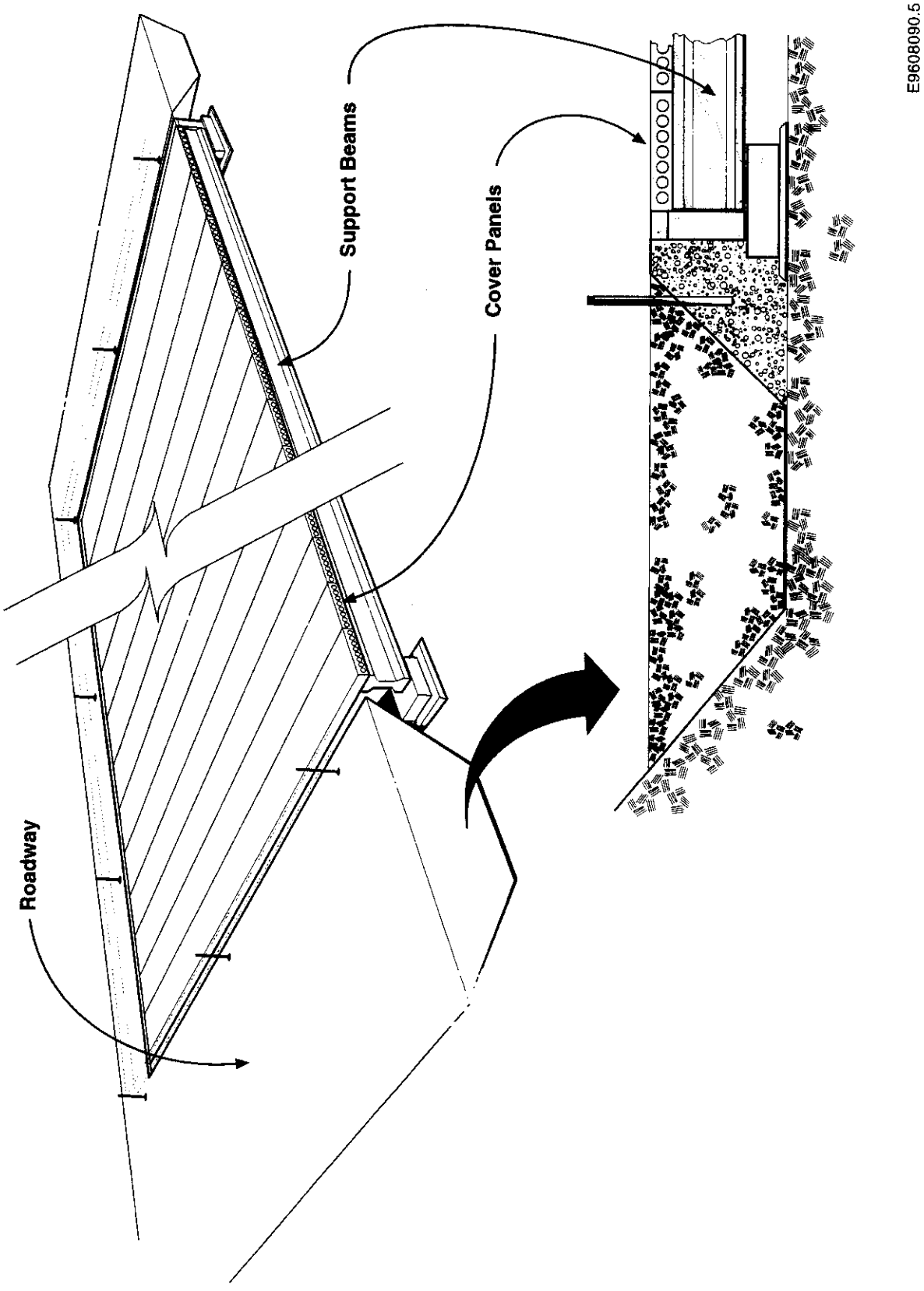


Figure 2-18. 116-N-3 Effluent Distribution System

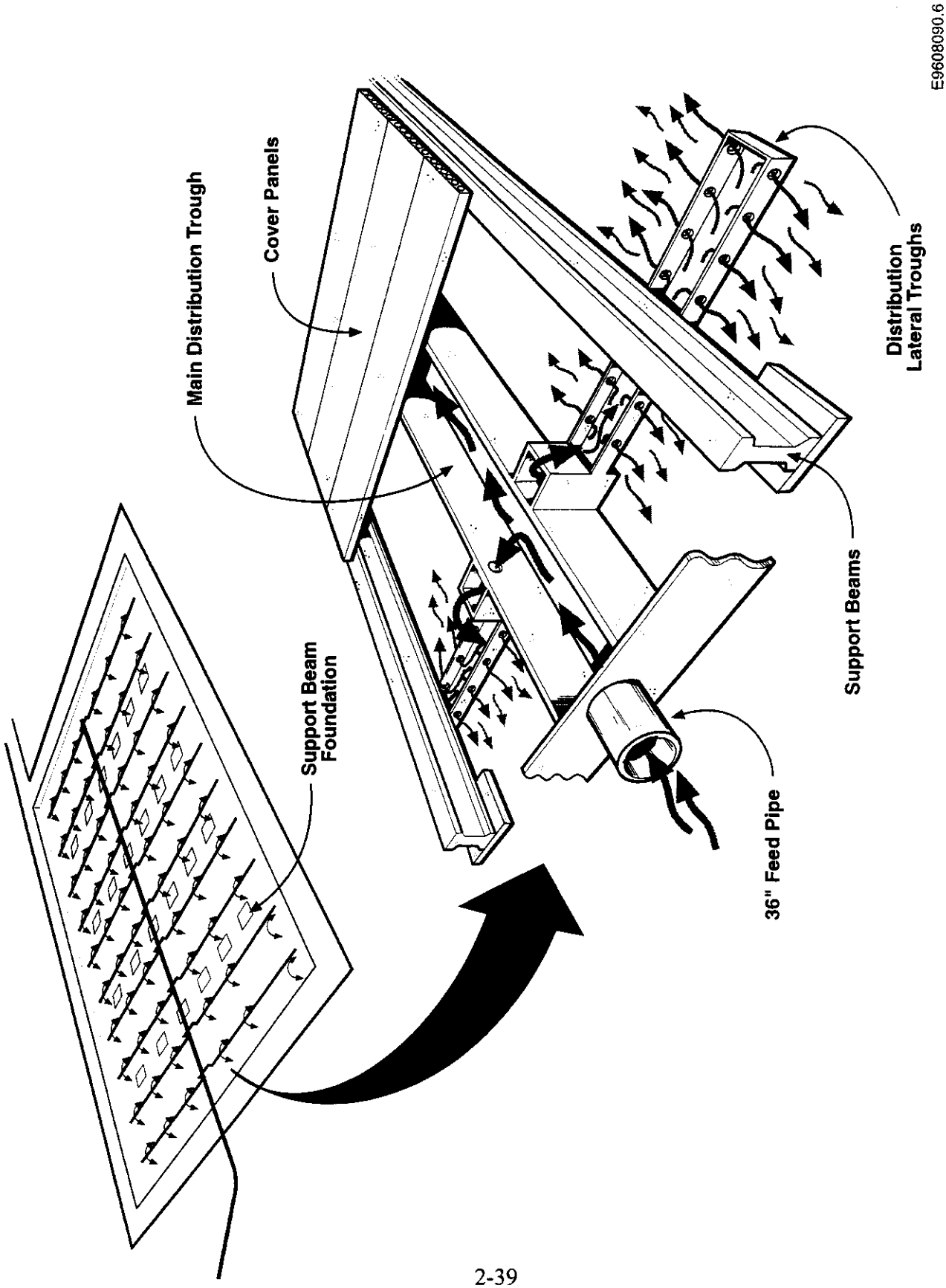


Figure 2-19. 116-N-3 Trench Construction.

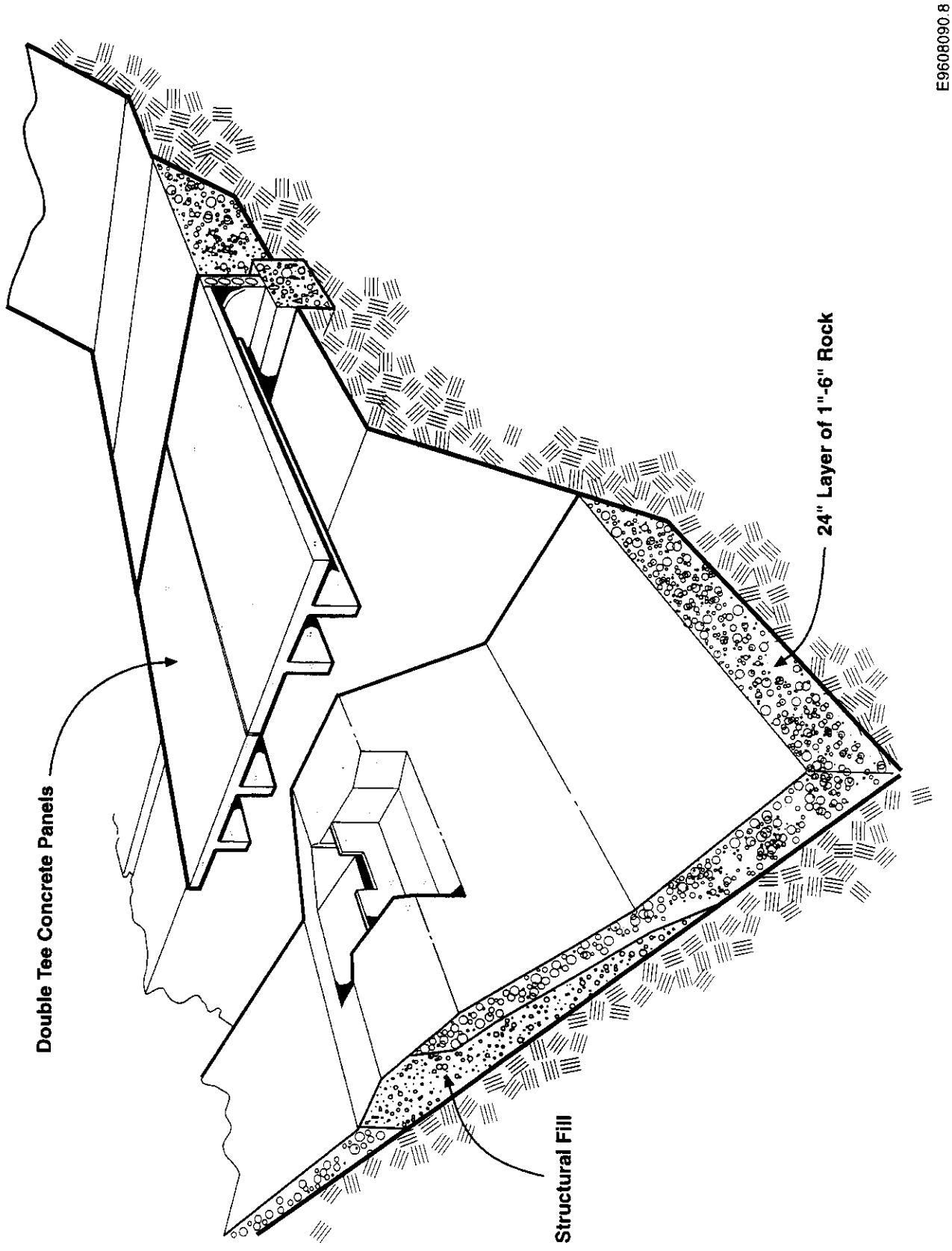
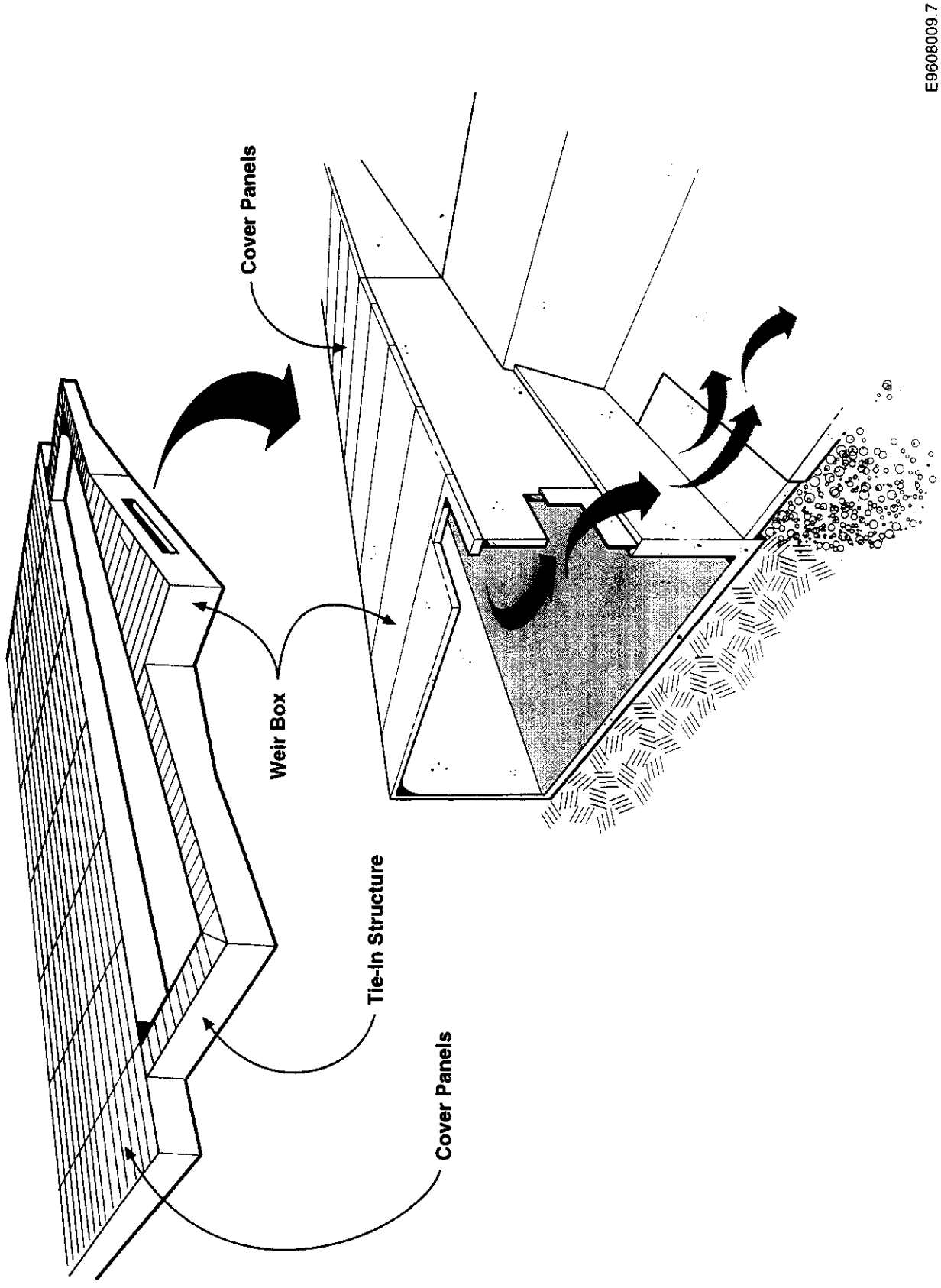


Figure 2-20. Tie-In Structure Between 116-N-3 Crib and Trench.



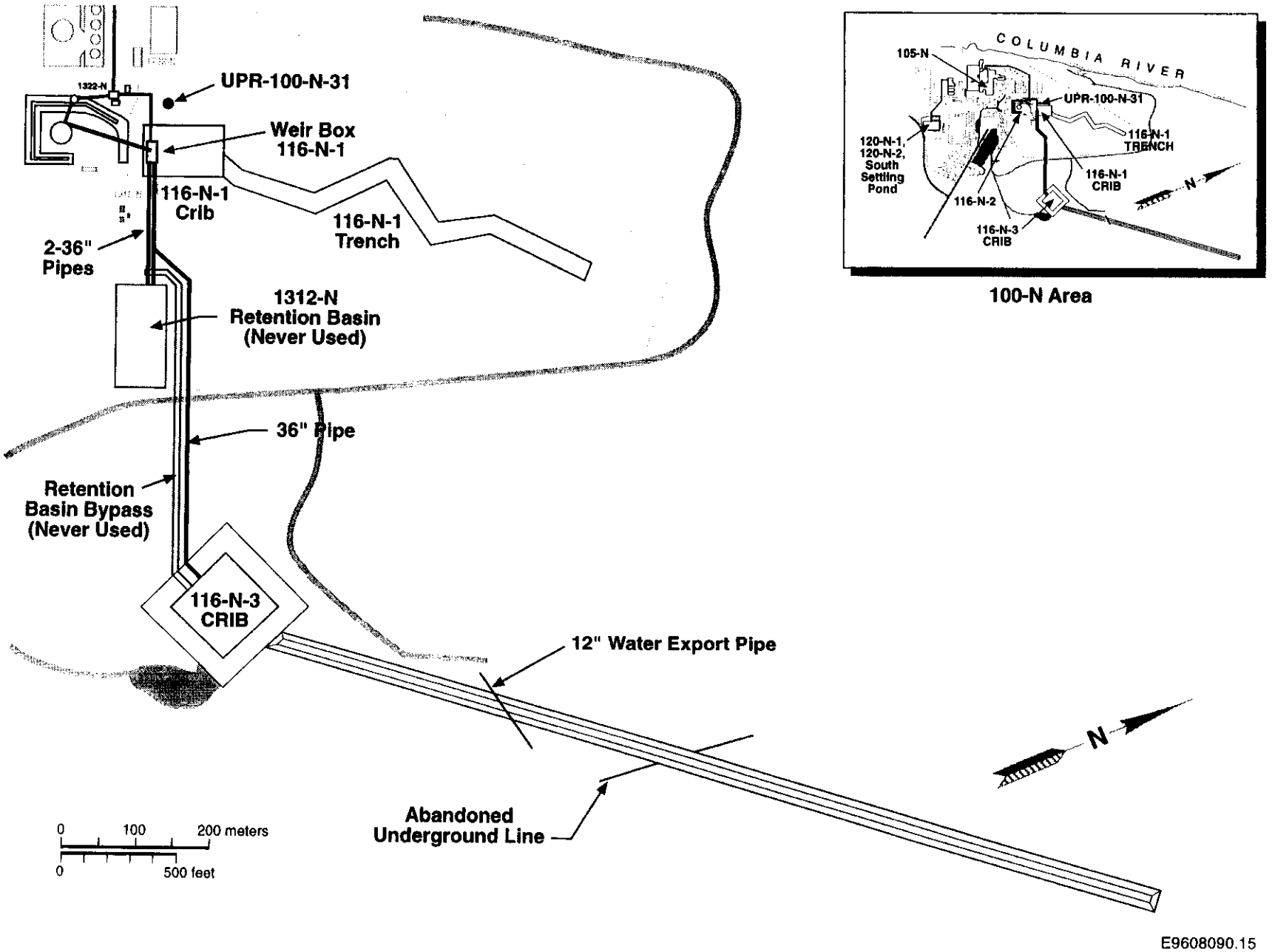


Figure 2-21. 116-N-3 Pipelines.

Figure 2-22. September 1995 Aerial View of 116-N-3.

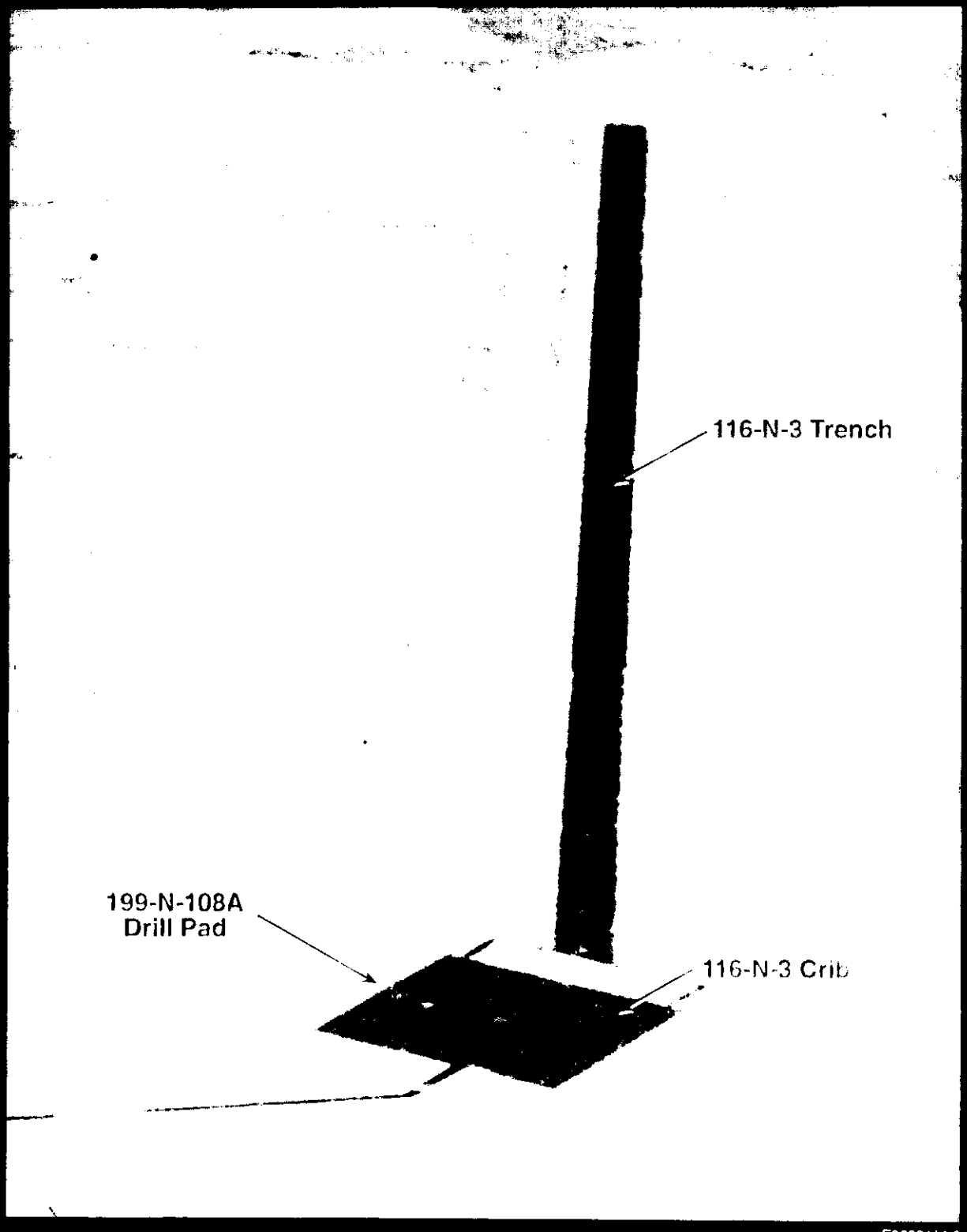


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Figure 2-23. General Topography at 116-N-3.

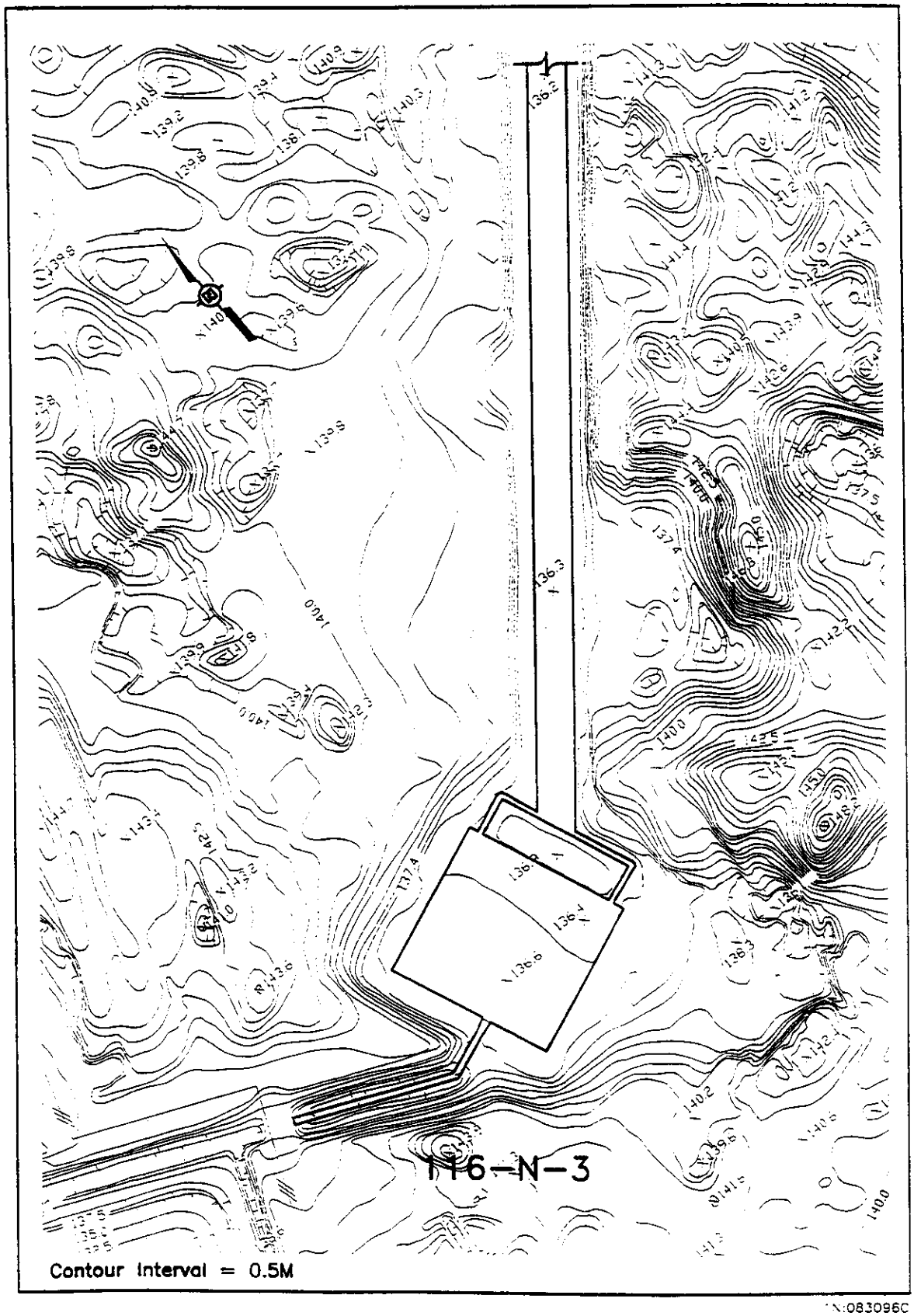

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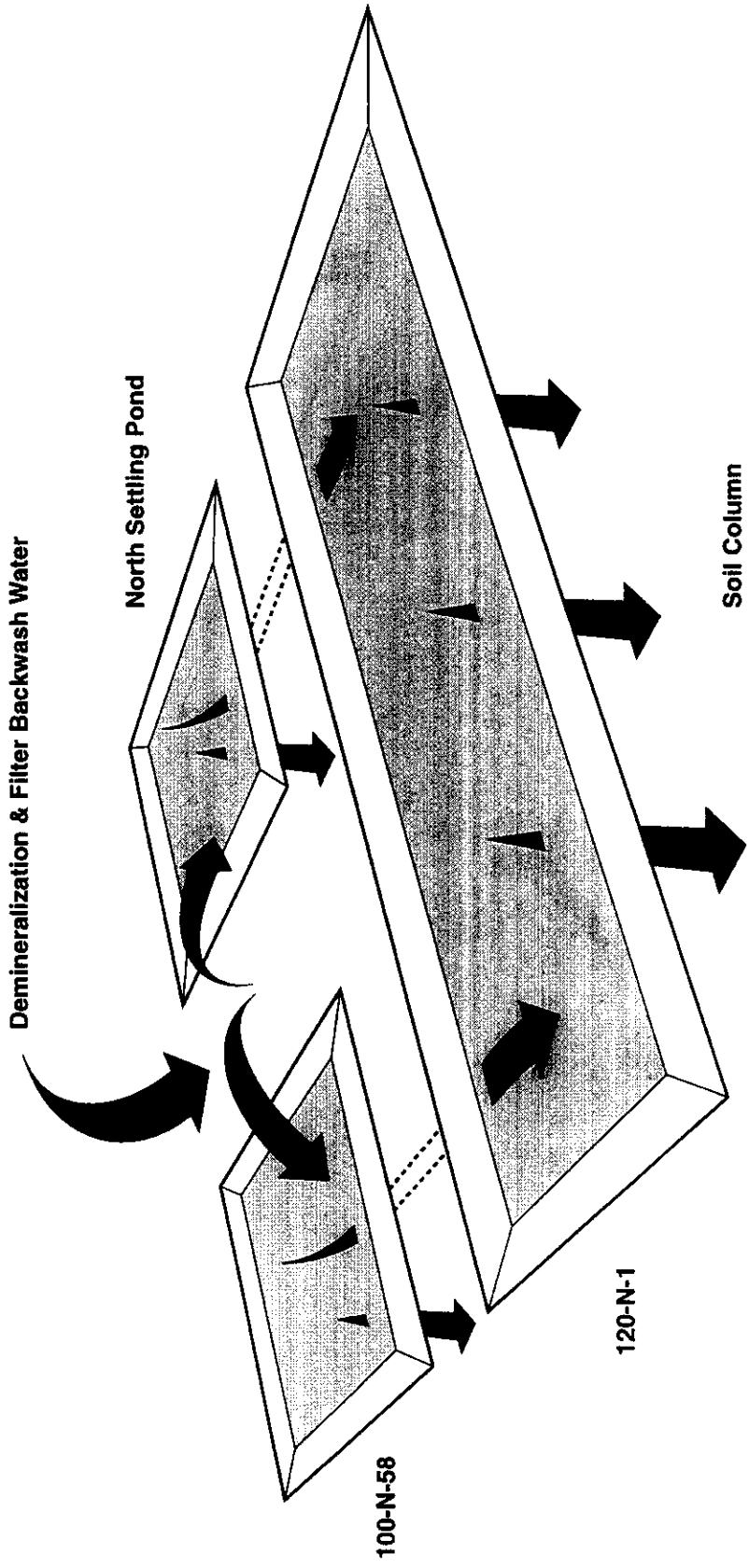
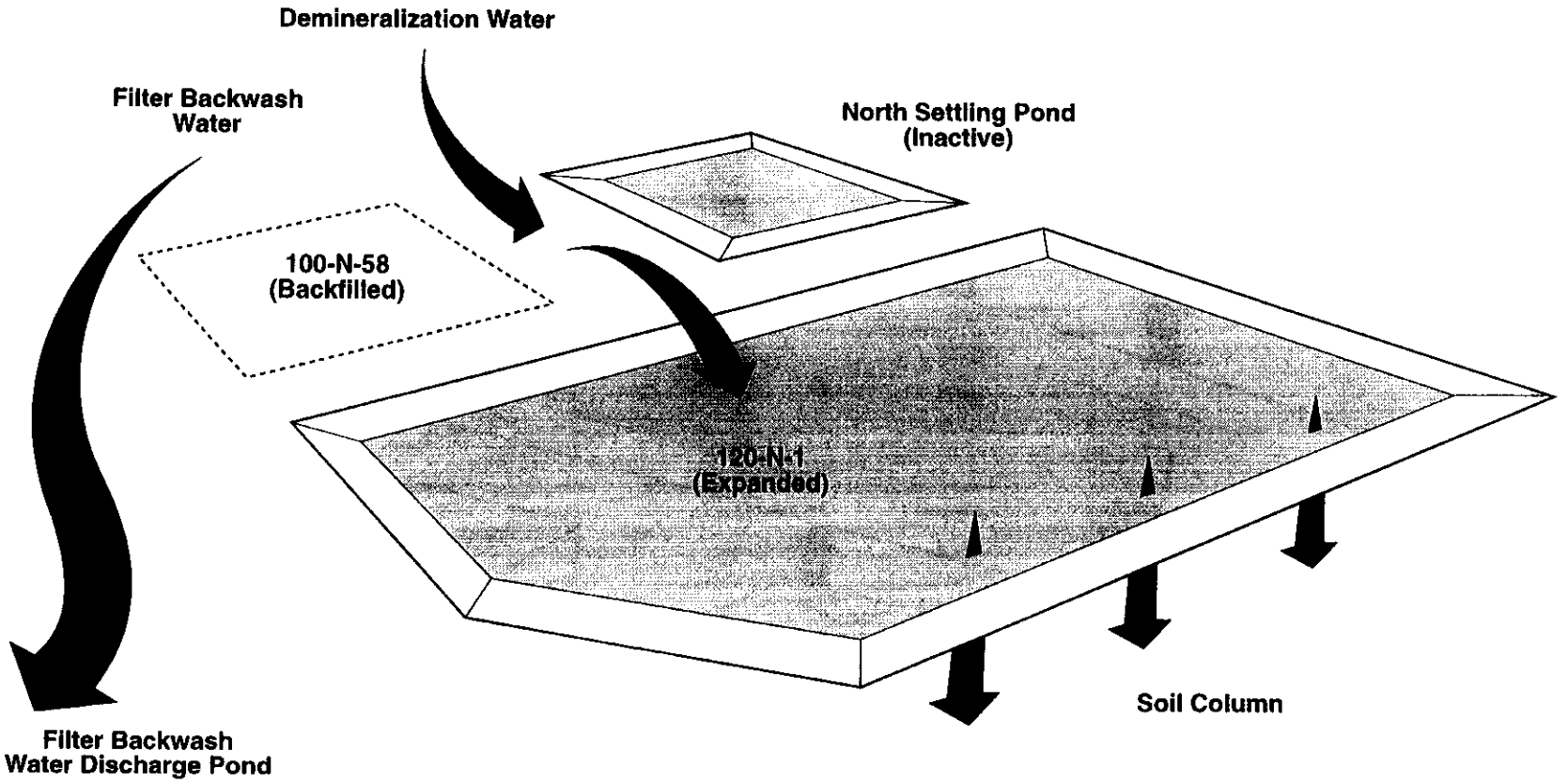
Figure 2-24. 120-N-1, 120-N-2, 100-N-58 Process Configuration 1977 to 1983.



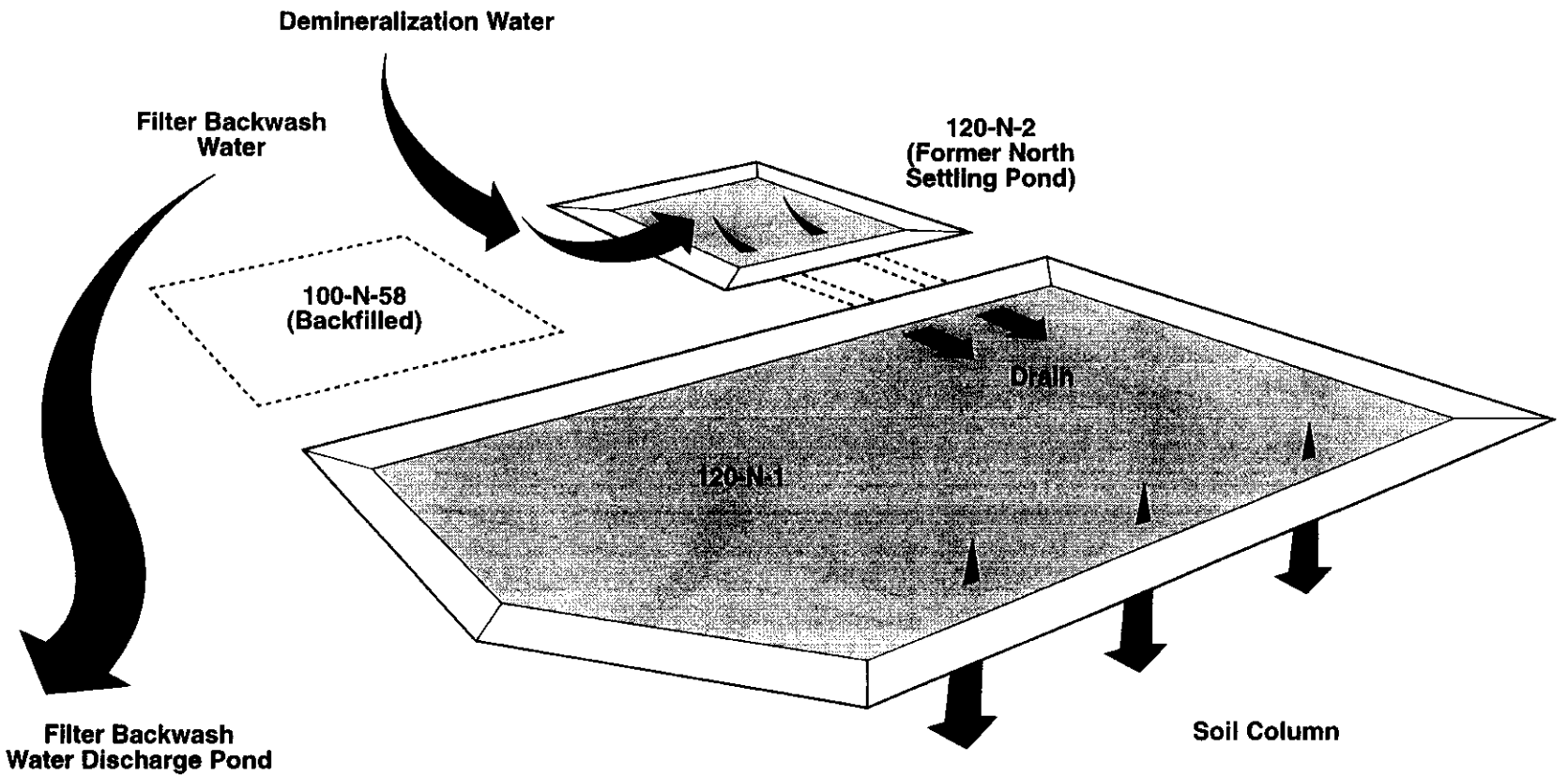
E9608090.9

Figure 2-25. 120-N-1, 120-N-2, 100-N-58 Process Configuration 1983 to 1986.



E9608090.10

Figure 2-26. 120-N-1, 120-N-2, 100-N-58 Process Configuration 1986 to 1988.



E9608090.11

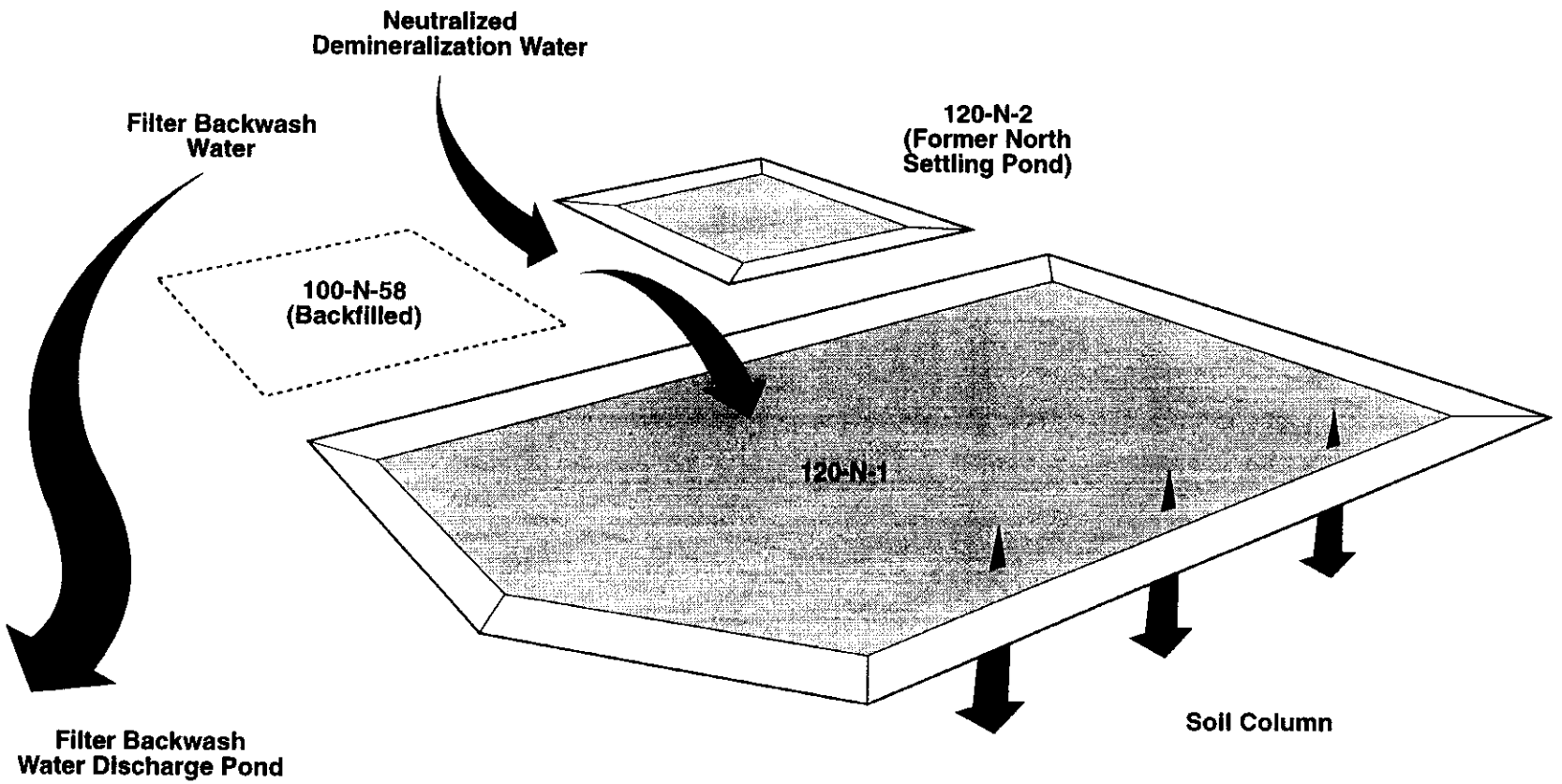


Figure 2-27. 120-N-1, 120-N-2, 100-N-58 Process Configuration 1988 to 1991.

E9608090.12

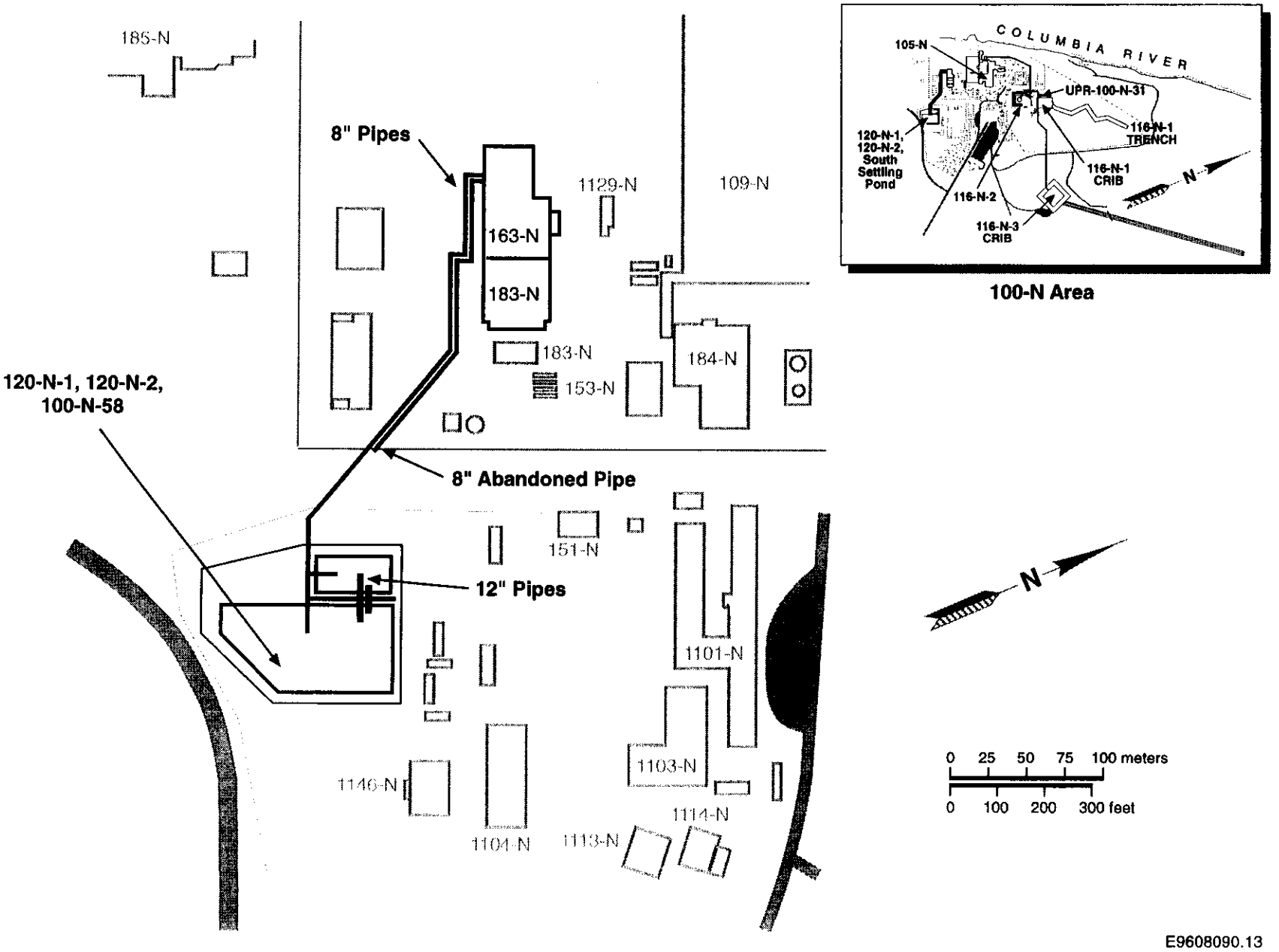
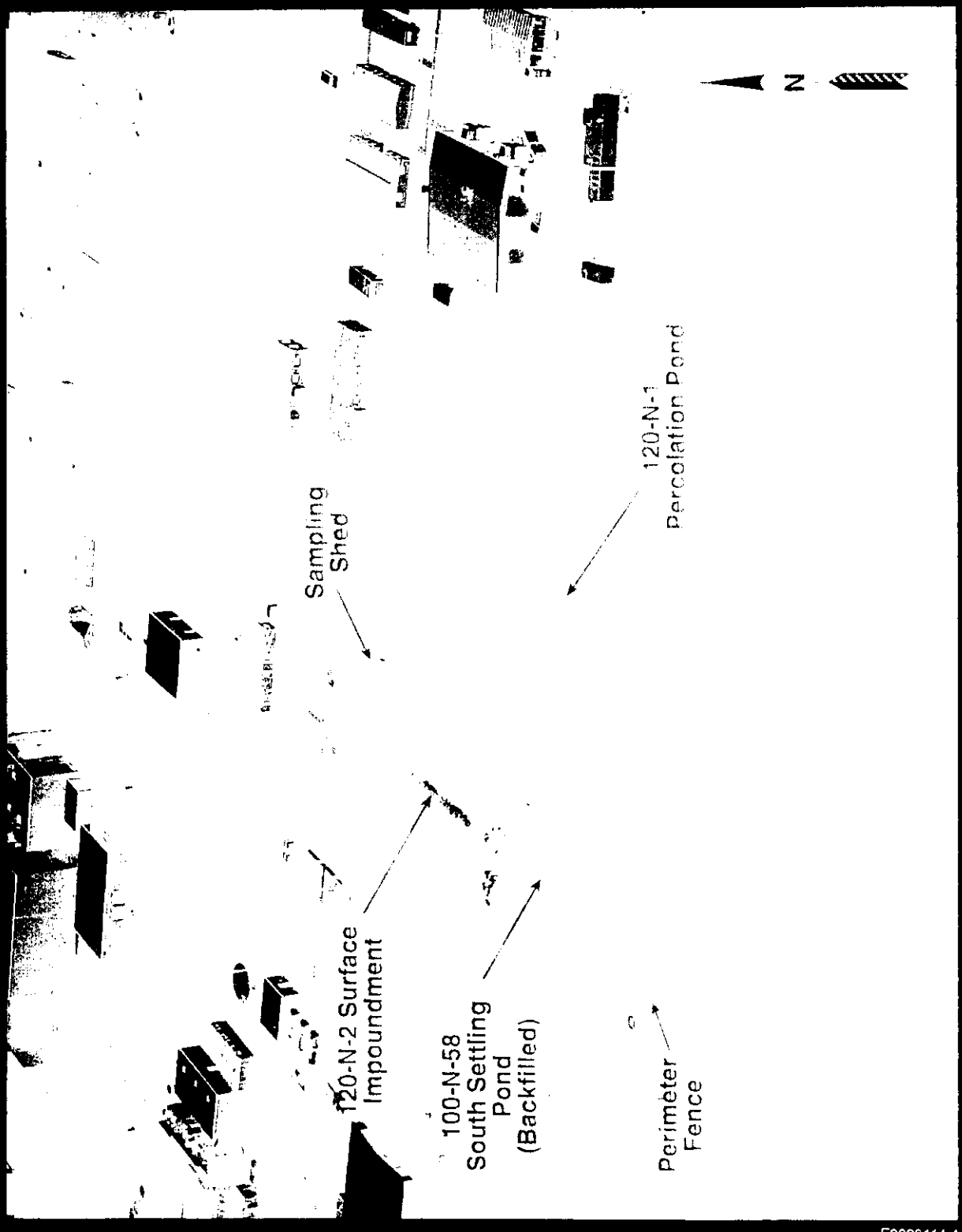


Figure 2-28. 120-N-1, 120-N-2, 100-N-58 Pipelines.

Figure 2-29. 1993 Aerial View of 120-N-1, 120-N-2, 100-N-58.



E9608114.4

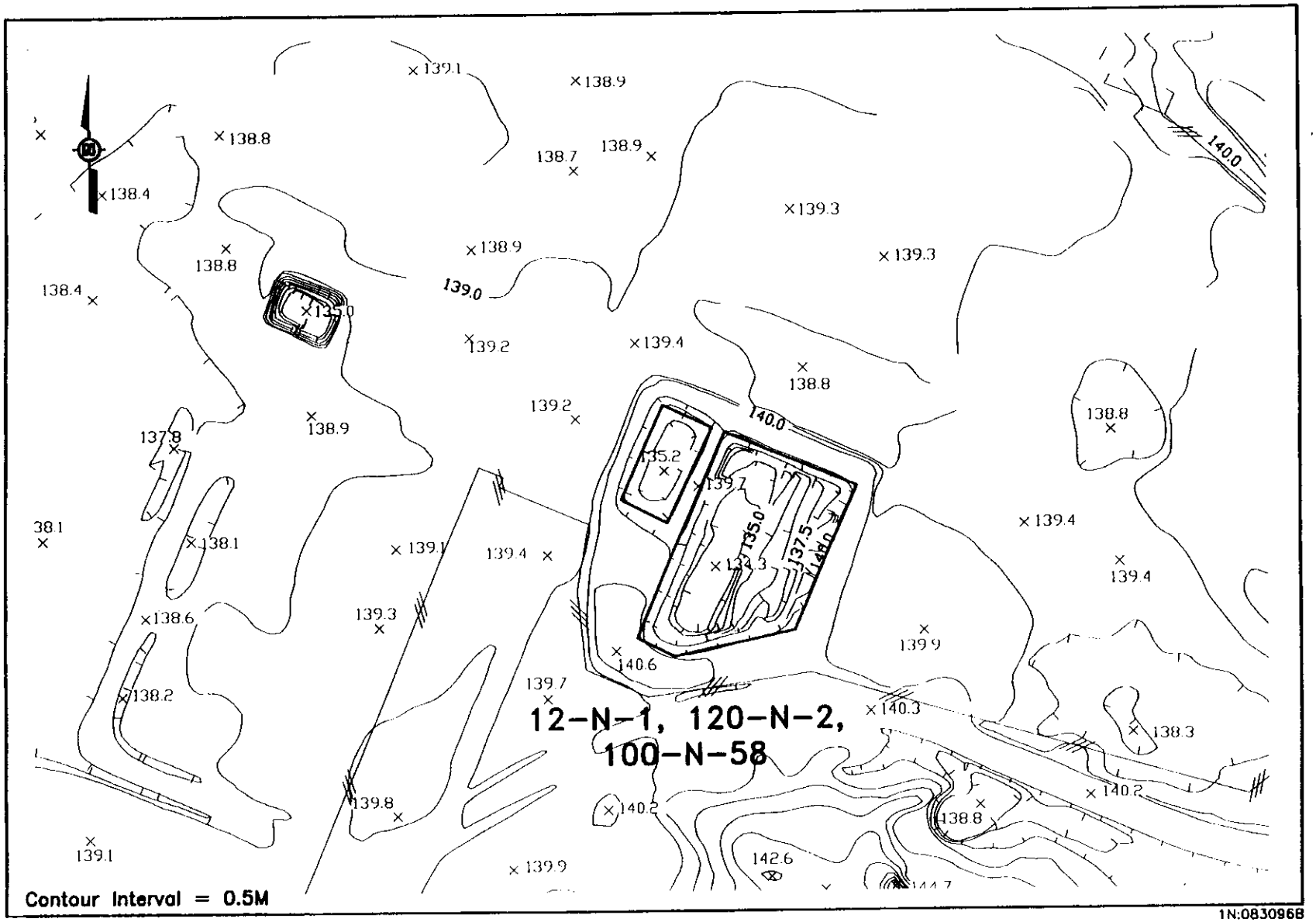
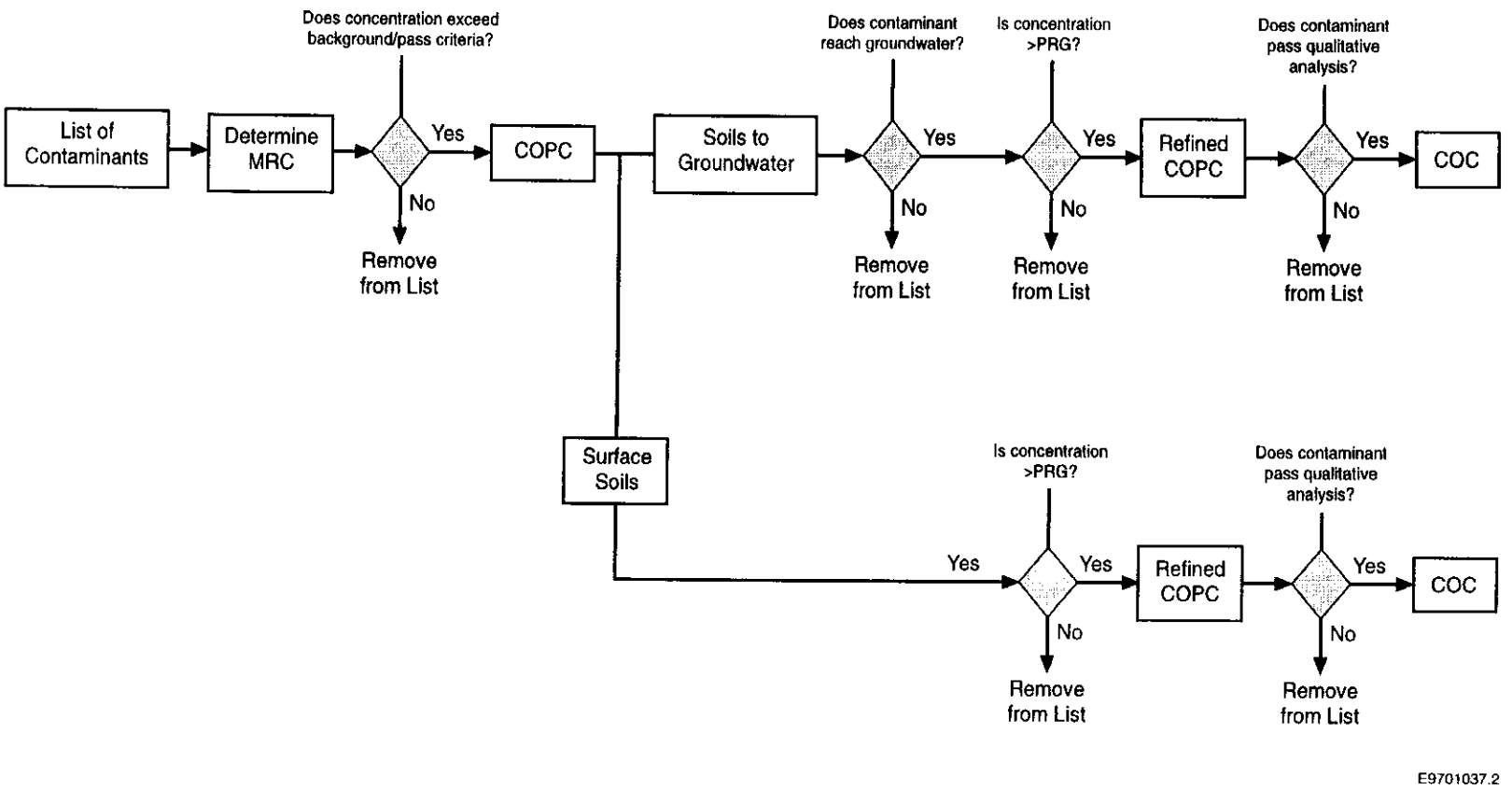
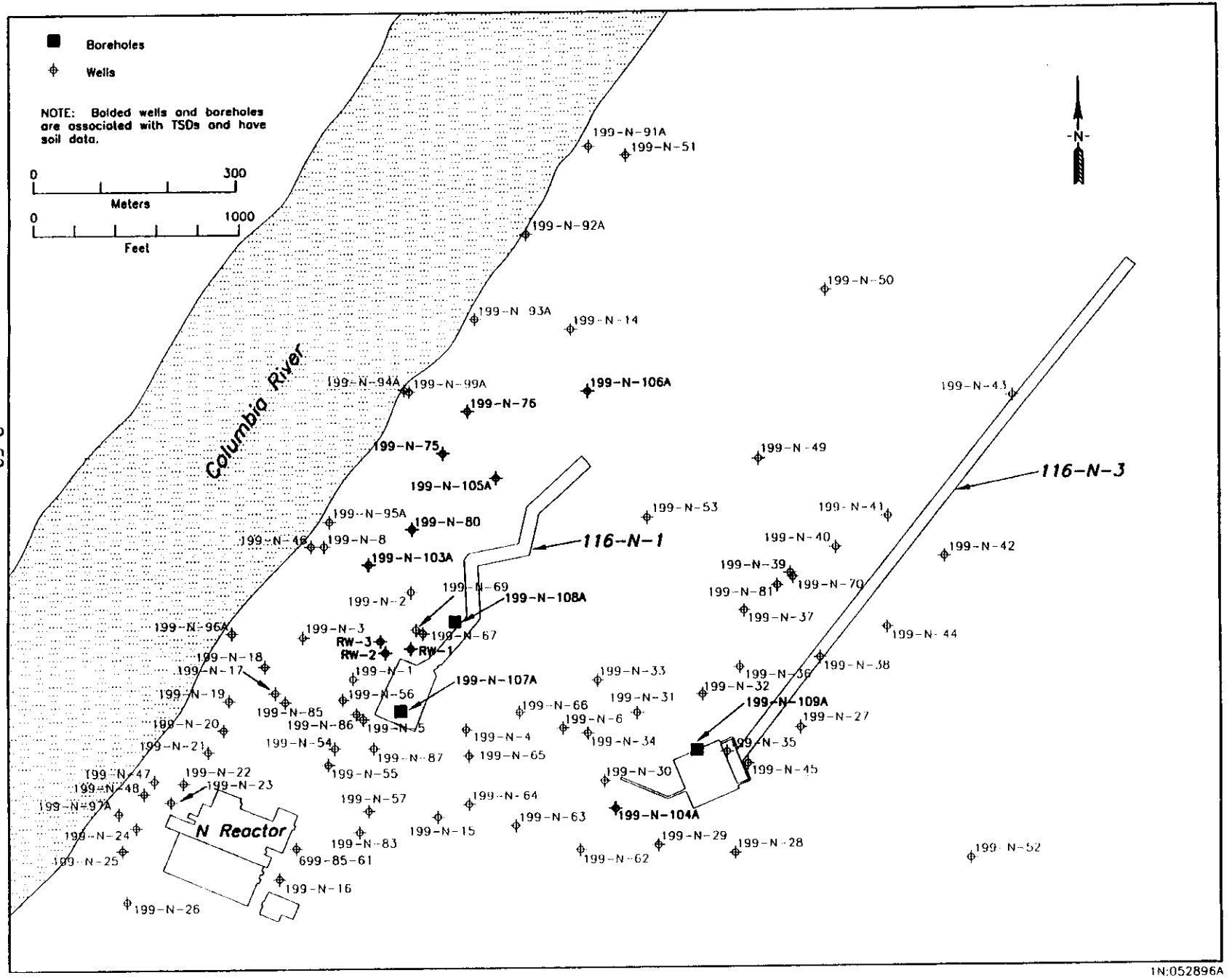


Figure 2-30. General Topography at 120-N-1, 120-N-2, 100-N-58.

Figure 2-31. Contaminants of Concern Development Process.





1N:052896A

Figure 2-32. 100-N Area Boreholes.

Table 2-1. 116-N-1 and 116-N-3 Cumulative Inventories, January 1, 1996.

Radionuclide	Half-Life (yr)	Inventory (Ci)	
		116-N-1	116-N-3
Cobalt-60	5.3	1,065	295
Strontium-90	29.1	1,670	201
Ruthenium-106	1.0	0.1	0.1
Cesium-134	2.1	1.5	0.5
Cesium-137	30.2	2,248	315
Plutonium-239/240	24,111	23	2.8

Table 2-2. Estimated Amounts of Dangerous Waste Discharged to 116-N-1 and 116-N-3.

Dangerous Waste	116-N-1[a] (lb/yr)	116-N-3[b] (lb/yr)
Methanol (F003)	6,200	6,200
Corrosive (D002)	20,600	20,600
Cadmium (D006)	100	100
Lead (D008)	150	150
Mercury (D009)	6,200	6,200
State-Only Carcinogens (WC02)	4,000	4,000
State-Only Toxic Wastes (WT02)	15,000	15,000
Sodium dichromate (D007)	10,000	None

Reference: Part A Permits, Revision 5, June 1995 (Appendix A).
NOTE: Estimated at the point of generation.
[a] Discharges to 116-N-1 occurred from 1963 to 1985. However, it is unlikely that the yearly discharges reported in the Part A permits were discharged this entire time (22 years).
[b] Discharges to 116-N-3 occurred from 1983 to 1991. However, it is unlikely that the yearly discharges reported in the Part A permits were discharged this entire time (8 years).

Table 2-3. Estimated Amounts of Dangerous Waste Discharged to 120-N-1 and 120-N-2.

Dangerous Waste	120-N-1 (lb/yr)	120-N-2 (lb/yr)
Corrosives (D002)	1,500,000,000	1,500,000,000

Reference: Part A Permits, Revision 3 (Appendix B).
NOTE: Discharges occurred from 1977 to 1991. However, it is unlikely that the yearly discharges reported in the Part A permits were discharged during this entire time (14 years).

Table 2-4. Chronology of Events for 116-N-1/116-N-3 Liquid Waste Disposal Facilities.

Unit	Date	Event/Activity Description
116-N-1	Dec. 1963	116-N-1 Crib began operations as the primary liquid effluent disposal facility for N Reactor.
	1965	116-N-1 zig-zag trench was constructed to provide additional liquid waste disposal capacity.
	July 1974	UPR-100-N-31 spill occurred.
	Early 1981	Additional riprap material was added to crib area to control surface contamination.
	Early 1982	116-N-1 Trench was covered with concrete panels to replace the inadequate wire mesh covering.
	1982	Riverbank spring sampling showed an increase in contaminants, indicating the effectiveness of the 116-N-1 Crib and Trench was decreasing.
	Oct. 1983	Discharges to 116-N-1 were reduced slightly as 116-N-3 Crib began operations.
	Sep. 1985	116-N-1 was no longer used for N Reactor effluent discharge. Until approximately June 1987, it was maintained as an emergency overflow discharge point in case of an accident.
	Aug.-Sep. 1988	A layer (1.2 to 1.5 m [4 to 5 ft] thick) of smaller rock was added to the entire crib.
116-N-3	Oct. 1983	116-N-3 Crib began receiving process effluent.
	Oct.-Nov. 1983	Crib percolation capacity was exceeded and the crib overflowed. Part of the effluent was diverted back to 116-N-1 to prevent overflows. Design and construction of 116-N-3 Trench began.
	Sep. 1985	116-N-3 Trench began receiving process effluent.
	Dec. 1986	N Reactor placed in standdown status and effluent discharges were reduced significantly.
	Apr. 1991	All effluent discharges were terminated.
	1993	Facility was disabled.

UPR = unplanned release

Table 2-5. Pipelines Feeding 116-N-1 and 116-N-3 Liquid Waste Disposal Facilities.

Pipeline Location	Type of Pipeline	Diameter		Length	
		in.	cm	ft	m
116-N-1					
1722-N to 116-N-1	Contaminated drain	36	91	1454	442
1722-N to 116-N-1	Radioactive drain	12	30	1454	442
116-N-2 to 116-N-1	Contaminated drain	24	61	212	65
116-N-2 to 116-N-1	Radioactive drain	12	30	212	65
116-N-2 to 116-N-1	Chemical waste	6	15	220	67
1322-N to 116-N-1	Radioactive drain	3	8	165	50
			116-N-1 Total	3717	1131
116-N-3					
116-N-1 to 116-N-3	Contaminated drain	36	91	2073	632
			116-N-3 Total	2073	632

Table 2-6. Chronology of Events for 120-N-1/120-N-2 TSD Units and Associated Facilities.

Unit	Date	Event/Activity Description
120-N-1, 120-N-2, 100-N-58, and North Settling Ponds	Aug. 1977	Percolation Pond and North and South Settling Ponds were put into service.
	1978	Annual dredging of the North and South Settling Ponds began to remove the impervious layer that formed from the separan and alum in the effluent.
	Late 1981	Annual dredging of the settling ponds not sufficient to prevent flooding. Dredging frequency was increased.
	Early 1983	The 120-N-1 Percolation Pond was enlarged from 1.2 million gal to 3.0 million gal. At the same time, the new 130-N-1 Filter Backwash Disposal Pond was built. The filter backwash water was re-routed to 130-N-1, enabling the North and South Settling Ponds to be taken out of service. The remaining Demineralization Plant effluent was delivered directly to the 120-N-1 Percolation Pond. The 100-N-58 South Settling Pond was backfilled to grade.
	May 1986	The 120-N-2 Surface Impoundment was built on the site of the North Settling Pond and put into service to treat dangerous wastes (corrosive regeneration effluents).
	Nov. 1988	An ENU was added to the 163-N Demineralization Plant, and the 120-N-2 Surface Impoundment was taken out of service. Effluent went directly into the 120-N-1 Percolation Pond.
	May 1991	All effluent discharges were terminated.

TSD = treatment, storage, and disposal
ENU = elementary neutralization unit

Table 2-7. Pipelines Feeding 120-N-1, 120-N-2, and 100-N-58.

Pipeline Location	Type of Pipeline	Diameter		Length	
		in.	cm	ft	m
163-N to 120-1/ 120-N-2	Corrosive drain	8	20	871	265
120-N-2 to 120-N-1	Corrosive drain	12	30	101	31
120-N-1, 120-N-2, and 100-N-58 Total				972	296

Table 2-8. List of Contaminants at 116-N-1/116-N-3 Surface Soils (0-10/15 ft bsg).

116-N-1	116-N-3
Radionuclides	
Cerium-144	Cerium-144
Cesium-134	Cesium-134
Cesium-137	Cesium-137
Cobalt-60	Cobalt-60
Europium-154	Europium-154
Europium-155	Europium-155
Manganese-54	Manganese-54
Plutonium-238	Plutonium-238
Plutonium-239/40	Plutonium-239/40
Potassium-40	Potassium-40
Radium-226	Radium-226
Ruthenium-106	Ruthenium-106
Strontium-90	Strontium-90
Thorium-228	Thorium-228
Thorium-232	Thorium-232
Tritium	Tritium
Uranium-233/234	Uranium-233/234
Uranium-238	Uranium-238
Inorganics	
Cadmium	Cadmium
Chromium	Lead
Lead	Mercury
Mercury	Nickel
Nickel	Nitrate
Nitrate	

bsg = below surrounding grade

Table 2-9. List of Contaminants at 116-N-1/116-N-3 Subsurface Soils (10/15 ft bsg to Groundwater).

116-N-1	116-N-3
Radionuclides	
Cerium-144	Cerium-144
Cesium-134	Cesium-134
Cesium-137	Cesium-137
Cobalt-60	Cobalt-60
Europium-154	Europium-154
Europium-155	Europium-155
Manganese-54	Manganese-54
Plutonium-238	Plutonium-238
Plutonium-239/40	Plutonium-239/40
Potassium-40	Potassium-40
Radium-226	Radium-226
Ruthenium-106	Ruthenium-106
Strontium-90	Strontium-90
Thorium-228	Thorium-228
Thorium-232	Thorium-232
Tritium	Tritium
Uranium-233/234	Uranium-233/234
Uranium-238	Uranium-238
Inorganics	
Cadmium	Cadmium
Chromium	Lead
Lead	Mercury
Mercury	Nickel
Nickel	Nitrate
Nitrate	

bsg = below surrounding grade

Table 2-10. List of Contaminants at 120-N-1, 120-N-2, and 100-N-58 Surface Soils (0-10/15 ft bsg).

Inorganics
Copper
Manganese
Nickel
Zinc

bsg = below surrounding grade

Table 2-11. Maximum Representative Concentration for Contaminants at 116-N-1 and 116-N-3 Surface and Subsurface Soil (0 ft to Groundwater). (Page 1 of 2)

Constituent Name	Maximum Value	Units	Background Value	Is Concentration > Background?
Radionuclides				
Cerium-144	11,000,000	pCi/g	N/A	Yes[a]
Cesium-134	41,000	pCi/g	0.0035	Yes
Cesium-137	83,000,000	pCi/g	0.92	Yes
Cobalt-60	53,000,000	pCi/g	0.0069	Yes
Europium-154	170,000	pCi/g	0.032	Yes
Europium-155	4,120	pCi/g	0.051	Yes
Manganese-54	4,400,000	pCi/g	N/A	Yes[a]
Plutonium-238	510,000	pCi/g	N/A	Yes[a]
Plutonium-239/40	2,800,000	pCi/g	0.02	Yes
Potassium-40	879,000	pCi/g	16.64	Yes
Radium-226	1.64	pCi/g	0.82	Yes
Ruthenium-106	110,000	pCi/g	0.0029	Yes
Strontium-90	770,000	pCi/g	0.17	Yes
Thorium-228	152	pCi/g	1.32	Yes
Thorium-232	2.52	pCi/g	1.32	Yes
Tritium	N/A	pCi/g	N/A	Yes[c]
Uranium-233/234	1.63 (U-234)	pCi/g	1.098 (U-234)	Yes
Uranium-238	9.1	pCi/g	1.06	Yes
Inorganics				
Cadmium	0.73	mg/kg	N/A	Yes[a]
Chromium	57.7	mg/kg	18.50	Yes
Lead	21.9	mg/kg	10.20	Yes

Table 2-11. Maximum Representative Concentration for Contaminants at 116-N-1 and 116-N-3 Surface and Subsurface Soil (0 ft to Groundwater). (Page 2 of 2)

Constituent Name	Maximum Value	Units	Background Value	Is Concentration > Background?
Inorganics				
Mercury	N/A	mg/kg	0.33	Yes[b]
Nickel	16.7	mg/kg	19.10	No
Nitrate	N/A	--	N/A	Yes[c]

N/A = value is not available
[a] Background not available; concentration assumed to exceed background.
[b] No data available; concentration assumed to exceed background.
[c] No data available; background not available. Kept in the list of contaminants because data not available.

Data from 199-N-76, 199-N-77, 199-N-80, 199-N-103A, 199-N-104A, 199-N-105A, 199-N-106A, 199-N-107A, 199-N-108A, 199-N-109A; RW#1, RW#2, RW#3; 116-N-1 sediments (TS) and 116-N-1 sediments (CS).

Background values for inorganics are from Hanford Site Background: Part 1 (DOE-RL 1995b) and are the 90th percentile of the log normal distribution.

Background values for radionuclides are from Hanford Site Background: Part 2 (DOE-RL 1996e) and are the 90th percentile of the log normal distribution.

Table 2-12. Maximum Representative Concentration for List of Contaminants at 120-N-1, 120-N-2, and 100-N-58 Surface Soil (0 to 10/15 ft bsg).

Constituent Name	Maximum Value	Units	Background Value	Is Concentration > Background?
Inorganics				
Copper	31.5	mg/kg	22	Yes
Manganese	702	mg/kg	512	Yes
Nickel	17.6	mg/kg	19.1	No
Zinc	94.4	mg/kg	67.8	Yes

Data from 199-N-88, 199-N-89, and the test pit.
Background values for inorganics are from Hanford Site Background: Part 1 (DOE-RL 1995b) and are the 90th percentile of the log normal distribution.
bsg = below surrounding grade

Table 2-13. Selection Rationale for Contaminants of Potential Concern at 116-N-1. (Page 1 of 3)

Constituent Name	Half-Life	COPC?	Rationale for COPC designation
Surface Soil (0-10/15 ft bsg)			
Radionuclides			
Cerium-144	285 days	No	Short half-life[a]
Cesium-134	2.06 years	No	Small fraction of cesium-137 activity
Cesium-137	30.0 years	Yes	Concentrations are greater than background
Cobalt-60	5.27 years	Yes	5 half-lives have not occurred
Europium-154	8.60 years	Yes	5 half-lives have not occurred
Europium-155	4.96 years	Yes	5 half-lives have not occurred
Manganese-54	312 days	No	Short half-life[a]
Plutonium-238	87.7 years	No	Small fraction of plutonium-239 activity
Plutonium-239/40	24,100 years	Yes	5 half-lives have not occurred
Potassium-40	1.28E09 years	No	No known N-Reactor source
Radium-226	1,620 years	No	Near background and naturally occurring in soil
Ruthenium-106	1.01 years	No	Short half-life[a]
Strontium-90	29.1 years	Yes	5 half-lives have not occurred. Plume in groundwater.
Thorium-228	1.91 years	No	Short half-life[a]
Thorium-232	1.4E10 years	Yes	5 half-lives have not occurred
Tritium	12.3 years	Yes	5 half-lives have not occurred. Plume in groundwater.
Uranium-233/234	245,000 years	Yes	5 half-lives have not occurred
Uranium-238	4.47E09 years	Yes	5 half-lives have not occurred
Inorganics			
Cadmium	N/A	Yes	No background data available
Chromium	N/A	Yes	Above background. Discharged to 1301-N only.
Lead	N/A	Yes	Above background data
Mercury	N/A	Yes	No soil data available. In Part A permits.

Table 2-13. Selection Rationale for Contaminants of Potential Concern at 116-N-1. (Page 2 of 3)

Constituent Name	Half-Life	COPC?	Rationale for COPC designation
Surface Soil (0-10/15 ft bsg)			
Inorganics			
Nickel	N/A	No	Less than background data
Nitrate	N/A	Yes	Plume in groundwater
Subsurface Soil (10/15 ft bsg to groundwater)			
Radionuclides			
Cerium-144	285 days	No	Short half-life[a]
Cesium-134	2.06 years	No	Small fraction of cesium-137 activity
Cesium-137	30.0 years	Yes	Concentrations are greater than background
Cobalt-60	5.27 years	Yes	5 half-lives have not occurred
Europium-154	8.60 years	Yes	5 half-lives have not occurred
Europium-155	4.96 years	Yes	5 half-lives have not occurred
Manganese-54	312 days	No	Short half-life[a]
Plutonium-238	87.7 years	No	Small fraction of plutonium-239 activity
Plutonium-239/40	24,100 years	Yes	5 half-lives have not occurred
Potassium-40	1.28E09 years	No	No known N-Reactor source
Radium-226	1,620 years	No	Near background and naturally occurring in soil
Ruthenium-106	1.01 years	No	Short half-life[a]
Strontium-90	29.1 years	Yes	5 half-lives have not occurred. Plume in groundwater.
Thorium-228	1.91 years	No	Short half-life[a]
Thorium-232	1.41E10 years	Yes	5 half-lives have not occurred
Tritium	12.3 years	Yes	5 half-lives have not occurred. Plume in groundwater.
Uranium-233/234	245,000 years	Yes	5 half-lives have not occurred
Uranium-238	4.47E09 years	Yes	5 half-lives have not occurred

Table 2-13. Selection Rationale for Contaminants of Potential Concern at 116-N-1. (Page 3 of 3)

Constituent Name	Half-Life	COPC?	Rationale for COPC designation
Subsurface Soil (10/15 ft bsg to groundwater)			
Inorganics			
Cadmium	N/A	Yes	No background data available
Chromium	N/A	Yes	Above background. Discharged to 1301-N only.
Lead	N/A	Yes	Above background data
Mercury	N/A	Yes	No soil data available. In Part A permits.
Nickel	N/A	No	Less than background data
Nitrate	N/A	Yes	Generally nontoxic in soil. However, will be evaluated for protection of groundwater and Columbia River.

[a] Short half-life is less than 2.2 years, since discharges ceased in 1985 (11 years/5 half-lives = 2.2 years)
bsg = below surrounding grade

Table 2-14. Selection Rationale for Contaminants of Potential Concern at 116-N-3. (Page 1 of 2)

Constituent Name	Half-Life	COPC?	Rationale for COPC designation
Surface Soil (0-10/15 ft bsg)			
Radionuclides			
Cerium-144	285 days	No	Short half-life[a]
Cesium-134	2.06 years	No	Small fraction of cesium-137 activity
Cesium-137	30.0 years	Yes	Concentrations are greater than background
Cobalt-60	5.27 years	Yes	5 half-lives have not occurred
Europium-154	8.60 years	Yes	5 half-lives have not occurred
Europium-155	4.96 years	Yes	5 half-lives have not occurred
Manganese-54	312 days	No	Short half-life[a]
Plutonium-238	87.7 years	No	Small fraction of plutonium-239 activity
Plutonium-239/40	24,100 years	Yes	5 half-lives have not occurred
Potassium-40	1.28E09 years	No	No known N-Reactor source
Radium-226	1,620 years	No	Near background and naturally occurring in soil
Ruthenium-106	1.01 years	No	Short half-life[a]
Strontium-90	29.1 years	Yes	5 half-lives have not occurred. Plume in groundwater.
Thorium-228	1.91 years	No	5 half-lives have not occurred
Thorium-232	1.41E10 years	Yes	5 half-lives have not occurred
Tritium	12.3 years	Yes	5 half-lives have not occurred. Plume in groundwater.
Uranium-233/234	245,000 years	Yes	5 half-lives have not occurred
Uranium-238	4.47E09 years	Yes	5 half-lives have not occurred
Inorganics			
Cadmium	N/A	Yes	No background data available
Lead	N/A	Yes	Above background data
Mercury	N/A	Yes	No soil data available. In Part A permits.
Nickel	N/A	No	Less than background data
Nitrate	N/A	Yes	Plume in groundwater

Table 2-14. Selection Rationale for Contaminants of Potential Concern at 116-N-3. (Page 2 of 2)

Constituent Name	Half-Life	COPC?	Rationale for COPC designation
Subsurface Soil (10/15 ft bsg to groundwater)			
Radionuclides			
Cerium-144	285 days	No	Short half-life[a]
Cesium-134	2.06 years	No	Small fraction of cesium-137 activity
Cesium-137	30.0 years	Yes	Concentrations are greater than background
Cobalt-60	5.27 years	Yes	5 half-lives have not occurred
Europium-154	8.60 years	Yes	5 half-lives have not occurred
Europium-155	4.96 years	Yes	5 half-lives have not occurred
Manganese-54	312 days	No	Short half-life[a]
Plutonium-238	87.7 years	No	Small fraction of plutonium-239 activity
Plutonium-239/40	24,100 years	Yes	5 half-lives have not occurred
Potassium-40	1.28E09 years	No	No known N-Reactor source
Radium-226	1,620 years	No	Near background and naturally occurring in soil
Ruthenium-106	1.01	No	Short half-life[a]
Strontium-90	29.1 years	Yes	5 half-lives have not occurred. Plume in groundwater.
Thorium-228	1.91 years	Yes	5 half-lives have not occurred
Thorium-232	1.41E10 years	Yes	5 half-lives have not occurred
Tritium	12.3 years	Yes	5 half-lives have not occurred. Plume in groundwater.
Uranium-233/234	245,000 years	Yes	5 half-lives have not occurred
Uranium-238	4.47E09 years	Yes	5 half-lives have not occurred
Inorganics			
Cadmium	N/A	Yes	No background data available
Lead	N/A	Yes	Above background data
Mercury	N/A	Yes	No soil data available. In Part A permits.
Nickel	N/A	No	Less than background data
Nitrate	N/A	Yes	Plume in groundwater

[a] Short half-life is less than 1 year, since discharges ceased in 1991 (5 years/5 half-lives = 1 year)
bsg = below surrounding grade
COPC = contaminant of potential concern

Table 2-15. Selection Rationale for Contaminants of Potential Concern at 120-N-1, 120-N-2, and 100-N-58.

Constituent Name	COPC?	Rationale for COPC designation
Surface Soil (0-10/15 ft bsg)		
Inorganics		
Copper	No	Within the range of background
Manganese	No	Within the range of background
Nickel	No	Within the range of background
Zinc	No	Within the range of background

bsg = below surrounding grade

Table 2-16. Contaminants of Potential Concern at 116-N-1.

Constituent Name	Rationale
Surface Soil (0-10/15 ft bsg)	
Radionuclides	
Cesium-137	Soil Data
Cobalt-60	Soil Data
Europium-154	Soil Data
Europium-155	Soil Data
Plutonium-239/40	Soil Data
Strontium-90	Soil Data
Thorium-232	Soil Data
Tritium	Groundwater Data
Uranium-233/234	Soil Data
Uranium-238	Soil Data
Inorganics	
Cadmium	Soil Data
Chromium	Soil Data
Lead	Soil Data
Mercury	Process Knowledge
Nitrate	Groundwater Data
Subsurface Soil (10/15 ft bsg to groundwater)	
Radionuclides	
Cesium-137	Soil Data
Cobalt-60	Soil Data
Europium-154	Soil Data
Europium-155	Soil Data
Plutonium-239/40	Soil Data
Strontium-90	Soil Data
Thorium-232	Soil Data
Tritium	Groundwater Data
Uranium-233/234	Soil Data
Uranium-238	Soil Data
Inorganics	
Cadmium	Soil Data
Chromium	Soil Data
Lead	Soil Data
Mercury	Process Knowledge
Nitrate	Groundwater Data

bsg = below surrounding grade

Table 2-17. Contaminants of Potential Concern at 116-N-3.

Constituent Name	Rationale
Surface Soil (0-10/15 ft bsg)	
Radionuclides	
Cesium-137	Soil Data
Cobalt-60	Soil Data
Europium-154	Soil Data
Europium-155	Soil Data
Plutonium-239/40	Soil Data
Strontium-90	Soil Data
Thorium-228	Soil Data
Thorium-232	Soil Data
Tritium	Groundwater Data
Uranium-233/234	Soil Data
Uranium-238	Soil Data
Inorganics	
Cadmium	Soil Data
Lead	Soil Data
Mercury	Process Knowledge
Nitrate	Groundwater Data
Subsurface Soil (10/15 ft bsg to groundwater)	
Radionuclides	
Cesium-137	Soil Data
Cobalt-60	Soil Data
Europium-154	Soil Data
Europium-155	Soil Data
Plutonium-239/40	Soil Data
Strontium-90	Soil Data
Thorium-228	Soil Data
Thorium-232	Soil Data
Tritium	Groundwater Data
Uranium-233/234	Soil Data
Uranium-238	Soil Data
Inorganics	
Cadmium	Soil Data
Lead	Soil Data
Mercury	Process Knowledge
Nitrate	Groundwater Data

bsg = below surrounding grade

3.0 REMEDIAL ACTION OBJECTIVES AND PRELIMINARY REMEDIATION GOALS

3.1 INTRODUCTION

The RAOs are general descriptions of what remedial action is expected to accomplish. Preliminary remediation goals are numeric expressions of RAOs and are used to assess the performance of proposed remedial actions. The PRGs are contaminant-specific concentrations considered protective of human health and the environment. PRGs have been developed for the media of concern at TSD units to evaluate potential remedial alternatives against applicable state and federal criteria.

The PRGs identified in this document are based on assumed land uses and exposure scenarios. Final remediation goals (or media-specific cleanup standards) will be determined when exposure scenarios appropriate for final land uses are defined for the 100-N Area. Preliminary remediation goals are based on conceptual exposure models, allowable risk levels, and regulatory standards. The RAOs and PRGs are established to protect human and ecological receptors that could be present in the 100-N Area following remedial action.

This section defines the inputs required and methodology used to develop PRGs for the COPCs. Remedial action objectives, conceptual exposure models, principal risk drivers, and PRGs are presented. The approach for developing the RAOs and PRGs is based on guidance discussed in the *Hanford Site Risk Assessment Methodology* (HSRAM) (DOE-RL 1995g), and on the precedents incorporated in the *100 Area Source Operable Unit Focused Feasibility Study Report* (DOE-RL 1995d); the interim remedial action ROD for the 100-BC-1, 100-DR-1, and 100-HR-1 source OUs (EPA 1995); the interim remedial action ROD for the 100-HR-3 and 100-KR-4 groundwater OUs (EPA 1996); and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 1996h).

The *Qualitative Risk Assessment for the 100-NR-1 Source Operable Unit* (BHI 1995b) identified risks at some source waste sites in the 100-N Area that may warrant remedial action. The *Qualitative Risk Assessment for the 100-NR-2 Source Operable Unit* (BHI 1995c) determined that some contaminant concentrations in groundwater exceed ARARs or other health-risk levels. As a result, the signatory agencies to the Tri-Party Agreement (Ecology, EPA, and DOE) agreed to perform an LFI project to determine whether immediate action on soil at 116-N-1 (1301-N) and/or 116-N-3 (1325-N) was required to protect groundwater. They also agreed to determine whether soil remediation was required to protect groundwater from a future potential impact and, if so, when remediation should be performed. The results of that project are presented and evaluated in the *1301-N and 1325-N Liquid Waste Disposal Facilities Limited Field Investigation Report* (DOE-RL 1996b). The information presented in the 100-N Area QRAs and LFIs was used in this CMS to evaluate remedial alternatives for the TSD waste sites in the 100-N Area. Ecology and the DOE Richland Operations Office (RL) have agreed to evaluate remedial alternatives based on two exposure scenarios.

The original intent was to evaluate the rural-residential and the recreational scenarios in this CMS (see Section 3.3). During the evaluation process, it became clear that there were only limited differences between these scenarios, and that a full evaluation of them would be of little value for decision making. An alternate scenario (i.e., modified CRCIA ranger/industrial) was developed and used as a surrogate for the recreational scenario to illustrate differences between the rural-residential scenario (a relatively unrestricted scenario, in terms of land use) and a more restrictive scenario.

3.2 REMEDIAL ACTION OBJECTIVES

Remedial action objectives are general descriptions of what remedial action is expected to accomplish. They provide a basis for evaluating the capability of a specific remedial measure to achieve compliance with ARARs or an intended level of risk protection for human health and the environment. 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 ARARs. An ARAR is a promulgated federal or state environmental cleanup standard, standard of control, substantive environmental protection requirement, criteria, or limitation. It must be one of the following:

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

In addition to ARARs, to be considered (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 ARARs. However, TBCs are identified and considered if ARARs do not exist for the substance or situations of concern or if the ARAR alone would not be sufficiently protective.

Appendix C discusses the major ARARs/TBCs and lists all the ARAR/TBC requirements that have been identified for the TSD waste sites.

The RAOs for radionuclides are based on agreements made between Ecology, the EPA, and RL that were established during development of the interim remedial action ROD for the 100-BC-1, 100-DR-1, and 100-HR-1 source OUs (EPA 1995) and the RDR/RAWP for the 100 Areas (DOE-RL 1996h). The RAOs for radionuclides in soil are based specifically on the draft EPA standard of 15 mrem/yr above background for protection of human health (40 *Code of Federal Regulations* [CFR] 196). The RAOs for radionuclides in water supplies are based on the maximum contaminant levels (MCLs) that correspond to 4 mrem/yr (40 CFR 141).

The remedial action goals for nonradioactive inorganic and organic contaminants will be based primarily on the following chemical-specific ARARs:

- Washington State *Model Toxics Control Act* (MTCA) (WAC 173-340)

- Nonzero MCL goals and MCL promulgated under the federal *Safe Drinking Water Act* (40 CFR 141) and/or the State of Washington (WAC 246-290)

- Ambient Water Quality Criteria (AWQC) developed under the federal *Clean Water Act* (CWA, Section 304) or standards promulgated by the State of Washington (WAC 173-201).

Remedial action objectives are defined as specifically as possible and usually include the following components:

- Media of interest
- Types of contaminants at the site
- Potential receptors
- Possible exposure pathways
- Levels of residual contaminants remaining following remediation.

Remedial action objectives for soils in the 100 Area were initially developed in the *100 Area Feasibility Study, Phases 1 and 2* (DOE-RL 1994). The RAOs developed for this CMS are based on the remedial action goals presented in the 100 Area Source OU FFS (DOE-RL 1995d) and in the RDR/RAWP for the 100 Area (DOE-RL 1996h). These initial objectives have been refined, based on the conceptual exposure models developed specifically for the 100-N Area and in light of additional information that has become available since these reports were completed.

Remedial action objectives for soils are as follows:

- Protect human and ecological receptors, under the rural-residential or modified CRCIA ranger/industrial scenarios, from exposure to radioactive contaminants in surface and subsurface soils, structures, and debris. Exposure routes include ingestion and inhalation, as well as external radiation exposure from radionuclides. Protection will be achieved by reducing concentrations of, or limiting exposure pathways to, contaminants in the upper 4.6 m (15 ft) of soil for the rural-residential exposure scenario and the upper 3 m (10 ft) of soil for the modified CRCIA ranger/industrial exposure scenario. The levels of reduction will be such that the total dose does not exceed the EPA draft proposed radionuclide soil cleanup standard of 15 mrem/yr above Hanford Site background for 1,000 years following remediation. The 1,000-year requirement ensures that the proposed standard accounts for decay of radionuclides to daughter products that are more highly radioactive.

- Protect potential human and ecological receptors under the rural-residential scenario from exposure by ingestion to inorganic contaminants present in surface and shallow subsurface soils and debris. Protection will be achieved by reducing concentrations of or reducing exposure pathways to, contaminants in the upper 4.6 m (15 ft) of soil to the State of Washington MTCA Method B levels.

- Protect potential human and ecological receptors under the modified CRCIA ranger/industrial exposure scenario from exposure by ingestion to inorganic contaminants present in surface and shallow subsurface soils and debris. Protection will be achieved by reducing concentrations of, or limiting exposure pathways to, contaminants in the upper 3 m (10 ft) of soil. The concentration will be reduced to levels that correspond to an ICR of 1×10^{-5} for carcinogens and a hazard quotient of less than one for noncarcinogens, using exposure parameters and assumptions in the HSRAM (DOE-RL 1995g).

- Protect the unconfined groundwater system from adverse impacts by reducing concentrations of radioactive and inorganic contaminants present in the soil column that could migrate to the groundwater. Contaminant levels will be reduced, or exposure pathways limited, so that concentrations reaching the groundwater do not exceed the State of Washington MTCA Method B levels or MCLs.

- Protect the Columbia River from adverse impacts so that current designated beneficial uses are maintained. Protect associated potential human and ecological receptors using and living in the river from exposure to radioactive and inorganic contaminants. Protection will be achieved by reducing concentrations of, or limiting exposure pathways to, contaminants present in the soil column that could migrate to the groundwater and eventually to the river. Contaminant levels will be reduced so that concentrations reaching the river do not exceed MTCA Method B values; MCLs promulgated under the federal *Safe Drinking Water Act*; or the State of Washington's Drinking Water Standards; AWQC; or the State of Washington Surface Water Quality Standards (WAC 173-201-045).

- Prevent destruction of significant cultural resources and sensitive wildlife habitat. Minimize the disruption of cultural resources and wildlife habitat in general and prevent adverse impacts to cultural resources and threatened or endangered species.

3.3 CONCEPTUAL EXPOSURE MODELS

Conceptual exposure models, which illustrate how receptors could come in contact with the contaminants in the 100-N Area, are presented in this section. The conceptual exposure models define the receptors, exposure pathways/routes, and points of exposure considered in development of PRGs. Remedial action objectives can be met by reducing contaminant concentrations at a site and/or by reducing or eliminating exposure pathways to those contaminants. The potential receptors, exposure routes, and points of contact must all be

considered while complying with RAOs and developing numeric remediation goals. Conceptual fate and transport models identify contaminant sources, release mechanisms, and contaminated media.

The two conceptual exposure models, rural-residential and modified CRCIA ranger/industrial, considered in this CMS are illustrated in Figure 3-1. They were developed to reflect the potential range of exposure scenarios for future use of the 100-N Area. These models describe the potential sources of contamination in soil, the hypothetical receptors that could come in contact with those contaminants, the exposure pathway/routes by which this exposure could occur, and the possible points of contact.

In evaluating potential conceptual exposure models for this CMS, the presence of strontium-90 contamination in the 100-N Area and its impact through the food-ingestion exposure pathway is significant. Strontium-90 enters the food chain and deposits in calcium-containing tissues. As a metabolic analog of calcium, strontium-90 is readily absorbed from the lung (inhalation), gastrointestinal tract (ingestion), or bloodstream (dermal exposure). The risk to potential receptors from exposure to strontium-90 increases substantially when the food-ingestion pathway is included in an exposure scenario.

For those radionuclides that are gamma emitters (e.g., cobalt-60, cesium-137, euorpium-152, and europium-154) and those for which the inhalation pathway is the largest contributor to total dose (e.g., plutonium-239/240), the food-ingestion exposure pathway provides a negligible contribution to total dose. Therefore, for these radionuclides, including or excluding food ingestion in a conceptual exposure model does not significantly influence the magnitude of the calculated PRGs. However, the food-ingestion exposure pathway can account for up to 70% of the total dose from strontium-90 contamination present in soil. Thus, conceptual exposure models can be segregated into two distinct categories: those that include the ingestion of strontium-90 through the food chain and those that do not.

The rural-residential scenario defined in this CMS incorporates conservative (i.e., virtually unrestricted) exposure assumptions including the food-ingestion pathway. Thus, PRGs, specifically the strontium-90 PRG, generated under this scenario are relatively stringent. Other relatively unrestricted-use scenarios that include ingestion of substantial quantities of plants and game animals (e.g., Native American use) require PRGs similar in magnitude to those associated with the rural-residential scenario.

Because future land-use decisions have not been made, an initial intent of this CMS was to develop a recreational scenario as an alternate to the rural-residential scenario. A range of applicable conceptual exposure models was evaluated. Some models considered included ingestion of food (i.e., meats, fruits, and vegetables) that, if acquired in the 100-N Area, may have accumulated contaminants from soil. Food ingestion is the largest contributor to total exposure from strontium-90. Therefore, including the food ingestion pathway in a recreational scenario results in a PRG for strontium-90 that is comparable to the strontium-90 PRG calculated under the rural-residential scenario. Thus, for comparative purposes (e.g., to present

contaminated soil volume/cost differences between potential land uses and remedial alternatives), a recreational scenario that does not include the food-ingestion exposure pathway is defined in this CMS. This scenario is the most conservative recreational, conceptual exposure model evaluated that does not include the food-ingestion pathway. Most conservative in this case means the conceptual exposure model that requires the most restrictive PRG.

For the purpose of this TSD CMS, it is assumed that the groundwater will not be used as a potable water supply or for irrigation purposes, in order to be consistent with the same decision in the 100-NR-1/NR-2 CMS. Irrigation will be considered only under the rural-residential scenario, and water for irrigation would be expected to be obtained from the most readily available source, the Columbia River, which was used for irrigation in this area before the construction of the Hanford Site.

The groundwater and the Columbia River must be protected from potential contaminants contained in the soils beneath the TSD waste sites. Therefore, RAOs have been developed to reduce future contaminant migration to the groundwater or the river. The MTCA B or MTCA C standards for groundwater or AWQC in the river will be the basis for determining the extent of the remedial action required (WAC 173-340-740). The MTCA B cleanup levels will be the basis for determining the extent of remedial action required in the rural-residential exposure scenario. The MTCA C cleanup levels will be the basis for determining remediation requirements under the modified CRCIA ranger/industrial exposure scenario.

3.3.1 Conceptual Model for Treatment, Storage, and Disposal Waste Sites

3.3.1.1 Contaminant Sources. The conceptual model for the TSD waste sites illustrates how contaminants from the soil are transported by physical, chemical, or biological processes to other media. The model also identifies which media are the principal concerns with respect to contaminants from the TSD waste sites. The overall concern is how the contaminants may be transported to receptors such as humans, plants, or animals.

Soils in the 100-N Area became contaminated as a result of planned and UPRs of contaminated liquid effluents during and immediately following the operation and shutdown of the N Reactor. Liquid effluent from the primary and secondary cooling water systems, shielding water used in the reactor fuel loading/unloading processes, and reactor decontamination fluids all carried radionuclides to the soil at the 116-N-1 and 116-N-3 waste sites. The reactor decontamination fluids also contained chemical constituents, such as nitrates and sulfates, and the cooling water contained corrosion inhibitors, such as hydrazine and sodium dichromate.

All significant wastes addressed in this CMS were released as liquids to the soil, and all the COPCs (as identified in Section 2.5) are radionuclides or inorganic chemicals. The original sources of the liquid effluent that contaminated the soil have ceased operation. The contaminated soil areas are referred to as secondary sources. Only the contaminated soil remains as a threat to human health or the environment. The conceptual site model addresses releases to the soil and the contaminants that were retained in the surface and subsurface soil. The

contaminants that infiltrated through the soil to groundwater are addressed in the 100-NR-1/NR-2 CMS (DOE-RL 1996c), by agreement between Ecology and RL.

3.3.1.2 Receptors and Exposure Pathways: Rural-Residential Use. The rural-residential exposure scenario used in this CMS is a slight modification of the residential or frequent-use scenario described in the HSRAM (DOE-RL 1995g) and is consistent with the assumptions developed for the EPA proposed radionuclide soil cleanup standard (40 CFR 196). Furthermore, it is consistent with the unrestricted-use assumptions defined in the interim remedial action ROD for the 100-BC-1, 100-DR-1, and 100-HR-1 source OUs (EPA 1995) and also with the rural-residential exposure scenario found in the RDR/RAWP (DOE-RL 1996h) and 1301-N/1325-N LFI report (DOE-RL 1996b). Under this scenario, occupancy of the land surface is assumed to be continuous for 365 days/year for a period of 30 years. It is assumed that human receptors could come into direct contact with contaminants in soil to a depth of 4.6 m (15 ft) because basements or other subsurface structures could be constructed within the site excavation to 3.7 m (12 ft), with a 0.9-m (3-ft) buffer of clean soil. These activities would allow human contact with potentially contaminated subsurface soil. Beyond 4.6 m (15 ft) in depth, it is reasonable to assume that soils would remain undisturbed by human activities, and direct contact with contaminants deeper than 4.6 m (15 ft) would not occur.

The exposure routes used to develop risk-based PRGs in soil within the top 4.6 m (15 ft) are ingestion of contaminated soil, inhalation of suspended dust, and external radiation exposure from radionuclides. Indirect exposure routes are consumption of local plants and animals. Risk-based PRGs for contaminant concentrations in soil were developed to address contaminant uptake by human receptors via the exposure pathways listed above. For contaminants in soils deeper than 4.6 m (15 ft), the concern is the potential migration of contaminants to groundwater and eventually to the Columbia River.

Under the rural-residential exposure scenario, groundwater underlying the 100-N Area would not be used as a potable water supply or for irrigation purposes for a period of time not expected to exceed 300 years (the estimated time required for strontium-90 to decay to the drinking water standard of 8 pCi/L). However, 0.76 m/yr (30 in./yr) of irrigation water from an off-site, uncontaminated source is assumed to be provided and is included in the exposure evaluations.

3.3.1.3 Receptors and Exposure Pathways: Modified CRCIA Ranger/Industrial Scenario. Section 3.3 noted that if the consumption of plants and animals acquired in the 100-N Area (i.e., the food-ingestion exposure pathway) was evaluated in the recreational exposure scenario, the resulting PRGs (specifically the strontium-90 PRG) would essentially be of the same order of magnitude as those required by the rural-residential scenario. Consequently, there would be little benefit in examining a recreational scenario that includes the food-ingestion pathway. Thus, to present a distinctly different exposure scenario alternative, the recreational exposure scenario used in this CMS does not include the food-ingestion pathway. The recreational exposure scenario used in this CMS is based on the ranger scenario developed in the *Human Scenarios for the Screening Assessment, Columbia River Comprehensive Impact Assessment* (Napier et al. 1996). The ranger scenario is similar to the HSRAM industrial scenario, the primary difference

being a smaller yearly exposure duration. Other minor differences among the CRCIA ranger scenario, the HSRAM industrial scenario, and the recreational scenario incorporated in this CMS include the soil ingestion rate and the air inhalation rate (Appendix F1). To reflect that the recreational scenario developed for this CMS is based on the CRCIA ranger scenario, and that it is similar to the HSRAM industrial scenario, it is labeled the modified CRCIA ranger/industrial scenario (Appendix F). For exposure purposes under this scenario, it is assumed that an individual (i.e., the ranger) will spend about 3 days/week (150 days/year) on the site for a period of 30 years. The individual is assumed to be on site 9 hours/day, with a third of the time spent in each of three location types: upland, shoreline, and on the river. Furthermore, it is assumed that 6 hours/day (of the total 9 hours/day) will be spent in contaminated areas; thus, the exposure duration is 37.5 days/year (i.e., 150 days/yr x 6 hr/day = 900 hr/yr x 1/24 days/hr = 37.5 days/yr). During this time the individual will be exposed to external radiation and to contaminants through the inhalation and soil ingestion pathways. This recreational exposure scenario assumes that humans will not inhabit the area. Furthermore, groundwater underlying the 100-N Area will not be used for irrigation or as a potable water supply (to be consistent with the same decision in the 100-NR-1/NR-2 CMS) for a period of time not expected to exceed 300 years (the estimated time required for strontium-90 to decay to the drinking water standard of 8 pCi/L).

It is assumed that human receptors could come into direct contact with contaminants in the soil to a depth of 3 m (10 ft) during recreational activities because of the following:

- Shallow excavations of a meter or so may occur during recreational activities, and because of biotic activity, humans may be exposed to contaminants from soil as deep as 3 m (10 ft).

- Because animals may live in burrows as deep as 3 m (10 ft), soil from 3 m (10 ft) could be brought to the surface by these animals.

- Plants can take up contaminants directly from the soil, and most plant roots occur in the upper 3 m (10 ft) of soil.

A review of the literature (DOE-RL 1995a; Gano and States 1982; Klepper et al. 1985) concerning potential biotic intrusion into remediated waste sites was conducted to determine the validity of using a 3-m (10-ft) excavation depth versus a 1.8-m (6-ft) depth for the recreational scenario (i.e., the modified CRCIA ranger/industrial scenario). The Great Basin pocket mouse appears to have the deepest burrow system, with maximum depths reported to about 2 m (6.6 ft). However, the Great Basin pocket mouse prefers deep, fine-textured soils not dominated by cheatgrass, which will be unlikely at remediated sites. Mammal intrusion into backfilled remediated sites will be limited to the depth of fine-textured topsoil placed over sites. Harvester ants have been reported to burrow to 2.7 m (8.9 ft) on the Hanford Site and perhaps are the most significant potential biological transport mechanisms of deep contamination (Rickard et al. 1987). Rickard et al. (1987) also reported that approximately 11% of the soil moved by ants was from depths greater than 1.5 m (4.9 ft), and that ant colonies tend to be more common in waste burial grounds than in neighboring undisturbed sites by a factor of 4 to 1.

A summary of rooting depths for local plants indicates a maximum depth of 2 m (6.6 ft) or less for most species (DOE-RL 1995a). Possible exceptions to this maximum root depth include big sagebrush, Russian thistle, snow buckwheat, and bitterbrush. However, Klepper et al. (1985) reported that maximum rooting depths are 2 m (6.6 ft) or less on the Hanford Site for these species, and that the majority of the root mass is located within the top 1 m (3.3 ft), especially the top 0.5 m (1.6 ft), for Hanford plants.

In summary, a recreational remediation depth of 1.8 m (6 ft) is realistic with respect to biological intrusion. Thus, if recreational land use is chosen for the 100-N Area, a 1.8-m (6-ft) excavation depth for remediation is adequate for mitigation of risk associated with potential human and ecological exposure. However, the 3-m (10-ft) depth is used in this CMS to maintain consistency with past recreational scenarios and the 100-NR-1/NR-2 CMS. It is reasonable to assume that beyond either depth, soils would remain undisturbed by human activities and direct contact with contaminants would not occur.

The modified CRCIA ranger/industrial exposure model assumes that direct human exposure to radionuclide contaminants within the top 3 m (10 ft) of soil occurs through ingestion of contaminated soil, inhalation of suspended dust, and external exposure to radiation. Indirect exposure pathways are not considered. Exposure to nonradionuclide contaminants in soil is based solely on the soil-ingestion pathway for preliminary screening purposes. In some cases, there may be no contaminants in the top 3 m (10 ft) of soil at a site. In these instances, there would be no exposure through these pathways. For contaminants in soils deeper than 3 m (10 ft), the concern is the potential migration of contaminants to groundwater and eventually to the Columbia River (Section 3.3.2).

3.3.1.4 Ecological Receptors. Because it is impractical to assess the toxic effects of numerous contaminants on potential ecological receptors, a representative species was selected as the maximally exposed species. It is believed that RAOs and PRGs developed to protect a maximally exposed species will also be protective of species that are less exposed (e.g., animals with larger home ranges that spend much of their time in uncontaminated areas).

The Great Basin pocket mouse was selected as representative of animal species that have the greatest potential for exposure to contaminants in soils present in the 100-N Area. The pocket mouse lives in burrows that may reach a reported depth of 2 m (6.6 ft) and feeds primarily on the seeds of native and introduced plant species. While in its burrow, the mouse may be in direct contact with contaminated soils and, therefore, is in close proximity to contaminants. The Great Basin pocket mouse has a small home range that approximates the size of many of the individual waste sites as discussed in the HSRAM (DOE-RL 1995g). Although it is unlikely that this home range completely overlaps with the contaminated soil zone, the CMS assumes complete overlap as a conservative approach. The pocket mouse may be exposed to contaminants through direct contact with contaminated soils or through the ingestion of contaminated soils, plants, and seeds.

The PRGs address plants as a generic, rather than species-specific, receptor because the information available on phytotoxicity of contaminants to plants is based primarily on domestic

species that do not occur in the 100-N Area. The principal exposure route for plants was considered to be the uptake of contaminants from the soil.

3.3.2 Groundwater Conceptual Model

Groundwater contamination at the 100-N Area is a major concern because (1) it can impact the Columbia River, which has been designated as a source for domestic water supply and is used for sport and commercial fishing, and (2) contaminants prevent potential future use of the unconfined aquifer until it is cleaned up. The impact and remediation of the groundwater is addressed in the 100-NR-1/NR-2 CMS (DOE-RL 1996c) by agreement between Ecology and RL.

Strontium-90 and tritium are the only two groundwater contaminants that are entering the river at concentrations exceeding groundwater PRGs. The presence of strontium-90 in the unconfined aquifer and on sediments in the vadose zone is a significant problem because strontium-90 adsorbs strongly to soil particles, has a half-life of 29 years, and is present in the groundwater at concentrations over 4,000 pCi/L. At this concentration, it will take about 300 years for strontium-90 to decay to the drinking water standard of 8 pCi/L. The vadose zone is a continuing source of contamination for the groundwater in the 100-N Area because the water table fluctuates in response to changes in Columbia River flows (elevation), thus remobilizing strontium-90 and other contaminants in the lower portion of the vadose zone to enter the groundwater.

Tritium in the unconfined aquifer is a short-term problem because of the shorter half-life of tritium (12.3 years). Tritium in the aquifer will naturally decay in about 25 years to levels below the drinking water standard of 20,000 pCi/L.

3.3.2.1 Contaminant Sources. The sources of contaminants for the groundwater beneath the TSD waste sites are the contaminated soils associated with these sites. The sources of contaminants for the Columbia River are the contaminated soils and the contaminated groundwater. Contaminants have migrated through soil into the groundwater, thereby contaminating the groundwater and subsequently enabling potential contaminant release into the Columbia River. Contaminants from soils may continue to migrate into groundwater, so the waste sites are indirect sources of contamination for the groundwater and, eventually, the Columbia River.

3.3.2.2 Receptors and Exposure Pathways. Protection of the Columbia River is a primary RAO for contaminated water media. Thus, the river is the focus for determining exposure pathways and evaluating risk to potential human and ecological receptors. Exposure durations for humans are the same as those defined under the rural-residential and modified CRCIA ranger/industrial exposure scenarios presented previously. Groundwater underlying the 100-N Area will not be used as a water supply for purposes of either drinking or irrigation for a period of time not expected to exceed 300 years (the estimated time required for strontium-90 to decay to the drinking water standard of 8 pCi/L). The water supply for irrigation for rural-residential

uses of the site would be the Columbia River. Thus, potential human exposure to groundwater contaminants is limited to dermal contact with and ingestion of seeps that may be present when the Columbia River is at low stage.

Ecological receptors include aquatic and riparian species. Direct exposure routes for aquatic species include uptake of contaminants through gill structure or other permeable organs and through ingestion of contaminants in food and water. Direct exposure pathways for riparian species include ingestion of contaminated prey and water. Ecological receptors may contact contaminants in groundwater seeps that may be present when the Columbia River is at low stage and in sediment pore water at the groundwater/river bottom interface. The major concern for aquatic species is exposure to contaminated groundwater as it mixes with river water in or near the river substrate (e.g., in the early life stages of salmon).

Because shoreline seeps are only accessible when the river is at low stage, contaminant concentrations in near-river wells are used to approximate concentrations of contaminants at the groundwater/river interface and to evaluate attainment of PRGs protective of the Columbia River. Existing groundwater, seep, and river-water data indicate that the near-river wells have higher contaminant concentrations than either the seeps or the river water (DOE-RL 1995h; Peterson and Johnson 1992). Only limited data are available for the seeps in the 100-N Area, and no data are available for pore water. Because Columbia River water infiltrates into the unconfined aquifer and mixes with groundwater, a dilution factor of one-half is applied to the near-river well concentrations to approximate the concentrations that exist at the groundwater/river water interface. For example, if the near-river well concentration for chromium is 20 μg/L, the concentration at the groundwater/river-water interface is expected to be 10 μg/L. This correction factor is consistent with the approach established in the interim remedial action ROD for the 100-HR-3 and 100-KR-4 groundwater OUs (EPA 1996).

The PRGs used in this CMS for protection of human and ecological receptors from contaminants in groundwater and from contaminants reaching the Columbia River by groundwater inflow are based on ARARs rather than on risk-based levels derived from risk assessment models. Therefore, specific exposure scenarios describing exposure durations, exposure pathways, and intake rates are not necessary. The use of ARARs as remediation goals for groundwater and the Columbia River was established during prior feasibility studies and is consistent with the interim remedial action RODs for the 100 Area source OUs (EPA 1995) and the 100-HR-3 and 100-KR-4 groundwater OUs (EPA 1996). Based on these precedents, protection of human and ecological receptors will be achieved by reducing contaminant concentrations reaching the Columbia River, as measured in near-river wells, to either MTCA Method B values, MCLs promulgated under the federal *Safe Drinking Water Act* or the State of Washington's Drinking Water Standards, AWQC, or the State of Washington's Surface Water Quality Standards (WAC 173-201-045).

3.4 PRELIMINARY REMEDIATION GOALS

Preliminary remediation goals are numeric expressions of the RAOs presented in Section 3.2. The PRGs are contaminant-specific concentrations that are considered protective of human health and the environment, assuming specific exposure scenarios. They are used to identify the contaminants that are the most likely drivers for proposed remedial action, to evaluate risk posed by specific contaminant concentrations, and to present preliminary cleanup goals for use during remedial design. The identified numeric goals are used in conjunction with estimates of soil volumes requiring remedial action to assess the performance of remedial alternatives and to estimate costs associated with potential remedial actions. Finally, PRGs may be used during development of media-specific cleanup standards, which would be specified in the subsequent ROD as levels to be achieved by remedial action.

Preliminary remediation goals are based on acceptable levels of human health and ecological risk, ARARs, points of compliance, and assumed future land use as defined by the conceptual exposure scenarios. In addition, PRGs are specified for individual hazardous substances. If multiple hazardous substances are present at a site, the suitability of using the PRGs as final cleanup values protective of human health and the environment will have to be evaluated based on site-specific information and the potential for contaminant interaction. Final remediation goals (or media-specific cleanup standards) will be determined when final land use(s) and appropriate exposure scenarios have been selected for the TSD units.

Contaminants of potential concern for the 116-N-1 and 116-N-3 waste sites were determined in Section 2.5 and are presented in Tables 2-16 and 2-17. As discussed in Section 2.5.5, there are no COPCs for the 120-N-1, 120-N-2, and 100-N-58 waste sites. Therefore, these waste sites are considered no-action units and will be closed solely in accordance with WAC 173-303-610 closure standards. Preliminary remediation goals have been determined for those radioactive and chemical constituents determined to be COPCs.

3.4.1 Preliminary Remediation Goals for Radionuclides in Soils

3.4.1.1 Human Exposure (Rural-Residential and Modified CRCIA Ranger/Industrial). The proposed standard for radioactive contaminants, as described in "The Radiation Site Cleanup Regulation: Preliminary Draft" (40 CFR 196), would limit radiation doses to 15 mrem/yr above natural background levels for 1,000 years following completion of remediation. The 1,000-year requirement ensures that the proposed standard accounts for decay of radionuclides to daughter products that are more radioactive. The 15 mrem/yr proposed standard corresponds to a lifetime ICR of 3×10^{-4}, and it falls within the range of other radiation protection standards promulgated by the EPA (e.g., standards employed under the *Uranium Mill Tailings Radiation Control Act* and the "National Emissions Standards for Hazardous Air Pollutants" [40 CFR 61]). The 15 mrem/yr standard is used for radiological cleanup in the interim remedial action ROD for the 100-BC-1, 100-DR-1, and 100-HR-1 source OUs (EPA 1995).

Limiting exposure levels to 15 mrem/yr above background acknowledges that background varies from site to site. Most radionuclides of concern in the 100-N Area, such as cobalt-60, cesium-137, europium-152, europium-154, strontium-90, and plutonium-239/240, are present at very low concentrations in background soils. Background concentrations of radionuclides in soils at the Hanford Site have been determined (DOE-RL 1996e) and must be used with appropriate radionuclide measurement techniques to distinguish site contamination from naturally occurring radionuclides.

To evaluate risk (i.e., dose) from exposure to radionuclide-contaminated soils, radionuclide concentrations (pCi/g) in soil must be converted to a dose rate (mrem/yr) using a dose assessment model. Similarly, to generate PRGs for radionuclide contaminants in soil, a dose assessment model is used to determine individual radionuclide concentrations (pCi/g) in soil that correspond to a dose rate of 15 mrem/yr above background. The RESidual RADioactivity (RESRAD) model has been used as the dose assessment model for generating PRGs for radionuclide contaminants in soil in the 100 Area of the Hanford Site. The model was developed by Argonne National Laboratory (ANL 1993) for implementing DOE guidelines for residual radioactive material in soil. The RESRAD model was evaluated by the EPA for use in performing dose assessments to support the EPA proposed radionuclide soil cleanup standard of 15 mrem/yr above background (40 CFR 196). The EPA, Ecology, and RL agreed in the RDR/RAWP (DOE-RL 1996h) to use RESRAD to calculate concentrations in soil of individual radionuclides that correspond to a dose rate of 15 mrem/yr. RESRAD will also be used to perform site-specific calculations for both radionuclides and nonradioactive metals to determine concentrations in the soil that are protective of groundwater and the Columbia River. The developers of the RESRAD model do not recommend using it to perform evaluations past 1,000 years.

The RESRAD model was used to calculate concentrations of individual radionuclide COPCs in soil that correspond to a dose rate of 15 mrem/yr through the exposure routes discussed in the rural-residential (Section 3.3.1.2) and modified CRCIA ranger/industrial (3.3.1.3) scenarios. Values are applicable at the time of remediation and are presented in Tables 3-1 and 3-2, respectively, for the 116-N-1 and 116-N-3 waste sites. The values presented in Tables 3-1 and 3-2 represent general PRGs based on RESRAD parameters from Appendix F. They are used to refine the COPC list, to estimate the volume of contaminated soil requiring remedial action, and to assist remedial design. They are not intended to represent final cleanup concentrations to be achieved by remedial action at a particular site.

3.4.1.2 Ecological Exposure. There is no established dose limit for protection of ecological receptors. Soil concentration values of 0.1 rad/day and 1 rad/day for terrestrial animals and plants, respectively, have been selected for provisional use for screening COCs for protection of ecological receptors in this CMS. The concentrations of individual radionuclides in soil at 116-N-1 and 116-N-3 that correspond to a dose limit of 0.1 rad/day for external and internal exposure of ecological receptors are also presented in Tables 3-1 and 3-2. These values are based on draft ecological risk evaluations under consideration by DOE (61 FR 6799). Use of these values for individual receptors within a population is believed to be conservative and would

require further evaluation if determined to be significant in selecting the preferred cleanup alternative.

Several authoritative agencies have concluded that radiation dose limits protective of human health should also protect plant and animal populations (EPA 1993). In most cases, the human health standard of 15 mrem/yr requires concentrations in the soil in a rural-residential scenario that are less than those concentrations associated with an exposure of 0.1 rad/day. Therefore, for exposure to most radionuclides in the soil under the rural-residential scenario, PRGs protective of human health are also considered protective of ecological receptors. However, in the reduced exposure of a recreational scenario, the human health standard of 15 mrem/yr may be met at concentrations of radionuclides in the soil that are greater than those concentrations associated with an ecological exposure of 0.1 rad/day. When this occurs for strontium-90, the concentration in soil corresponding to an ecological exposure of 0.1 rad/day is selected as the PRG for exposure in the modified CRCIA ranger/industrial scenario (summarized in Table 3-6).

3.4.2 Preliminary Remediation Goals for Chemical Contaminants in Soils

3.4.2.1 Rural-Residential. Preliminary remediation goals for chemical constituents in soil under a rural-residential scenario are based on cleanup standards specified in MTCA cleanup regulations (WAC 173-340-704 through 706). Method B (WAC 173-340-705) specifies cleanup levels for groundwater, surface water, soil, and air, assuming no restrictions on possible future land uses. Cleanup levels for individual hazardous substances are established using applicable state and federal laws and the risk equations specified in WAC 173-340-720 through 750. Cleanup levels for individual carcinogens are based on the upper bound of the estimated excess lifetime cancer risk of one in one million (1×10^{-6}). In addition, cleanup levels for individual noncarcinogenic substances are set at concentrations that are anticipated to result in no acute or chronic toxic effects on human health and the environment. This level corresponds to a hazard quotient of less than one.

If a hazardous waste site involves multiple hazardous substances and/or multiple pathways of exposure, MTCA Method B cleanup levels for individual substances must be modified in accordance with the human-health risk-assessment procedures outlined in WAC 173-340-708. This modification of cleanup levels, if necessary, would take place during the verification of site cleanup following remediation. Under this method, the total excess lifetime cancer risk for a site shall not exceed one in 100,000 (1×10^{-5}), and the hazard index for substances with similar noncarcinogenic toxic effects shall not exceed one (WAC 173-340-705[4]).

Stated cleanup levels for some contaminants may be less than the practical quantitation limits or area background. When MTCA Method B cleanup levels are below area background concentrations, cleanup levels may be set at concentrations equal to the agreed-upon site or area background (WAC 173-340-706[1][a]). Area background for selected nonradioactive contaminants in soil was characterized for the Hanford Site (DOE-RL 1995b). Similarly, when cleanup levels are below practical quantitation limits for nonradioactive contaminants, the PRGs will default to the practical quantitation limits (WAC 173-340-707[2]). Therefore, the PRGs for

nonradioactive inorganic contaminants in soil will reflect whichever is greatest among MTCA Method B cleanup levels, agreed-upon background, or practical quantitation limits, but in no case greater than concentrations specified under MTCA Method C (WAC 173-340-706[2]). Preliminary remediation goals based upon direct exposure to soils in the rural-residential exposure scenario, Hanford-specific background concentrations, and practical quantitation limits for inorganic contaminants in soil are presented in Table 3-3 (a) and (b), for waste sites 116-N-1 and 116-N-3, respectively.

3.4.2.2 Modified CRCIA Ranger/Industrial. The MTCA cleanup regulation acknowledges that recreational activities may occur at a site but does not provide parameters for evaluating recreational exposures. However, the regulations stipulate that cleanup levels for sites under a recreational exposure scenario shall be at least as stringent as the MTCA Method C cleanup levels (WAC 173-340-740[1][d]). Therefore, for this CMS, the PRGs for inorganic contaminants in soil, protective of human receptors under a modified CRCIA ranger/industrial exposure scenario, are based on cleanup standards corresponding to a total excess lifetime cancer risk of one in 100,000 and a hazard quotient of less than one, using exposure parameters and assumptions in the HSRAM (DOE-RL 1995g). If a hazardous waste site involves multiple hazardous substances and/or multiple pathways of exposure, Method C cleanup levels for individual substances must be modified in accordance with procedures outlined in WAC 173-340-708. In making these adjustments, the hazard index shall not exceed one and the total excess cancer risk shall not exceed one in 100,000 (WAC 173-340-706[4]). Using exposure times discussed in Section 3.3.1.3, the PRGs for nonradioactive inorganic contaminants in the modified CRCIA ranger/industrial exposure scenario were calculated assuming direct exposure of human receptors to contaminants through the inhalation and soil ingestion pathways. The calculated PRGs have been summarized in Table 3-3 (a) and (b).

3.4.2.3 Ecological. Current techniques for estimating PRGs for inorganic contaminants in soil, protective of ecological receptors, involve use of no-observed adverse-effect levels from toxicological studies. The no-observed adverse-effect levels are combined with species-specific exposure assumptions to estimate concentrations in soil that would not be expected to cause an adverse effect. However, PRGs estimated in this manner are based on ensuring that individual organisms will not be exposed to soil concentrations causing adverse effects. Therefore, PRGs calculated in this manner may not be pertinent for protecting animal populations and ecological communities. Those PRGs protective of individual organisms will generally be overprotective of populations and communities.

Field studies at the Hanford Site have found no evidence suggesting impacts to the natural wildlife populations and communities as a result of toxic inorganic contaminants (Landeen et al. 1993; DOE-RL 1995i). Furthermore, initial review of terrestrial exposure models indicates that ecological exposure to most inorganic contaminants is expected to be limited because areas of inorganic contamination are small by comparison to the home ranges of most animals, and because most metals do not tend to bio-accumulate (Suter 1993; EPA 1976; Fish and Wildlife Service 1987, 1988). Protection of ecological receptors from inorganic contaminants will be

accomplished by remediating soils to levels protective of human receptors and by minimizing or eliminating exposure pathways to the ecological receptors.

3.4.3 Preliminary Remediation Goals for Soils that are Protective of Groundwater

The National Primary Drinking Water Regulations and MTCA Method B standards specify MCLs for radionuclides and nonradioactive contaminants in drinking water. In the absence of an MCL for lead, the drinking water action level was used as the basis for the PRG. MCLs are published for radium-226 and radium-228 (40 CFR §141.15) and for tritium and strontium-90 (40 CFR §141.16). The concentrations for all other radionuclides must be calculated, based upon limiting radioactive dose in drinking water to 4 mrem/yr, using a 2-L/day drinking-water intake and the 168-hour data listed in *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air or Water for Occupational Exposure* (NBS 1963). If two or more radionuclides are present, the sum of their annual dose shall not exceed 4 mrem/yr (40 CFR §141.16). For some radionuclides, the concentrations in water calculated with this method are higher than 1/25 of the DOE derived concentration guides (DCG) in water (1/25 of the DCG corresponds to a dose of 4 mrem/yr). In these cases, 1/25 of the DCG is used to develop PRGs in water, rather than the tabulated or calculated MCL value.

Residual radioactive and nonradioactive contaminants remaining in soil after remediation must be at such levels that concentrations of contaminants reaching the unconfined aquifer, and eventually the Columbia River, by migration through the soil column do not exceed PRGs considered protective of groundwater and the river. These residual contaminant concentrations must be equal to or less than 100 times the groundwater cleanup level established in accordance with MTCA Method B (WAC 173-340-720) unless it can be demonstrated that a higher soil concentration is protective of groundwater at the site (WAC 173-303-740[3][a][ii][A]). The unit gradient model (DOE-RL 1996b) was used to demonstrate that some residual soil contaminants do not reach the unconfined aquifer within 1,000 years (the calculation was confirmed by RESRAD). Thus, for these contaminants, a PRG for residual soil contamination protective of groundwater has not been provided. The travel-time calculations are presented in Appendix G.

The contaminants that reach groundwater are tritium, uranium-233/234, uranium-238, chromium VI, and nitrate. Protection of groundwater is achieved by reducing the concentration of those residual soil contaminants predicted to reach groundwater to concentrations less than or equal to 100 times the groundwater MCLs per MTCA Method B. For example, the groundwater MCL for chromium VI is 80 μg/L. The concentration in soil equal to 100 times this value is 8 mg/kg. Values of PRGs in soil, which will be protective of groundwater, have been tabulated in Table 3-4 for waste sites 116-N-1 and 116-N-3.

3.4.4 Preliminary Remediation Goals for Soils That Are Protective of the Columbia River

To achieve protection of the Columbia River, contaminants remaining in the soil after remedial action shall not cause the river's AWQC to be exceeded. Two additional contaminant transport steps, beyond migration through the soil column and leaching into the groundwater, must also be

considered in the calculation of PRGs in soil: (1) transport through the unconfined aquifer from beneath the waste sites to the river's edge, and (2) discharge from the groundwater into the river. These two steps were addressed by the dilution/attenuation factor model summarized in Appendix D of the RDR/RAWP (DOE-RL 1996h). This model accounts for the time required for a contaminant to travel to the river through the unconfined aquifer underlying a site, for radionuclide decay occurring during that time period, and for a 1:1 dilution factor applied to contaminant concentrations measured in near-river wells.

Dilution/attenuation factor PRGs are tabulated in Table 3-5 for those contaminants predicted to reach groundwater in less than 1,000 years. A default value of two times the contaminant-specific surface water PRG is the minimum dilution/attenuation factor PRG reported as a conservative approximation of the dilution, which occurs between the unconfined aquifer and the groundwater-river interface. For example, the PRG for chromium VI in surface water is 10 μg/L. Therefore, the minimum dilution/attenuation factor PRG for chromium VI in groundwater would be 20 μg/L.

The use of this default value is consistent with the approach established in the interim remedial action ROD for the 100-HR-3 and 100-KR-4 groundwater OUs (EPA 1996), which presents a former AWQC for chromium VI in surface water. This approach dilutes near-river well concentrations 1:1 in order to estimate the concentration at the groundwater/river interface. This dilution is necessary to account for infiltration and mixing of the unconfined aquifer with water from the Columbia River. Because this dilution factor was developed for chromium VI, a highly mobile constituent, using it for a much less mobile constituent, such as strontium, would be considered highly conservative.

To be consistent, the same methodology applied to concentrations of residual contaminants in soil to achieve protection of groundwater (i.e., 100 times the PRG) was applied to achieve protection of the Columbia River. For those residual soil contaminants predicted to reach groundwater, protection of the river is achieved by reducing the PRGs for soils to concentrations less than or equal to 100 times the dilution/attenuation factor PRGs. For example, the dilution/attenuation factor PRG for chromium VI, determined above, is 20 μg/L. The concentration in soil equal to 100 times this value is 2 mg/kg. Values of PRGs in soil that will be protective of the Columbia River are tabulated in Table 3-5 for waste sites 116-N-1 and 116-N-3.

3.4.5 Summary of Preliminary Remediation Goals for Soil

Preliminary remediation goals for the 116-N-1 and 116-N-3 waste sites are summarized in Table 3-6. These PRGs quantify the RAOs discussed in Section 3.2. Table 3-6 includes PRGs for direct exposure to soil and PRGs that are protective of groundwater and the Columbia River.

Figure 3-1. Exposure Model for Human and Ecological Receptors.

Exposure		Human Receptors			
		Radionuclides		Nonradionuclides	
Media	Route	Rural Residential	MCRIS*	Rural Residential	MCRIS*
Soils	Ingestion	●	●	●	●
	Dermal	—	—	—	—
	External	●	●	NA	NA
Air (Dust)	Inhalation	●	●	—	—
	External	—	—	NA	NA
Groundwater	Ingestion	—	—	—	—
	Inhalation	—	—	—	—
	Dermal	—	—	—	—
	External	—	—	NA	NA
Surface Water	Ingestion	—	—	—	—
	Inhalation	—	—	—	—
	Dermal	—	—	—	—
	External	—	—	NA	NA
Biota	Dairy	I	—	—	—
	Beef	I	—	—	—
	Game	I	—	—	—
	Fish	I	—	—	—
	Plant/Crop	I	—	NA	NA

SOURCE: DOE-RL, 1993a

* Modified CRCIA Ranger/Industrial Scenario

NA = Not Applicable

E9608093.1

● Primary Pathway

I Indirect Pathway

— Pathway Not Assessed

Table 3-1. Source Waste Site 116-N-1. Single Radionuclide Surface Soil COPC Concentrations Corresponding to a 15 mrem/yr Dose Rate. Surface Soil Concentrations Needed to Exceed the Wildlife Dose Limit of 0.1 rad/day for the Great Basin Pocket Mouse.

Radionuclide	Concentration in Soil (pCi/g)			
	15 mrem/yr Dose Rate		Ecological Dose > 0.1 rad/day	
	Rural-Residential Exposure Scenario with Irrigation	MCRIS	External	Internal
Cesium-137	6.1	46.5	3,287	12,000
Cobalt-60	1.4	9.7	800	45,000
Europium-154	3.1	20.5	1,600	2,300,000,000
Europium-155	127	843	3,300	1,200,000,000
Plutonium-239/240	23.5	85.5	900,000	170,000
Strontium-90	3.7	3,885	no dose	14.8
Thorium-232	0.94	6.6	1,200,000	no dose
Tritium	241	16,110	no dose	430,000
Uranium-233/234	101	199	1,500,000	660
Uranium-238	69	262	1,500,000	750

MCRIS = Modified CRCIA Ranger/Industrial Scenario

Table 3-2. Source Waste Site 116-N-3. Single Radionuclide Surface Soil COPC Concentrations Corresponding to a 15 mrem/yr Dose Rate. Surface Soil Concentrations Needed to Exceed the Wildlife Dose Limit of 0.1 rad/day for the Great Basin Pocket Mouse.

Radionuclide	Concentration in Soil (pCi/g)			
	15 mrem/yr Dose Rate		Ecological Dose > 0.1 rad/day	
	Rural-Residential Exposure Scenario with Irrigation	MCRIS	External	Internal
Cesium-137	6.1	46.5	3,287	12,000
Cobalt-60	1.4	9.7	800	45,000
Europium-154	3.1	20.5	1,600	2,300,000,000
Europium-155	127	843	3,300	1,200,000,000
Plutonium-239/240	23.5	85.5	900,000	170,000
Strontium-90	3.7	3,885	no dose	14.8
Thorium-228	2.2	13.6	6,500,000	no dose
Thorium-232	0.94	6.6	1,200,000	no dose
Uranium-233/234	101	199	1,500,000	660
Uranium-238	69	262	1,500,000	750

MCRIS = Modified CRCIA Ranger/Industrial Scenario

Table 3-3. Preliminary Remediation Goals for Direct Exposure to Nonradioactive Contaminants in Surface Soil.

(a) 116-N-1

Contaminant	PRGs in Soil (mg/kg)		Hanford-Specific Background in Soil[d] (mg/kg)	Practical Quantitation Limit in Soil[f] (mg/kg)
	Rural-Residential Exposure Scenario[a]	MCRIS		
Cadmium	80	4,542	NA[e]	0.8
Chromium (III)	80,000	100,000[c]	18.5[g]	0.5
Chromium (VI)	400	22,711	18.5[g]	0.7
Lead	250[b]	250[b]	10.2	0.3
Mercury	24	1,363	0.33	0.8

(b) 116-N-3

Contaminant	PRGs in Soil (mg/kg)		Background in Soil[d] (mg/kg)	Practical Quantitation Limit in Soil[f] (mg/kg)
	Rural-Residential Exposure Scenario[a]	MCRIS		
Cadmium	80	4,542	NA[e]	0.8
Lead	250[b]	250[b]	10.2	0.3
Mercury	24	1,363	0.33	0.8

[a] Based on MTCA, Method B for direct exposure. Values are applicable to contaminants detected within the top 4.6 m (15 ft) of soil (WAC 173-340-740[6][c]).
[b] MTCA Method B value not available. MTCA Method A value is used.
[c] Calculated PRG exceeds 100,000 mg/kg; therefore, 100,000 mg/kg is selected by default.
[d] Background concentrations are 90th percentile of log-normal distribution. Source: *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes* (DOE-RL 1995b).
[e] NA--not applicable, contaminant not detected in soil during background study.
[f] Source of Practical Quantitation Limits: Contract-Required Quantitation Limits/Contract-Required Detection Limits specified in 100 Area Quality Assurance Project Plans.
[g] Measured as total chromium.
MCRIS = Modified CRCIA Ranger/Industrial Scenario
MTCA = *Model Toxics Control Act*
PRG = preliminary remediation goal

Table 3-4. Contaminant-Specific Concentrations in 116-N-1 and 116-N-3 Soil that Achieve Protection of Groundwater.

Contaminant	K_d (mL/g)	Groundwater PRG (pCi/L or μg/L)	Contaminant-Specific Concentration in Soil (pCi/g or mg/kg)		
			100 X PRG for Ground-water	Rural Residential Exposure Scenario	MCRIS
Cesium-137	50	120	[a]	[a]	[a]
Cobalt-60	50	147	[a]	[a]	[a]
Europium-154	200	59	[a]	[a]	[a]
Europium-155	200	800	[a]	[a]	[a]
Plutonium-239/240	200	1	[a]	[a]	[a]
Strontium-90	15	8	[a]	[a]	[a]
Thorium-228	200	2	[a]	[a]	[a]
Thorium-232	200	2	[a]	[a]	[a]
Tritium	0	20,000	2,000	2,000[b]	2,000[b]
Uranium-233/234	2	20	2	2[b]	2[b]
Uranium-238	2	24	2.4	2.4[b]	2.4[b]
Cadmium	30	5	[a]	[a]	[a]
Chromium (III)	200	16,000	[a]	[a]	[a]
Chromium (VI)	0	80	8	8[b]	8[b]
Lead	30	15	[a]	[a]	[a]
Mercury	30	2	[a]	[a]	[a]
Nitrate	0	44,000	4,400	4,400[b]	4,400[b]

[a] The unit gradient model predicts the contaminant will not reach groundwater within a 1,000-year time frame. It is anticipated that sampling will be required to verify that cleanup has been achieved, and that contaminants left in place are not migrating.

[b] Default to 100 times the groundwater PRG (100 times the MTCA B value for groundwater remediation).

MTCA = *Model Toxics Control Act*

PRG = preliminary remediation goal

MCRIS = Modified CRCIA Ranger/Industrial Scenario

Table 3-5. Contaminant-Specific Concentrations in 116-N-1 and 116-N-3 Soil that Achieve Protection of the Columbia River.

Contaminant	K_d (mL/g)	Surface Water PRG (pCi/L or μg/L)	Dilution/ Attenuation Factor PRG (pCi/L or μg/L)	Contaminant-Specific Concentration in Soil (pCi/g or mg/kg)	
				Rural-Residential Exposure Scenario	MCRIS
Cesium-137	50	129	[a]	[a]	[a]
Cobalt-60	50	147	[a]	[a]	[a]
Europium-154	200	59	[a]	[a]	[a]
Europium-155	200	800	[a]	[a]	[a]
Plutonium-239/240	200	1	[a]	[a]	[a]
Strontium-90	15	8	[a]	[a]	[a]
Thorium-228	200	2	[a]	[a]	[a]
Thorium-232	200	2	[a]	[a]	[a]
Tritium	0	20,000	56,300	5,630[b]	5,630[b]
Uranium-233/234	2	20	40	4[b]	4[b]
Uranium-238	2	24	48	4.8[b]	4.8[b]
Cadmium	30	0.9	[a]	[a]	[a]
Chromium (III)	200	180	360	[a]	[a]
Chromium (VI)	0	10	20	2[b]	2[b]
Lead	30	1.8	[a]	[a]	[a]
Mercury	30	0.012	[a]	[a]	[a]
Nitrate	0	44,000	88,000	8,800[b]	8,800[b]

[a] The unit gradient model predicts the contaminant will not reach groundwater within a 1,000-year time frame. It is anticipated that sampling will be required to verify that cleanup has been achieved and that contaminants left in place are not migrating.
[b] Default to 100 times the Dilution-Attenuation Factor PRG.
PRG = preliminary remediation goal
MCRIS = Modified CRCIA Ranger/Industrial Scenario

Table 3-6. Summary of Preliminary Remediation Goals.

Contaminant	Preliminary Remediation Goals in Soil (pCi/g or mg/kg)					
	Surface Exposure Scenarios		Protection of Groundwater		Protection of the Columbia River	
	Rural-Residential with Irrigation (above 15 ft)	MCRIS (above 10 ft)	Rural-Residential with Irrigation (below 15 ft)	MCRIS (below 10 ft)	Rural-Residential with Irrigation (below 15 ft)	MCRIS (below 10 ft)
Cesium-137	6.1	46.5	[a]	[a]	[a]	[a]
Cobalt-60	1.4	9.7	[a]	[a]	[a]	[a]
Europium-154	3.1	20.5	[a]	[a]	[a]	[a]
Europium-155	127	843	[a]	[a]	[a]	[a]
Plutonium-239/240	23.5	85.5	[a]	[a]	[a]	[a]
Strontium-90	3.7	3,885	[a]	[a]	[a]	[a]
Thorium-228	2.2	13.6	[a]	[a]	[a]	[a]
Thorium-232	0.94	6.6	[a]	[a]	[a]	[a]
Tritium	241	16,110	2,000[b]	2,000[b]	5,630[b]	5,630[b]
Uranium-233/234	101	199	2[b]	2[b]	4[b]	4[b]
Uranium-238	69	262	2.4[b]	2.4[b]	4.8[b]	4.8[b]
Cadmium	80	4,542	[a]	[a]	[a]	[a]
Chromium (III)	80,000	100,000	8[b]	8[b]	2[b]	2[b]
Chromium (VI)	400	22,711	8[b]	8[b]	2[b]	2[b]
Lead	250	250	[a]	[a]	[a]	[a]
Mercury	24	1,363	[a]	[a]	[a]	[a]
Nitrate	NA[c]	NA[c]	4,400[b]	4,400[b]	8,800[b]	8,800[b]

[a] The Unit Gradient Model predicts the contaminant will not reach groundwater within a 1,000-year time frame.
[b] Default to 100 times the groundwater PRG or (for the river) 100 times the Dilution-Attenuation Factor PRG.
[c] NA--not applicable; soil ingestion/inhalation through surface exposure are not exposure pathways for nitrates.
MCRIS = Modified CRCIA Ranger/Industrial Scenario

4.0 CONTAMINANTS AND REMEDIATION VOLUMES

Now that the PRGs have been established, the next steps in the refinement process are to determine the refined COPCs (RCOPCs) and COCs and then to identify areas and volumes for remediation at 116-N-1 and 116-N-3. The COPCs for the TSD facilities were identified in Section 2.5. These include radionuclides and inorganics at 116-N-1 and 116-N-3. The RAOs, PRGs, and expected site conditions are the primary determinants of the areas and volumes of soil to be remediated. This section identifies which of the COPCs may travel to groundwater, compares the PRGs to the characterization data from each facility, identifies the COCs, and then defines the areas of concern and the potential volumes requiring remediation (remediation volumes). There are no COPCs for 120-N-1, 120-N-2, or 100-N-58 (see Section 2.5.5) so therefore there are no remediation volumes to calculate.

4.1 DATA SELECTION AND PRESENTATION

Considerable characterization data exist for the facilities. Therefore, the data have been separated to facilitate a meaningful comparison to PRGs. Table 4-1 presents boreholes and samples associated with surface and subsurface soils at 116-N-1 and 116-N-3 that are used in the comparison. At 116-N-1, three groups of soil samples have been collected within the facility (trench sediments [TS-01 to TS-09], crib borehole 199-N-107A, and trench borehole 199-N-108A). At 116-N-3, two groups of soil samples have been collected within the facility (crib sediments [CS-01 to CS-12] and crib borehole 199-N-109A). There are no surface soils in the 116-N-1 Trench or the 116-N-3 Crib and Trench. Additionally, samples have not been collected from the 116-N-3 Trench. All the other soil samples collected at 100-N from boreholes and wells that are associated with contamination from 116-N-1 and 116-N-3 have been collected outside of the facilities (199-N-75, 199-N-76, 199-N-80, 199-N-103A, 199-N-104A, 199-N-105A, 199-N-106A, 199-N-107A, 199-N-108A, 199-N-109A, RW#1, RW#2, RW#3). Figure 2-32 shows the locations of all the samples, except the sediment samples that were collected from the sediments at the bottom of the facilities. The labels for boreholes that have soil data and are associated with contamination from 116-N-1 and 116-N-3 are bolded. The labels for all other wells and boreholes that do not have soil data, or are not associated with the TSD units or their resulting contamination, have been left in standard font weight.

4.2 COMPARISON TO PRELIMINARY REMEDIATION GOALS

The maximum detected concentrations in the year 2010 are compared to the PRGs (Section 3.0), to determine the RCOPCs. All of the data had to be decayed to one date for comparison to PRGs.

4.2.1 Comparison of Data to Preliminary Remediation Goals for Surface Exposure

The surface soil COPCs and their maximum concentration in the year 2010 were compared to the modified CRCIA ranger/industrial and rural-residential exposure scenario direct exposure PRGs identified in Table 3-6. Following the protocol described in Section 2.5, those contaminants that had an MRC greater than the PRG were designated RCOPCs. The comparison of maximum concentrations to direct surface exposure PRGs for the rural-residential exposure scenario is presented in Tables 4-2 (116-N-1 Crib) and 4-3 (outside of 116-N-1/ 116-N-3). The comparison of maximum concentrations to direct surface exposure PRGs for the modified CRCIA ranger/industrial exposure scenario is presented in Tables 4-4 (116-N-1 Crib) and 4-5 (outside of 116-N-1/116-N-3). Contaminants that exceeded PRGs were selected as the RCOPCs.

Refined COPCs were then evaluated to determine the extent of the area and depth of PRG exceedence. This process defined the probable extent of contamination and is documented in Appendix G. Note that surface soils for the residential scenario are from 0 to 4.6 m (0 to 15 ft) bsg at 116-N-1 and 116-N-3 (because of the varying topography) and below ground surface (bgs) for the boreholes outside of the facilities (because topography is relatively flat). Surface soils for the modified CRCIA ranger/industrial scenario are from 0 to 3.0 m (0 to 10 ft), as presented in Sections 2.0 and 3.0. Subsurface soils are all soils located below these depths.

4.2.2 Comparison of Data to Preliminary Remediation Goals for Protection of Groundwater and the Columbia River

The analysis of the potential for individual contaminants to reach groundwater and the Columbia River is presented in Appendix G. The unit gradient model (DOE-RL 1996b) was used to determine whether individual contaminants could reach groundwater within 1,000 years. The 1,000-year time period was adopted from "Radiation Site Cleanup Regulation: Preliminary Draft" (40 CFR 196). In addition, this time interval is used in the interim remedial action ROD for the 100-BC-1, 100-DR-1, and 100-HR-1 source OUs (EPA 1995) and the 100-NR-1/NR-2 CMS. The RESRAD model was used to validate the results of the unit gradient model to be consistent with the 100-NR-1/NR-2 CMS. If contaminants were predicted to reach groundwater within 1,000 years, the PRG comparisons to soil concentrations at the time of remediation were performed. If the contaminant would not reach groundwater within 1,000 years, it was eliminated from further consideration for these pathways. It was assumed that contaminants, once in groundwater, would also migrate to the Columbia River.

The assessment of travel time to groundwater is presented in Appendix G and is summarized in Tables 4-6 (rural-residential) and 4-7 (modified CRCIA ranger/industrial). Under both the rural-residential and modified CRCIA ranger/industrial exposure scenarios, chromium, uranium-233/234, and uranium-238 were predicted to reach groundwater within 1,000 years. Furthermore, nitrate and tritium, if present in soil, were predicted to reach groundwater. On the other hand, cesium-137, cobalt-60, europium-154, europium-155, plutonium-239/240, strontium-90, thorium-232, cadmium, lead, and mercury were predicted to not reach groundwater in 1,000 years and were eliminated from further consideration. Concentrations in subsurface

soils for the contaminants that reach groundwater were then compared to the groundwater and Columbia River protection PRGs identified in Table 3-6. Those contaminants that had a maximum concentration greater than the PRG were designated RCOPCs. The rural-residential exposure scenario PRG comparisons are presented in Tables 4-8 (116-N-1), 4-9 (116-N-3), and 4-10 (outside of 116-N-1/116-N-3). The comparison of maximum concentrations to PRGs for the modified CRCIA ranger/industrial exposure scenario are presented in Tables 4-11 (116-N-1), 4-12 (116-N-3), and 4-13 (outside of 116-N-1/116-N-3).

The rural-residential and modified CRCIA ranger/industrial exposure scenario RCOPCs are presented in Table 4-14 for 116-N-1 and 116-N-3.

4.3 SELECTION OF CONTAMINANTS OF CONCERN

Determining the COCs from the list of RCOPCs is the final step in the process to define the probable areas and volumes for remediation. As described in Section 2.5, this involves a qualitative assessment of the RCOPCs based on process knowledge, characterization data, and engineering judgment.

The assessment conducted for this TSD CMS determined that all RCOPCs should be designated COCs.

The COCs for the rural-residential and modified CRCIA ranger/industrial exposure scenario for 116-N-1 and 116-N-3 are presented in Table 4-15. The list of COCs and information from previous reports serve as the basis to define the areas and volumes of soil to be remediated. It is assumed that the COCs for UPR-100-N-31 are the same as those established for 116-N-1 surface soils.

4.3.1 Radionuclide Contaminants of Concern

4.3.1.1 Radionuclides in Surface Soils. Cobalt-60, cesium-137, europium-154, europium-155, plutonium-239/240, strontium-90, and tritium were identified as radionuclide COCs in surface soils at the 116-N-1 Crib. The majority of contamination occurs from cobalt-60, cesium-137, plutonium-239/240, and strontium-90, resulting from discharges of water primarily from the fuel rod storage basin and secondarily from the reactor cooling water. The highest radionuclide concentrations occur at the crib base to a few feet below the crib base at 4 m (13 ft) bgs (DOE-RL 1996b). The interval from the base of the crib to a few feet below is referred to as the "concentrated layer." It is assumed that a concentrated layer exists at the soil base of the 116-N-1 Crib and Trench and at the 116-N-3 Crib and Trench (DOE-RL 1996b). Of these radionuclides, plutonium has the longest half-life and will remain in the soil for thousands of years after the other nuclides have decayed away. Plutonium was not detected at concentrations that would classify soils for disposal as transuranic waste (100 nCi/g). Other radionuclides that have been detected in the concentrated layer include americium-241, cesium-134, cobalt-58,

europium-154, europium-155, manganese-54, plutonium-238, potassium-40, radium-226, radium-228, thorium-228, throium-232, uranium-234, and uranium-238 (DOE-RL 1996b).

Surface soil samples collected within the 116-N-1 Crib were not analyzed for tritium (half-life is 12.3 years). However, outside of the facility, tritium was detected in low concentrations up to 2 pCi/g, which is several orders of magnitude less than the direct exposure PRGs. Nonetheless, because insufficient data exist for tritium, it has been kept as a COC.

Also identified as a radionuclide COC in the 116-N-1 Crib surface soils is europium-155, although concentrations exceeded PRGs under a residential scenario only. Previous soil sample analysis at 116-N-1 indicates that europium-154 and europium-155 are found in the environment together.

Additionally, plutonium-239/240 has been added as a COPC for subsurface soil at both 116-N-1 and 116-N-3. The plutonium-239/240 contaminated soils do not currently appear to exceed PRGs for the protection of groundwater or the Columbia River within the next 1,000 years, nor is excavation of subsurface soil specifically required by regulation to prevent direct exposure. However, the plutonium-239/240 may represent a very high risk to an individual if direct exposure should occur (DOE-RL 1996b; BHI 1995b; DOE-RL 1995f; BHI 1996). Furthermore, plutonium-239/240 is a long-lived radionuclide (plutonium-239 half-life of 24,000 years; plutonium-240 half-life of 6,580 years). There is also uncertainty in the modeling effort to predict groundwater and the Columbia River impacts after 1,000 years.

The bottoms of the 116-N-1 Trench, 116-N-3 Crib, and 116-N-3 Trench are all more than 3 m (10 ft) below the surrounding surface grade, and consequently "surface" soils are not associated with these sites under the MCRIS scenario. Therefore, there are no COCs in the "surface" soils under the MCRIS scenario.

There are no "surface" soils associated with the 116-N-1 Trench under the rural-residential scenario because the bottom is below 4.6 m (15 ft) below surrounding grade. Surface soils are associated with the 116-N-1 Crib, 116-N-3 Crib, and 116-N-3 Trench under the rural-residential scenario.

4.3.1.2 Radionuclides in Subsurface Soils. At 116-N-1 and 116-N-3, tritium and plutonium-239/240 are the only radionuclide COCs in subsurface soils. Tritium is not readily retarded in the soil and essentially travels with water; it would therefore travel to groundwater within 1,000 years, as presented in Appendix G. There is the possibility that, with the relatively short half-life of tritium, any that may be present in soil would decay before reaching groundwater. Tritium has been kept as a COC, however, because insufficient soil data exist for it and, if it were present in soil, it would reach groundwater. However, it is not anticipated that remediation for tritium in the soil would be required, due to the fact that it is not retarded in soil. This assumption would need to be verified by sample collection and analysis. Currently, there is a plume of tritium in groundwater beneath 116-N-1 and 116-N-3, as described and evaluated by the 100-NR-1/NR-2 CMS.

4.3.2 Inorganic Contaminants of Concern

4.3.2.1 Inorganics in Surface Soils. At the 116-N-1 Crib, nitrate and mercury were identified as inorganic COCs in the surface soil. Nitrate is present in groundwater and, therefore, was evaluated as a potential COC. Since available data are insufficient to eliminate nitrate as a COC, it has been retained. However, because nitrate is not readily retarded in soil and travels with water, nitrate is not expected to be present in the soil column at significant concentrations, especially in surface soils. Consequently, remediation of surface soils as a result of a nitrate problem is not anticipated. This assumption would have to be verified by sample collection and analysis.

Mercury was discharged to 116-N-1 during reactor operations. Samples have not been collected within the facilities to determine if mercury is present in the soil column. However, the part A permits for the TSD units report significant discharges of mercury to the units. Because of the lack of analytical data, mercury has been retained as a 116-N-1 surface soil COC.

4.3.2.2 Inorganics in Subsurface Soils. At the 116-N-1 Crib and Trench, chromium and nitrate were identified as inorganic COCs in subsurface soil. Chromium is present in the soil at levels exceeding the hexavalent chromium PRG. However, it is unlikely that the chromium present is hexavalent chromium, but rather is trivalent chromium (DOE-RL 1996b). If true, then the chromium would not reach groundwater in 1,000 years, and it would be eliminated as a COC. However, because the valance state of chromium is not known at this time, chromium has been retained as a COC. The assumption that the chromium is trivalent would have to be verified by sample collection and analysis.

Nitrate may be present in subsurface soil at 116-N-1, but is unlikely, for the same reasons presented above for surface soils. A nitrate plume exists in groundwater beneath 116-N-1, as described in the 100-NR-1/NR-2 CMS.

At 116-N-3, nitrate is the only subsurface soil inorganic COC. Chromium is not considered a COC because it was not discharged to the facility.

4.4 SUMMARY OF CONCERN FOR REMEDIATION AT 116-N-1 AND 116-N-3

The following summarizes the conclusions of the COC process:

- Surface soils (top 3.0/4.6 m [10/15 ft] bsg) in the 116-N-1 Crib exceed PRGs for radionuclides and possibly for nitrate and mercury. The primary COCs (principal risk-driver radionuclides identified in the QRA [DOE-RL 1996b]) are cobalt-60, cesium-137, strontium-90, and plutonium-239/240. It is assumed that these surface soils are present at the 116-N-1 Crib and possibly at UPR-100-N-31. At the 116-N-1 Trench and 116-N-3 Crib and Trench, the bottom of the facilities is more than 3.0 m (10 ft) bsg; thus, no surface soils are present under the MCRIS. However, under the rural-residential scenario,

contaminated soils are present within 4.6 m (15 ft) of the surface at the 116-N-3 Crib and Trench and the COCs are assumed to be the same as those for the 116-N-1 Crib. There are no contaminated soils present within 4.6 m (15 ft) of the surface at the 116-N-1 Trench.

- Plutonium-239/240 is present in a concentrated layer beneath the facilities and has been identified as a COC for subsurface soil. It is assumed that this layer is about 0.91 to 1.5 m (3 to 5 ft) thick and is present beneath the 116-N-1 Crib and Trench and the 116-N-3 Crib and Trench.

- Subsurface soils (>3.0/4.6 m [10/15 ft] bsg) may exceed PRGs for tritium and nitrate. It is assumed that these contaminants may be present at the 116-N-1 Trench, 116-N-3 Crib, and 116-N-3 Trench. The UPR-100-N-31 spill occurred in the surface soils, which were reportedly removed and disposed. Because of the topography at the 116-N-1 Crib, it is assumed that the subsurface soils below 3.0 to 4.6 m (10 to 15 ft) would meet PRGs (essentially the surface soils would contain the tritium and nitrate, if present).

- Subsurface soils (> 3.0/4.6 m [10/15 ft] bsg) may exceed PRGs for chromium at the 116-N-1 Trench. Because of the topography at the 116-N-1 Crib, it is assumed that the subsurface soils below 3.0/4.6 m (10/15 ft) would meet PRGs (essentially the surface soils would contain the chromium, if present).

4.5 AREA OF CONTAMINATION FOR RADIOLOGICAL SITES

Using available data, the 1301-N/1325-N LFI report (DOE-RL 1996b) describes the contamination beneath the facilities. It discusses a concentrated layer, located immediately below the waste site, where the vast majority of contaminants are concentrated.

A mass balance calculation for 116-N-1 was included as part of the 1301-N/1325-N DQO report (Section 3.4.4). The purpose of the mass balance calculation was to present an account for the contaminants discharged to the facility. The calculation was performed for four contaminants: cobalt-60, cesium-137, strontium-90, and plutonium-239/240. The results of this effort indicate that the entire documented inventory of cobalt-60, cesium-137, and plutonium-239/240 can be accounted for within the first 0.8 m (2.5 ft) of the soil column under the facility. The mass balance shows that most of the strontium-90 should be within the first 4 m (13 ft) of the soil column (BHI 1996).

The data collected during the 1301-N/1325-N LFI report confirmed the conceptual model that was developed during the DQO workshops for this LFI. Because of the close correlation between the LFI data and the conceptual model, the model is considered to be an accurate representation of the vertical distribution of contaminants throughout the vadose zone. Therefore, contaminant inventories within the soil column have not been repeated.

The DQO workshop identified a need for additional information to adequately determine the extent of lateral distribution of contaminants within these facilities. The LFI activity provided some indication that lateral distribution of contaminants may have occurred. Sometimes, significant sand layers were intercepted during drilling. For example, a sand layer consisting of very coarse to fine sand 4.9 m (16 ft) thick was encountered in well 199-N-103A, and a 1.5-m (5-ft) sand layer was encountered in 199-N-104A. A 3.0-m (10-ft) sand layer was intercepted in borehole 199-N-107A, and a 1.9-m (6-ft) sand layer was encountered in borehole 199-N-108A. Minor sand lenses were encountered in borehole 199-N-109A. Sand layers in the vadose zone may have promoted the localized lateral spread of contamination from 116-N-1 and 116-N-3 during operation of the facilities. The sand zones are discontinuous and cannot, with certainty, be traced between wells (DOE-RL 1996b).

Some migration from the concentrated layer may have occurred because of these spot heterogeneities in the vadose zone, but no evidence exists to indicate widespread vertical or horizontal spread of the contaminants (DOE-RL 1996b).

Information provided in Sections 4.3 and 4.4, along with the PRGs developed in Section 3.0, are used in the following section to develop a general concept of which soils need to be addressed during remediation and which contaminants will be encountered. This will provide the basis for determining applicable technologies and remedial alternatives.

4.6 REMEDIATION VOLUMES

This section estimates the volumes of contaminated materials and clean overburden that would have to be removed to achieve the RAOs described in Section 3.2. In estimating the depth of the contaminated volume for each waste site, the remedial action goals corresponding to each RAO were considered. These included goals for protection of surface receptors (for both a rural-residential exposure scenario and a modified CRCIA ranger/industrial exposure scenario), for protection of groundwater, and for protection of the Columbia River. For each waste site, the volumes were estimated based on meeting all the RAOs. For this CMS, these estimates are used to cost, evaluate, and compare alternatives. The actual volume of soil to be addressed by remedial action would be evaluated with respect to the following balancing criteria: (1) protection of human health and the environment, (2) presence of ecological and cultural resources, (3) worker safety, (4) remediation costs, (5) decay of short-lived radionuclides, (6) sizing of the Environmental Restoration Disposal Facility (ERDF), (7) the use of institutional controls, and (8) long-term monitoring costs.

Although 116-N-1 and 116-N-3 are each designated as a single waste site, each is actually composed of two different structures that have unique characteristics: a crib and a trench. It is, therefore, appropriate to address each crib and trench individually when discussing remediation depths (elevations) and remediation volumes. In addition to soil volumes for each crib and trench, demolition waste volumes (e.g., concrete structures) and pipelines for each will be discussed. These soil volumes are shown in Figure 4-1 for the rural-residential exposure

scenario and Figure 4-2 for the modified CRCIA ranger/industrial exposure scenario and are summarized in Table 4-16. For further clarification, Figure 4-3 shows a cross section of the units and the depths for both rural-residential and modified CRCIA ranger/industrial exposure scenarios. Additional details on how these volumes are calculated are presented in Appendix D.

4.6.1 116-N-1 Crib Volume

4.6.1.1 Rural-Residential Exposure Scenario. The 116-N-1 Crib is described in detail in Section 2.0 as the first effluent disposal site for the N Reactor. It was used the longest and contains the highest contaminant levels. It also is the only facility with a drill hole directly through it. The crib, therefore, has the most representative information. The crib was formed by taking material from the interior to build walls, thus forming an enclosed basin. The crib was then filled with boulders, which are now contaminated. The bottom of the crib is at an elevation of 137.2 m (450 ft) amsl; the approximate elevation of the surrounding surface is 138.7 m (455 ft) amsl. A depth of 4.6 m (15 ft) below the surrounding surface grade for a rural-residential exposure scenario would extend to an elevation of 134 m (440 ft) amsl, which is 3.0 m (10 ft) below the boulder base of the crib.

Based on information provided in the 1301-N/1325-N LFI report, the elevation of the bottom of the concentrated layer is between 136 and 133 m (447 and 437 ft) amsl, the elevations of the two sample points bounding the bottom of the layer. Figure 4-1 shows these elevations in a typical lengthwise cross section, through the crib.

Because there is no evidence of widespread lateral distribution of contaminants, the bottom width is estimated as equal to the maximum width where the effluent entered the soil column. For the 116-N-1 Crib, a shallow facility, it is assumed that maximum width would be the bottom dimensions of the facility. For a deeper facility with shallow sloping sides, such as a trench, this width would be measured at the elevation of the operating water level.

The estimated lateral extent of the contaminated soils is defined by the sloping sides (1.5 units of run to 1.0 [1.5:1.0] unit of rise). The top of the contaminated soils extends outward from the crib to the side slope. This provides for consideration of the limited lateral distribution of contaminants as defined in the 1301-N/1325-N LFI report.

Using the data and assumptions described above, a contaminated soils volume for the 116-N-1 Crib was calculated to be 15,400 bank cubic meters (bcm) or 20,100 bank cubic yards (bcy), and the clean overburden volume is 3,500 bcm (4,600 bcy). A "bank" cubic meter (or yard) is defined as a cubic meter of in-place soils that have a natural compaction from being in place for a long period of time. This unit is used in contrast to the "loose" cubic meter (or yard), which is defined as a cubic meter of soils after excavation that includes a swelling factor (i.e., bcm multiplied by swelling factor).

Because it is anticipated that no contaminants are in the subsurface soil that require remediation to protect groundwater or the Columbia River, there is no volume calculation for soils deeper than those described above.

Successful remediation of the contaminated soils above the 134 m (440 ft) amsl elevation would satisfy the PRGs and the RAOs established in this CMS for a rural-residential exposure scenario. The methodology for determining remediation depths is consistent with the approach used in the ROD for the 100-BC-1, 100-DR-1, and 100-HR-1 OUs (EPA 1995).

4.6.1.2 Modified CRCIA Ranger/Industrial Exposure Scenario. The remediation depth for the modified CRCIA ranger/industrial exposure scenario is 3.0 m (10 ft), or 1.5 m (5 ft) less than the depth for the rural-residential scenario described above. This raises the bottom elevation for 116-N-1 Crib remediation up to 136 m (445 ft) amsl. All other assumptions are identical. This remediation depth is 1.5 m (5 ft) below the boulder base of the crib, extending into the soil (Figures 4-2 and 4-3).

Using these assumptions, the estimated contaminated soil volume under a modified CRCIA ranger/industrial exposure scenario for the 116-N-1 Crib is 10,300 bcm (13,400 bcy), and the clean overburden volume is 1,500 bcm (2,000 bcy). Remediation of this volume would meet all the RAOs and PRGs developed for a modified CRCIA ranger/industrial exposure scenario and is consistent with the approach used in the ROD for 100-BC-1, 100-DR-1, and 100-HR-1.

4.6.1.3 Other Waste Considerations. Demolition or solid waste that will result from the remediation of the 116-N-1 Crib includes only the weir box. This volume (67 bcm [88 bcy]) is the same for both exposure scenarios and does not impact the cost estimates for one alternative more than another, except in the case where no action might be proposed. Likewise, the pipelines discussed in Section 2.0 are summarized in Appendix D, and the cost of addressing them is included in the estimates. Without data on which to base a decision, it was assumed that the pipelines were contaminated and the soils excavated to remove them were not contaminated. This assumption is consistent with the 100-NR-1/NR-2 CMS.

4.6.2 116-N-1 Trench Volume

4.6.2.1 Rural-Residential Exposure Scenario. As mentioned above, the 116-N-1 Trench is a different structure from the crib. The trench is a long, narrow excavation with shallow sloping sides (1.5:1.0). The bottom elevation is 134 m (439 ft) amsl and the surrounding surface elevation is approximately 138.7 m (455 ft) amsl. The trench has a concrete cover at 138 m (453 ft) amsl, and the operating water level was estimated to be 135 m (444 ft) amsl, which is 1.5 m (5 ft) above the bottom of the trench.

The soils directly beneath the trench are assumed to be similar to the soils beneath the crib. Using this information, coupled with the existence of the plutonium-239/240 in a concentrated layer beneath the trench, it is assumed that the depth of the soils to be remediated is 1.5 m (5 ft) below the base of the trench. This corresponds to an elevation of 132 m (434 ft) amsl. This

volume is expected to contain significant contamination. The bottom width of the remediation zone is 7.6 m (25 ft), which equates to the width of the trench at the operating water level. The sides of the contaminated area come up at 1.5:1.0 from the bottom. The top of the contaminated area is the operating water level. The area between the operating water level and the surrounding surface is considered to be clean overburden.

Based on these assumptions, the contaminated soil volume for 116-N-1 Trench is 13,300 bcm (17,400 bcy), and the clean overburden volume is 15,300 bcm (20,000 bcy).

4.6.2.2 Modified CRCIA Ranger/Industrial Exposure Scenario. The 116-N-1 Trench remediation depth for the modified CRCIA ranger/industrial scenario is the same as that for the rural-residential scenario. This soil removal would be driven by the concentrated layer that is present beneath the facilities. It is assumed that removal of this layer would also remove any other COCs (i.e., nitrate, chromium, and/or tritium) that may be present in concentrations that exceed PRGs, thus deeper excavation would not be required.

Under a modified CRCIA ranger/industrial exposure scenario, the total contaminated soil volume for the 116-N-1 Trench is 13,300 bcm (17,400 bcy) and the overburden total is 15,300 bcm (20,000 bcy). These volumes are applicable only to the MCRIS-6 alternative. There would be no excavation of contaminated soil from the 116-N-1 Trench under the MCRIS-7 or 8 alternatives which involve capping or vitrification.

4.6.2.3 Other Waste Considerations. Demolition or solid waste that will result from the remediation of the 116-N-1 Trench includes concrete covers, support beams, foundations, overflow weir wall, shotcrete, and the wooden poles and netting left in the trench. This volume (1,850 bcm [2,420 bcy]) is the same for both exposure scenarios and does not impact the cost estimates for one alternative more than another, except in the case where no action might be proposed.

4.6.3 116-N-3 Crib Volume

4.6.3.1 Rural-Residential Exposure Scenario. The same assumptions made for the 116-N-1 Trench hold for the 116-N-3 Crib. Therefore, it is assumed that the depth of the soils to be remediated is 1.5 m (5 ft) below the base of the crib to an elevation of 133 m (436 ft). It is also assumed that removal of this layer would remove any other COCs (i.e., nitrate, chromium, and/or tritium) that may be present in concentrations exceeding PRGs, thus deeper excavation would not be required.

The elevation of the top of the crib cover is 136 m (447 ft) amsl. Because the crib was known to have flooded during the early stages of operation, this elevation also is the approximate operating water level. The surrounding surface elevation is approximately 1.3 m (4 ft) higher at an elevation of 137.5 m (451 ft) amsl.

The bottom width is the same as the crib bottom because the crib is shallow and the walls are vertical. The sides of the contaminated soils slope up from the bottom at 1.5:1.0 and extend to the surface at an elevation equal to that of the top of the crib cover. The entire volume is considered to be contaminated, and there is no clean overburden associated with this facility. The total contaminated soils volume is 8,500 bcm (11,100 bcy), and the clean overburden volume is 1,400 bcm (1,900 bcy).

4.6.3.2 Modified CRCIA Ranger/Industrial Exposure Scenario. The remediation volumes for the 116-N-3 Crib for a modified CRCIA ranger/industrial scenario are the same as for the rural-residential scenario. However, these volumes are applicable only to the MCRIS-6 alternative. There would be no excavation of contaminated soil from the 116-N-3 Crib under the other MCRIS-7 or 8 alternatives which involve capping or vitrification.

4.6.3.3 Other Waste Considerations. Demolition or solid waste that would result from the remediation of the 116-N-1 Crib includes concrete covers, support beams, foundations, side panels, and the effluent distribution system. This volume (996 bcm [1,303 bcy]) is the same for both exposure scenarios and does not impact the cost estimates for one alternative more than another, except in the case where no action might be proposed. Without data on which to base a decision, it was assumed that the pipelines were contaminated and the soils excavated to remove them were not contaminated. This assumption is consistent with the 100-NR-1/NR-2 CMS.

4.6.4 116-N-3 Trench Volume

4.6.4.1 Rural-Residential Exposure Scenario. The 116-N-3 Trench is a completely different structure from the 116-N-3 Crib. It is a long, straight, narrow trench with shallow sloping sides (1.5:1.0). The bottom elevation of the trench is 133 m (437 ft) amsl, and the operating water level is 1.5 m (5 ft) above that, at 135 m (442 ft) amsl.

The characteristics of how the contaminants are distributed throughout the soil column are essentially analogous to the 116-N-3 Crib, despite differences in construction (although concentrations are expected to be lower). The assumptions applied to the crib can, therefore, be made for this site: (1) the bottom width of the contaminated area is the same as the width of the trench at the operating water level; (2) the contamination starts at the operating water level and extends laterally to the sides, which slope up at 1.5:1.0; (3) the material above the operating water level is clean overburden; and (4) the bottom of the contaminated soil volume is 1.5 m (5 ft) below the bottom of the trench, at an elevation of 133 m (436 ft). Although the bottom of the concentrated layer cannot be defined by data collected from the trench, it is assumed to be similar to the other structures and would be remediated with this volume.

Only the first portion of the trench (226 m [740 ft]) was ever used, and the contamination is expected to extend only through that section. As a result, the first portion is the only section considered in the volume calculation.

Using these assumptions and a rural-residential exposure scenario, the total contaminated soil volume for the 116-N-3 Trench is 8,200 bcm (10,800 bcy), and the overburden total is 6,000 bcm (900 bcy).

4.6.4.2 Modified CRCIA Ranger/Industrial Exposure Scenario. The remediation volumes for the 116-N-3 Trench for a modified CRCIA ranger/industrial scenario are the same as for the rural-residential scenario. However, these volumes are applicable only to the MCRIS-6 alternative. There would be no excavation of contaminated soil from the 116-N-3 Trench under the other MCRIS alternatives which involve capping or vitrification.

4.6.4.3 Other Waste Considerations. Demolition or solid waste that would result from the remediation of the 116-N-3 Trench includes concrete covers, support beams, foundations, and the tie-in structure. This volume (2,505 bcm [3,276 bcy]) is the same for both exposure scenarios and does not impact the cost estimates for one alternative more than another, except in the case where no action might be proposed. As discussed in Section 2.4.3, two pipelines that cross the 116-N-3 Trench will be encountered during remediation of the 116-N-3 Trench. These pipelines are not associated with waste disposal at this site, are not expected to require remediation, and are not addressed in any cost estimates.

4.6.5 UPR-100-N-31 Spill Volume

4.6.5.1 Rural-Residential Exposure Scenario. The same general assumptions employed above were used to calculate the remediation volume for UPR-100-N-31. Contamination is assumed to begin at the surface, and soils would be remediated to a depth of 4.6 m (15 ft). The bottom area is assumed to be equal to the area of the spill, which is 188 m^2 (2,025 ft^2). The sides slope up at 1.5:1.0, as shown in Figure 4-1. By assuming the entire remediation volume is contaminated, consideration is given for the lateral spread of contaminants. This approach is consistent with the other units in this TSD CMS and is based on the data available for those units from the LFI activities. However, this is not consistent with the approach used in the 100-NR-1/NR-2 CMS, where a lack of data requires them to default to the standard calculation approach in which sides are considered to be clean overburden.

Using a rural-residential exposure scenario, the total contaminated soil volume for UPR-100-N-31 is 2,000 bcm (2,600 bcy). There is no overburden associated with this site. Remediation of this volume would meet all the RAOs and PRGs developed for a rural-residential exposure scenario and is consistent with the approach used in the ROD for 100-BC-1, 100-DR-1, and 100-HR-1.

4.6.5.2 Modified CRCIA Ranger/Industrial Exposure Scenario. All assumptions employed in the rural-residential scenario are used in the modified CRCIA ranger/industrial scenario, except that the remediation depth is 3.0 m (10 ft), as shown in Figure 4-2. This results in a total contaminated soil volume of 1,000 bcm (1,400 bcy), with no overburden. This volume is applicable to the MCRIS-6, 7 and 8 alternatives. Remediation of this volume would meet all the RAOs and PRGs developed for a modified CRCIA ranger/industrial exposure scenario.

4.6.5.3 Other Waste Considerations. There are no other waste considerations for UPR-100-N-31. No concrete structures or pipelines are involved with this waste site, and only the contaminated soil volume is considered in any cost estimates.

4.6.6 Remediation Volume Summary

Table 4-16 provides a summary of the remediation volumes calculated above. More information about these calculations can be found in Appendix D of this report.

This section has established the COCs, defined the area of contamination, and calculated remediation volumes. As a result, applicable remedial technologies can be identified and remedial alternatives can be developed that will effectively clean up the sites. Section 5.0 of this report addresses remedial technologies and alternatives.

Figure 4-1. Remediation Zone for Rural-Residential Exposure Scenario.

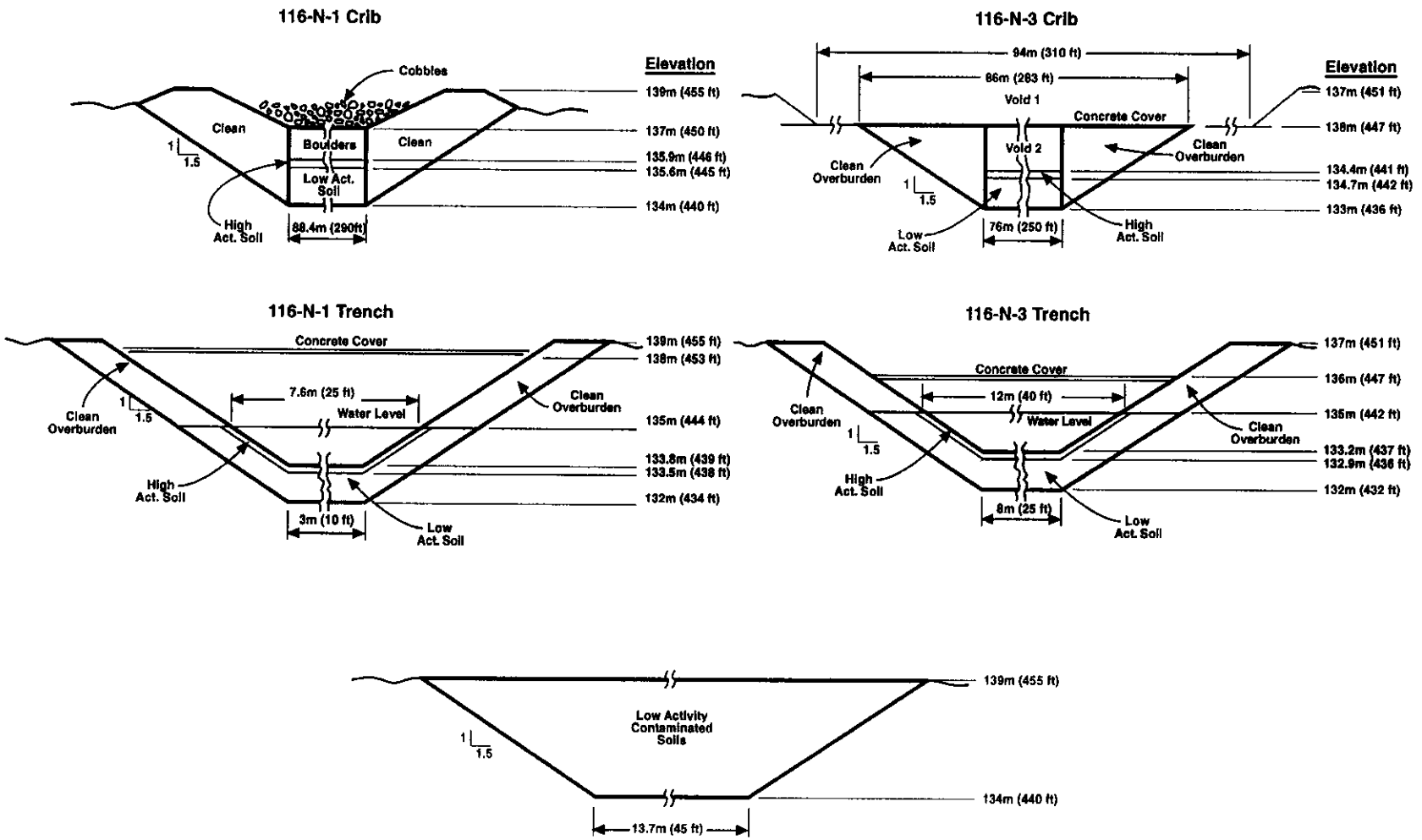


Figure 4-2. Remediation Zone for Modified CRCIA Ranger/Industrial Exposure Scenario.

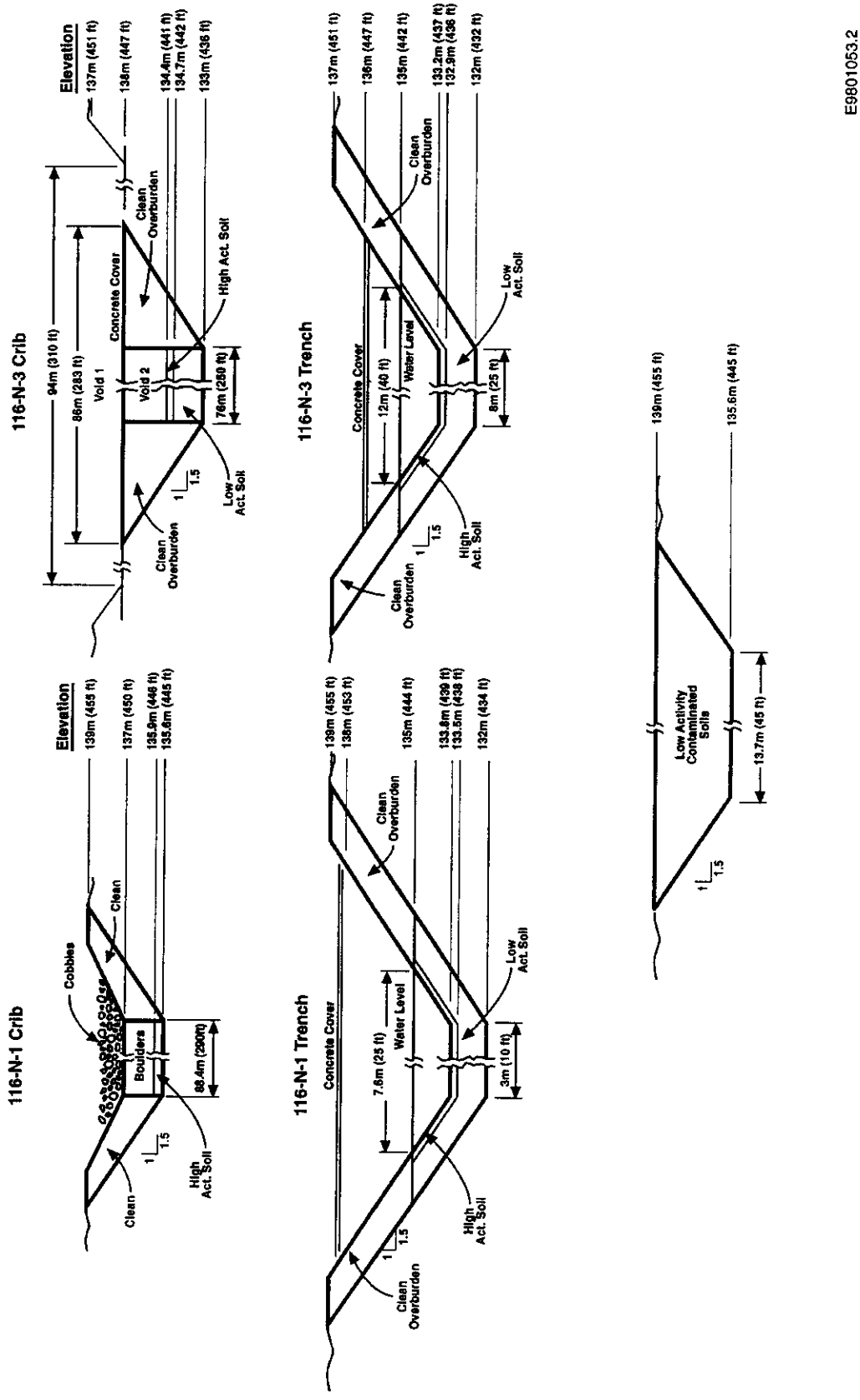


Figure 4-3. Remediation Zone Cross-Section for 116-N-1 and 116-N-3.

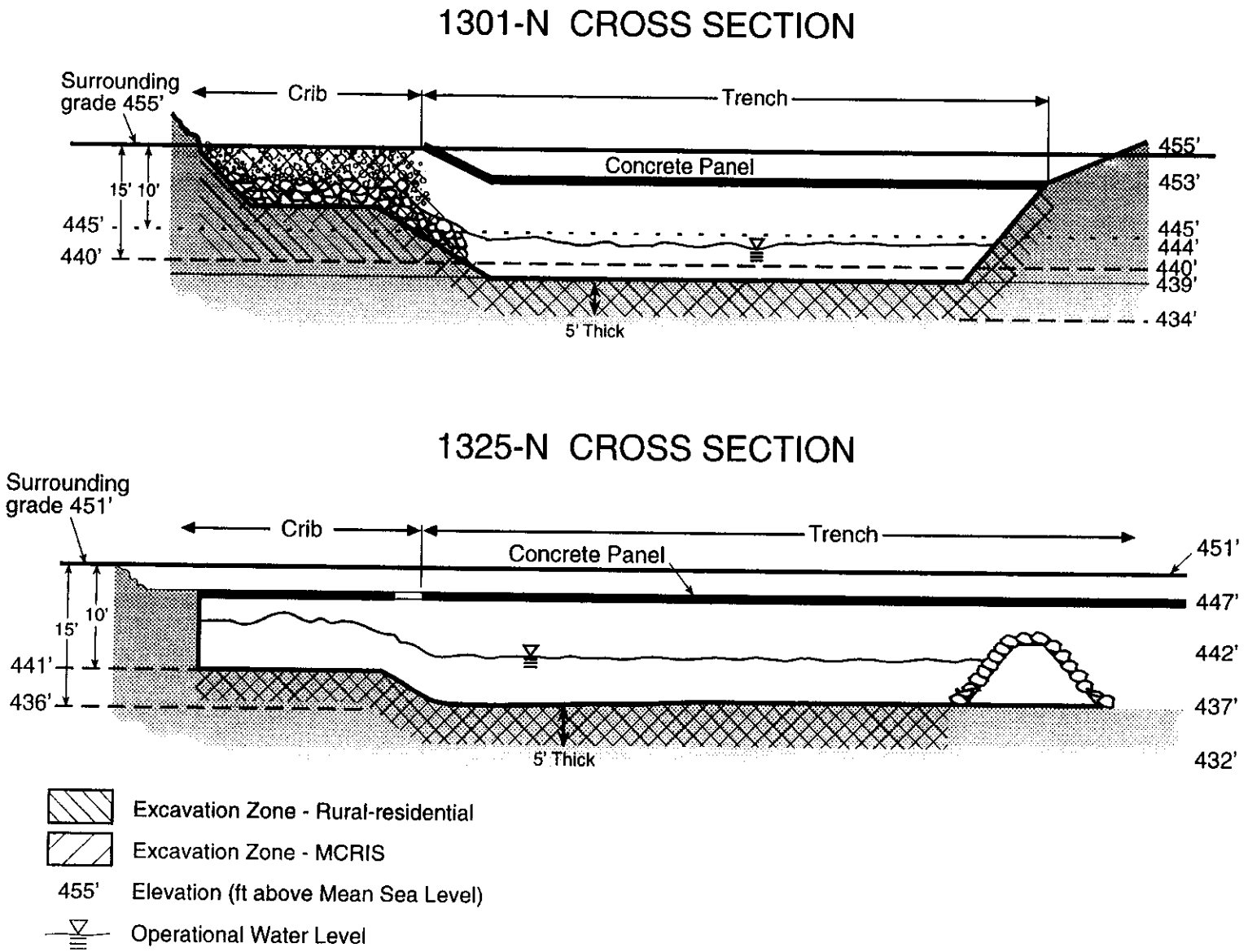


Table 4-1. Boreholes and Samples Associated with Treatment, Storage, and Disposal Facilities.

TSD Facility	Borehole/Samples
116-N-1 Crib	Surface Soil (elevation 455 ft - 445/440 ft) 199-N-107A Subsurface Soil (elevation <445/440 ft) 199-N-107A
116-N-1 Trench	Surface Soil (elevation 455 ft - 445/440 ft) 199-N-108A (rural-residential only) Subsurface Soil (elevation < 445/440 ft) 199-N-108A Sediments (TS-01 to TS-09)
116-N-3 Crib	Surface Soil (elevation 451 ft - 450/445 ft) no soil in this zone Subsurface Soil (elevation <450/445 ft) 199-N-109A Sediments (CS-01 to CS-12)
116-N-3 Trench	Surface Soil (elevation 451 ft - 450/445 ft) no soil in this zone Subsurface Soil (elevation <450/445 ft) samples not collected from the trench
116-N-1/116-N-3 (Outside the facilities)	Surface Soil (0-10/15 ft bgs) 199-N-75 199-N-103A 199-N-76 199-N-104A 199-N-80 199-N-105A 199-N-106A RW#2 RW#1 RW#3 Subsurface Soil (>10/15 ft bgs) 199-N-75 199-N-103A 199-N-76 199-N-104A 199-N-80 199-N-105A 199-N-106A RW#2 RW#1 RW#3

Table 4-2. PRG Comparison for 116-N-1 Rural-Residential Exposure-Surface Soils (0-15 ft).

Constituent	No. of Records	No. of Detects	Maximum Detected Concentration	Minimum Detected Concentration	Surface Exposure - Rural Residential PRG	
					Level	Exceeded
Radionuclides (pCi/g)						
[redacted]						
Thorium-232	3	0	-	-	0.94	0
Tritium	N/A	N/A	-	-	965	-
Uranium-233/234	3	0	-	-	101	0
Uranium-238	3	1	1.7	1.7	69	0
Inorganics (mg/kg)						
Cadmium	3	2	0.73	0.46	80	0
Chromium	3	3	57.7	22.2	400	0
Lead	3	3	21.9	0.57	250	0
Mercury	N/A	N/A	-	-	24	0
Nitrate	N/A	N/A	-	-	-	-

All radionuclide data decayed to year 2010.
Samples: 199-N-107A and 199-N-108A
N/A - not analyzed
Shading indicates contaminant concentrations that exceed PRGs.

Table 4-3. PRG Comparison for Outside 116-N-1 and 116-N-3 Rural-Residential Exposure-Surface Soils (0-15 ft).

Constituent	No. of Records	No. of Detects	Maximum Detected Concentration	Minimum Detected Concentration	Surface Exposure - Rural Residential PRG	
					Level	Exceeded
Radionuclides (pCi/g)						
Cesium-137	18	9	0.40	0.004	6.3	0
Cobalt-60	18	9	0.02	0.001	1.6	0
Europium-154	4	0	-	-	3.3	-
Europium-155	4	0	-	-	146	-
Plutonium-239/240	2	0	-	-	23.5	0
Strontium-90	8	2	1.0	0.61	3.8	0
Thorium-228	5	5	0.7	0.41	3.2	0
Thorium-232	9	9	0.7	0.42	0.94	0
Tritium	N/A	N/A	-	-	965	-
Uranium-233/234	N/A	N/A	-	-	101	-
Uranium-238	9	5	9.1	0.46	69	0
Inorganics (mg/kg)						
Cadmium	5	5	0.61	0.43	80	0
Chromium	5	5	8.7	7.6	400	0
Lead	5	5	5.1	3.1	250	0
Mercury	5	1	0.11	0.11	24	0
Nitrate	N/A	N/A	-	-	-	-

All radionuclide data decayed to year 2010
Samples: 199-N-103A, 199-N-104A, 199-N-105A, 199-N-106A, 199-N-75, 199-N-76, 199-N-80, RW #1, RW #2 and RW #3
N/A - not analyzed

Table 4-4. PRG Comparison for 116-N-1 Modified CRCIA Ranger/Industrial Exposure-Surface Soils (0-10 ft).

Constituent	No. of Records	No. of Detects	Maximum Detected Concentration	Minimum Detected Concentration	Surface Exposure - MCRIS PRG	
					Level	Exceeded
Radionuclides (pCi/g)						
Europium-155	5	5	554	19.7	970	0
Thorium-232	2	0	-	-	8.1	0
Tritium	N/A	N/A	-	-	60,930	-
Uranium-233/234	N/A	N/A	-	-	417	-
Uranium-238	2	0	-	-	483	0
Inorganics (mg/kg)						
Cadmium	2	2	0.73	0.46	6,813	0
Chromium	2	2	57.7	45.7	34,067	0
Lead	2	2	21.9	6.3	250	0
Mercury	N/A	N/A	-	-	2,044	-
Nitrate	N/A	N/A	-	-	-	-

MCRIS - Modified Columbia River Comprehensive Impact Assessment Ranger/Industrial Scenario
All radionuclide data decayed to year 2010.
Samples: 199-N-107A
N/A - not analyzed
Shading indicates contaminant concentrations that exceed PRGs.

Table 4-5. PRG Comparison for Outside 116-N-1 and 116-N-3 Modified CRCIA Ranger/Industrial Exposure-Surface Soils (0-10 ft).

Constituent	No. of Records	No. of Detects	Maximum Detected Concentration	Minimum Detected Concentration	Surface Exposure - MCRIS PRG	
					Level	Exceeded
Radionuclides (pCi/g)						
Cesium-137	13	6	0.40	0.01	47.6	0
Cobalt-60	13	6	0.02	0.001	11.1	0
Europium-154	2	0	-	-	22.2	-
Europium-155	2	0	-	-	770	-
Plutonium-239/240	2	0	-	-	200	-
Strontium-90	7	1	1.0	1.0	4,672	0
Thorium-228	5	5	0.70	0.41	21	0
Thorium-232	7	7	0.72	0.42	8.1	0
Tritium	N/A	N/A	-	-	60,930	-
Uranium-233/234	N/A	N/A	-	-	417	-
Uranium-238	7	5	9.1	0.46	483	0
Inorganics (mg/kg)						
Cadmium	5	5	0.61	0.43	6,813	0
Chromium	5	5	8.7	7.6	34,067	0
Lead	5	5	5.1	3.1	250	0
Mercury	5	1	0.11	0.11	2,044	0
Nitrate	N/A	N/A	-	-	-	-

MCRIS - Modified Columbia River Comprehensive Impact Assessment Ranger/Industrial Scenario
All radionuclide data decayed to year 2010.
Samples: 199-N-103A, 199-N-104A, 199-N-105A, 199-N-106A
199-N-75, 199-N-76, 199-N-80, RW #1, RW #2 and RW #3
N/A - not analyzed

Table 4-6. Summary of Contaminants that Travel to Groundwater in Less than 1,000 Years - Rural-Residential Exposure Scenario. (Page 1 of 2)

Contaminant and Borehole	Elevation (ft amsl)	Soil Concentration (mg/kg or pCi/g)	Travel Time to Groundwater (year)	Soil Concentration Upon Reaching the Water Table (pCi/g)
Chromium VI				
199-N-107A	449 447 430 401	45.7 57.7 12.7 12.4	31 29 24 5.5	45.7 57.7 12.7 12.4
199-N-108A	440.5 432 413 393.5	22.2 20.4 27.3 13	25 21 15 1.9	22.2 20.4 27.3 13
199-N-109A	441 439 432 425 410 389.5	8.9 6.2 3.2 5 1.7 12.2	13.5 13 11 8.3 6 0.7	8.9 6.2 3.2 5 1.7 12.2
199-N-75	452 449 446 397 385	8.5 8.7 7.6 14.7 7.8	29 28 27 5 0.4	8.5 8.7 7.6 14.7 7.8
199-N-76	452 449 430 398 388.5	8.2 8.3 11.3 11.4 8.9	29 28 11 5.7 1.4	8.2 8.3 11.3 11.4 8.9
Uranium-233/234				
199-N-107A	430 401	0.48 0.3	675 130	0.48 0.3
199-N-108A	413 393.5	0.53 0.4	410 250	0.53 0.4
199-N-109A	441 432 425 410 389.5	1.36 0.73 0.64 0.35 0.45	800 700 600 340 48	1.36 0.73 0.64 0.35 0.45
199-N-75	397 385	0.62 0.69	190 15	0.62 0.69

Table 4-6. Summary of Contaminants that Travel to Groundwater in Less than 1,000 Years - Rural-Residential Exposure Scenario. (Page 2 of 2)

Contaminant and Borehole	Elevation (ft amsl)	Soil Concentration (mg/kg or pCi/g)	Travel Time to Groundwater (year)	Soil Concentration Upon Reaching the Water Table (pCi/g)
199-N-76	398	1.2	210	1.2
199-N-80	395 384	0.33 0.36	170 6	0.33 0.36
Uranium-238				
199-N-103A	423	0.52	550	0.52
199-N-104A	390	0.87	50	0.87
199-N-105A	421	0.5	580	0.5
199-N-107A	430 401	0.44 0.36	675 130	0.44 0.36
199-N-108A	440.5 432 413 393.5	1.74 0.84 0.49 0.48	800 525 410 250	1.74 0.84 0.49 0.48
199-N-109A	432 425 410 389.5	0.44 0.53 0.5 0.42	700 600 340 48	0.44 0.53 0.5 0.42
199-N-75	449 446 397	0.5 0.73 0.47	990 900 190	0.5 0.73 0.47
199-N-76	449 430 398 388.5	0.46 0.53 0.49 0.54	990 650 210 67	0.46 0.53 0.49 0.54
199-N-80	384	0.35	6	0.35

amsl = above mean sea level

Table 4-7. Summary of Contaminants that Travel to Groundwater in Less than 1,000 Years - Modified CRCIA Ranger/Industrial Exposure Scenario. (Page 1 of 2)

Contaminant and Borehole	Elevation (ft amsl)	Soil Concentration (mg/kg or pCi/g)	Travel Time to Groundwater (year)	Soil Concentration Upon Reaching the Water Table (pCi/g)
Chromium VI				
199-N-107A	449 447 430 401	45.7 57.7 12.7 12.4	115 112 90 22	45.7 57.7 12.7 12.4
199-N-108A	440.5 432 413 393.5	22.2 20.4 27.3 13	110 84 60 7.6	22.2 20.4 27.3 13
199-N-109A	441 439 432 425 410 389.5	8.9 6.2 3.2 5 1.7 12.2	52 50 43 35 27 2.9	8.9 6.2 3.2 5 1.7 12.2
199-N-75	452 449 446 397 385	8.5 8.7 7.6 14.7 7.8	130 125 120 20 1.6	8.5 8.7 7.6 14.7 7.8
199-N-76	452 449 430 398 388.5	8.2 8.3 11.3 11.4 8.9	130 125 82 24 5.3	8.2 8.3 11.3 11.4 8.9
Uranium-233/234				
199-N-108A	393.5	0.4	500	0.4
199-N-109A	389.5	0.45	280	0.45
199-N-75	395	0.69	80	0.69
199-N-80	395 384	0.33 0.36	950 15	0.33 0.36

Table 4-7. Summary of Contaminants that Travel to Groundwater in Less than 1,000 Years - Recreational Exposure Scenario. (Page 2 of 2)

Contaminant and Borehole	Elevation (ft amsl)	Soil Concentration (mg/kg or pCi/g)	Travel Time to Groundwater (year)	Soil Concentration Upon Reaching the Water Table (pCi/g)
Uranium-238				
199-N-104A	390	0.87	300	0.87
199-N-108A	393.5	0.48	500	0.48
199-N-109A	389.5	0.42	280	0.42
199-N-76	388.5	0.54	390	0.54
199-N-80	384	0.35	15	0.35

amsl = above mean sea level

Table 4-8. PRG Comparison for 116-N-1 Rural-Residential Exposure-Subsurface Soil (>15 ft).

Constituent	No. of Records	No. of Detects	Maximum Detected Concentration	Minimum Detected Concentration	Protection of Groundwater and River - Rural Residential PRG	
					Level	Exceeded
Radionuclides (pCi/g)						
Tritium	N/A	N/A	-	-	2,000	-
Uranium-233/234	5	5	0.53	0.30	2	0
Uranium-238	5	5	0.49	0.36	2.4	0
Inorganics (mg/kg)						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nitrate	N/A	N/A	-	-	4,400	-

All radionuclide data decayed to year 2010.
Samples: 199-N-107A, 199-N-108A, Sediments (TS)
N/A - not analyzed
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs except chromium as noted.
Therefore, being protective of groundwater is also being protective of the Columbia River.
[a] 8 - protection of groundwater, 2 - protection of Columbia River
Shading indicates contaminant concentrations that exceed PRGs

Table 4-9. PRG Comparison for 116-N-3 Rural-Residential Exposure-Subsurface Soil (>15 ft).

Constituent	No. of Records	No. of Detects	Maximum Detected Concentration	Minimum Detected Concentration	Protection of Groundwater and River - Rural Residential PRG	
					Level	Exceeded
Radionuclides (pCi/g)						
Tritium	N/A	N/A	-	-	-	-
Uranium-233/234	4	4	0.73	0.35	2	0
Uranium-238	4	4	0.53	0.42	2.4	0
Inorganics (mg/kg)						
Nitrate	N/A	N/A	-	-	4,400	-

All radionuclide data decayed to year 2010.
Samples: 199-N-109A, Sediments (CS)
N/A - not analyzed
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs. Therefore, being protective of groundwater is also being protective of the Columbia River.

Table 4-10. PRG Comparison for Outside 116-N-1 and 116-N-3 Rural-Residential Exposure-Subsurface Soil (>15 ft).

Constituent	No. of Records	No. of Detects	Maximum Detected Concentration	Minimum Detected Concentration	Protection of Groundwater and River - Rural Residential PRG	
					Level	Exceeded
Radionuclides (pCi/g)						
Uranium-233/234	N/A	N/A	-	-	2	-
Uranium-238	37	6	0.54	0.47	2.4	0
Inorganics (mg/kg)						
Nitrate	4	4	54.6	2.6	4,400	0

All radionuclide data decayed to year 2010.
Samples: 199-N-103A, 199-N-104A, 199-N-105A, 199-N-106A, 199-N-75, 199-N-76, 199-N-80, RW #1, RW #2 and RW #3
N/A - not analyzed
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs except chromium as noted. Therefore, being protective of groundwater is also being protective of the Columbia River.
a 8 - protection of groundwater, 2 - protection of Columbia River
Shading indicates contaminant concentrations that exceed PRGs.

Table 4-11. PRG Comparison for 116-N-1 Modified CRCIA Ranger/Industrial Exposure-Subsurface Soil (>10 ft).

Constituent	No. of Records	No. of Detects	Maximum Detected Concentration	Minimum Detected Concentration	Protection of Groundwater and River - MCRIS PRG	
					Level	Exceeded
Radionuclides (pCi/g)						
Tritium	N/A	N/A	-	-	2,000	-
Uranium-233/234	7	6	1	0.30	2	0
Uranium-238	7	6	0.84	0.36	2.4	0
Inorganics (mg/kg)						
Nitrate	N/A	N/A	-	-	4,400	-

MCRIS - Modified Columbia River Comprehensive Impact Asessment (CRCIA) Ranger/Industrial Scenario
All radionuclide data decayed to year 2010.
Samples: 199-N-107A, 199-N-108A and Sediments (TS)
N/A - not analyzed
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs except chromium as noted. Therefore, being protective of groundwater is also being protective of the Columbia River.
[a] 8 - protection of groundwater, 2 - protection of Columbia River
Shading indicates contaminant concentrations that exceed PRGs.

Table 4-12. PRG Comparison for 116-N-3 Modified CRCIA Ranger/Industrial Exposure-Subsurface Soil (>10 ft).

Constituent	No. of Records	No. of Detects	Maximum Detected Concentration	Minimum Detected Concentration	Protection of Groundwater and River - MCRIS PRG	
					Level	Exceeded
Radionuclides (pCi/g)						
Tritium	N/A	N/A	-	-	2,000	-
Uranium-233/234	5	5	0.73	0.35	2	0
Uranium-238	5	5	0.53	0.42	2.4	0
Inorganics (mg/kg)						
Nitrate	N/A	N/A	-	-	4,400	-

MCRIS - Modified Columbia River Comprehensive Impact Assessment (CRCIA) Ranger/Industrial Scenario
All radionuclide data decayed to year 2010.
Samples: 199-N-109A and Sediments (CS)
N/A - not analyzed
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs. Therefore, being protective of groundwater is also being protective of the Columbia River.

Table 4-13. PRG Comparison for Outside 116-N-1 and 116-N-3 Modified CRCIA Ranger/Industrial Exposure-Subsurface Soil (>10 ft).

Constituent	No. of Records	No. of Detects	Maximum Detected Concentration	Minimum Detected Concentration	Protection of Groundwater and River - MCRIS PRG	
					Level	Exceeded
Radionuclides (pCi/g)						
[illegible]						
Uranium-233/234	N/A	N/A	-	-	2	-
Uranium-238	37	6	0.54	0.47	2.4	0
Inorganics (mg/kg)						
[illegible]						
Nitrate	4	4	54.6	2.6	4,400	-

MCRIS - Modified Columbia River Comprehensive Impact Assessment (CRCIA) Ranger/Industrial Scenario
All radionuclide data decayed to year 2010.
Samples: 199-N-103A, 199-N-104A, 199-N-105A, 199-N-106A,
199-N-75, 199-N-76, 199-N-80, RW #1, RW #2 and RW #3
N/A - not analyzed
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs except chromium as noted.
Therefore, being protective of groundwater is also being protective of the Columbia River.
a 8 - protection of groundwater, 2 - protection of Columbia River
Shading indicates contaminant concentrations that exceed PRGs.

Table 4-14. Refined Contaminants of Potential Concern in 116-N-1 and 116-N-3.

	116-N-1 Crib[b]		116-N-1 Trench		116-N-3 Crib and Trench	
	Rural-Residential	**MCRIS**	**Rural-Residential**	**MCRIS**	**Rural-Residential**	**MCRIS**
Surface Soil (0 to 10/15 ft)						
Radionuclides	Cesium-137 Cobalt-60 Europium-154 Europium-155 Plutonium-239/240 Strontium-90 Tritium[a]	Cesium-137 Cobalt-60 Europium-154 Plutonium-239/240 Strontium-90 Tritium[a]	No soils within 4.6 m (15 ft) of surface	No soils within 3 m (10 ft) of surface	Cesium-137 Cobalt-60 Europium-154 Europium-155 Plutonium-239/240 Strontium-90 Tritium[a]	No soils within 3 m (10 ft) of surface
Inorganics	Nitrate[a] Mercury[c]	Nitrate[a] Mercury[c]			Nitrate[a] Mercury[c]	
Subsurface Soil (> 10/15 ft)						
Radionuclides	Tritium[a]	Tritium[a]	Tritium[a]	Tritium[a]	Tritium[a]	Tritium[a]
Inorganics	Chromium[a] Nitrate[a]	Chromium[a] Nitrate[a]	Chromium[a] Nitrate[a]	Chromium[a] Nitrate[a]	Nitrate[a]	Nitrate[a]

[a] Insufficient soil data available. Unlikely that the constituent is present in soil in significant concentrations, due to its properties; however, since analytical data are insufficient, it has been retained as a contaminant of potential concern.
[b] The refined contaminants of potential concern (RCOPCs) for UPR-100-N-31 are assumed to be the same as 116-N-1 Crib surface soil RCOPCs.
[c] Insufficient soil data available. Kept as a RCOPC.
MCRIS = Modified CRCIA Ranger/Industrial Scenario

Table 4-15. Contaminants of Concern in 116-N-1 and 116-N-3.

	116-N-1 Crib[b]		116-N-1 Trench		116-N-3 Crib and Trench	
	Rural-Residential	**MCRIS**	**Rural-Residential**	**MCRIS**	**Rural-Residential**	**MCRIS**
Surface Soil (0 to 10/15 ft)						
Radionuclides	Cesium-137 Cobalt-60 Europium-154 Europium-155 Plutonium-239/240 Strontium-90 Tritium[a]	Cesium-137 Cobalt-60 Europium-154 Europium-155 Plutonium-239/240 Strontium-90 Tritium[a]	No soils within 4.6 m (15 ft) of surface	No soils within 3 m (10 ft) of surface	Cesium-137 Cobalt-60 Europium-154 Europium-155 Plutonium-239/240 Strontium-90 Tritium[a]	No soils within 3 m (10 ft) of surface
Inorganics	Nitrate[a] Mercury[c]	Nitrate[a] Mercury[c]			Nitrate[a] Mercury[c]	
Subsurface Soil (> 10/15 ft)						
Radionuclides	Tritium[a] Plutonium-239/240	Tritium[a] Plutonium-239/240	Tritium[a] Plutonium-239/240	Tritium[a] Plutonium-239/240	Tritium[a] Plutonium-239/240	Tritium[a] Plutonium-239/240
Inorganics	Chromium[a] Nitrate[a]	Chromium[a] Nitrate[a]	Chromium[a] Nitrate[a]	Chromium[a] Nitrate[a]	Nitrate[a]	Nitrate[a]

[a] Insufficient soil data available. Unlikely that the constituent is present in soil in significant concentrations, due to its properties; however, since analytical data are insufficient, it has been retained as a contaminant of concern (COC).
[b] It is assumed that the COCs for UPR-100-N-31 are the same as those for the 116-N-1 Crib surface soil.
[c] Insufficient soil data available. Kept as a contaminant of potential concern (COPC).
MCRIS = Modified CRCIA Ranger/Industrial Scenario

Table 4-16. Remediation Volume Summary.

Facility	High Activity Contaminated Soils Volume		Low Activity Contaminated Soils Volume		Clean Overburden Volume		Total Volume	
	bcm	bcy	bcm	bcy	bcm	bcy	bcm	bcy
Removal (RRES-6)								
116-N-1 Crib	1,026	1,343	14,369	18,796	3,512	4,594	18,907	24,733
116-N-1 Trench	1,278	1,672	11,989	15,683	15,263	19,967	28,530	37,321
116-N-3 Crib	1,699	2,222	6,795	8,889	1,427	1,867	9,921	12,978
116-N-3 Trench	958	1,253	7,270	9,511	6,002	7,851	14,230	18,615
UPR-100-N-31	0	0	2,007	2,625	0	0	2,007	2,625
Total	4,961	6,490	42,429	55,504	26,204	34,279	73,595	96,273
Removal (MCRIS-6)								
116-N-1 Crib	1,026	1,343	9,237	12,083	1,539	2,014	11,803	15,440
116-N-1 Trench	1,278	1,672	11,989	15,683	15,263	19,967	28,530	37,321
116-N-3 Crib	1,699	2,222	6,795	8,889	1,427	1,867	9,921	12,978
116-N-3 Trench	958	1,253	7,270	9,511	6,002	7,851	14,230	18,615
UPR-100-N-31	0	0	1,040	1,361	0	0	1,040	1,361
Total	4,961	6,490	36,331	47,527	24,232	31,699	65,525	85,716
Capping (MCRIS-7)								
116-N-1 Crib	1,026	1,343	9,237	12,083	1,539	2,014	11,803	15,440
116-N-1 Trench	0	0	0	0	0	0	0	0
116-N-3 Crib	0	0	0	0	0	0	0	0
116-N-3 Trench	0	0	0	0	0	0	0	0
UPR-100-N-31	0	0	1,040	1,361	0	0	1,040	1,361
Total	1,026	1,343	10,277	13,444	1,539	2,014	12,843	16,801
In Situ Vitrification (MCRIS-8)								
116-N-1 Crib	1,026	1,343	9,237	12,083	1,539	2,014	11,803	15,440
116-N-1 Trench	0	0	0	0	0	0	0	0
116-N-3 Crib	0	0	0	0	0	0	0	0
116-N-3 Trench	0	0	0	0	0	0	0	0
UPR-100-N-31	0	0	1,040	1,361	0	0	1,040	1,361
Total	1,026	1,343	10,277	13,444	1,539	2,014	12,843	16,801

bcm = bank cubic meters
bcy = bank cubic yards

5.0 REMEDIAL TECHNOLOGIES AND ALTERNATIVES

The purpose of this section is to identify, develop, and evaluate a focused range of potentially applicable response actions, remedial technologies, and process options for those TSD units recommended for further remedial action at 116-N-1, 116-N-3, and UPR-100-N-31. Appendix B presents the activities that are part of the clean closure plan for the 120-N-1, 120-N-2, and 100-N-58 units. The process options, technologies, and potential response actions identified in this section focus on those that are most viable for remediation of radioactive and dangerous wastes.

Descriptions of the process options and technologies are presented first, followed by the initial screening of technologies. This screening process focuses on identifying remedial technologies to achieve the RAOs. Process options and technologies were identified by compiling information obtained from EPA documents, reference program sources, and other relevant technical references. Specific sources of information include the following:

- EPA Superfund Innovative Technology Evaluation program
- WHC engineering studies and evaluations
- Bechtel Hanford, Inc., engineering studies and evaluations
- Remedial Options (ReOpt™), version 3.1, software developed by Pacific Northwest National Laboratory
- Vendors of process systems for site remediation
- Standard engineering texts
- *100 Area Feasibility Study Phases 1 and 2* (DOE-RL 1994)
- *100 Area Source Operable Unit Focused Feasibility Study Report* (DOE-RL 1995d)
- *100 Area Excavation Treatability Test Report* (DOE-RL 1996a)
- *Soil Washing for the 100-DR-1 Operable Unit Treatability Test Report* (DOE-RL 1995e).

The 100 Area Phase 1 and 2 FS and the 100 Area Source OU FFS reports serve as the baseline for identifying and screening technologies, identifying general response actions, and developing remedial alternatives. General response actions are actions that, singly or in combination, will satisfy the RAOs. The first primary objective of this section is to briefly describe remedial technologies. The second is to refine, based on more recent information, the discussion of

remedial alternatives that were developed in the supporting documents listed above to be more site specific.

After the applicable technologies are identified in this section, potentially applicable alternatives are assembled and evaluated. The result is a list of alternatives that are effective and implementable at the TSD units.

5.1 DESCRIPTION AND SCREENING OF TECHNOLOGIES

The technologies identified in the 100 Area Phase 1 and 2 FS are described in detail in Appendix C of that document (DOE-RL 1994). Technology descriptions are also available in the 100 Area Source OU FFS (DOE-RL 1995d). Only brief technology descriptions are included in this CMS, except for new technologies or ones for which new information has become available. A no-action process option has not been discussed here because there are no technologies associated with this action. However, a no-action remedial alternative is discussed in Section 5.2. The technologies discussed in this section include the following:

- Institutional controls
- Containment
- Removal
- In situ treatment
- Ex situ treatment.

5.1.1 Institutional Controls

Institutional controls are commonly used on the Hanford Site. Institutional controls are physical and legal barriers to prevent access to contaminants. Physical institutional control technologies may or may not include fences, but do include warning signs and security personnel. Legal institutional control technologies include restrictions on land use through permits, zoning ordinances or restrictive convenants. Institutional controls are also an alternative and as such are discussed in Section 5.2. Institutional controls as a technology are discussed below and will be required in some of the alternatives discussed in Section 5.2.

5.1.1.1 Access Control. Controlling site access involves temporary or permanent physical restrictions to prevent or reduce exposure to site contaminants. Possible methods of controlling access to contaminated sites include signs, entry control, artificial or natural barriers, and active surveillance. Implementation and maintenance costs increase as the level of protection increases.

The advantages of access control are that some protection of human health is provided and implementation is relatively simple and does not require contact with contaminated media. A disadvantage of access control is that it does not effectively achieve containment, removal, destruction, or treatment. Furthermore, continual monitoring of the controls is required. In

general, access controls are effective for time periods when sites are under active DOE control. Public access and unauthorized entry or disturbance of sites is prohibited during these periods.

5.1.1.2 Land-Use Restrictions. Land-use restrictions are administration actions to prevent or reduce future human exposure to contaminants remaining on site. Land may be designated for recreational uses, which would prevent potential spread of contamination through construction and agricultural activities. Residential designations restrict land use in different manners. Sometimes they permanently prohibit excavation or subsurface construction on any site containing hazardous materials following remediation. Often these restrictions are used as temporary measures while other remedial actions are taking place. Land-use restrictions can be applied to a large geographical area or to a specific location (such as individual waste sites) within an area.

The advantage of land-use restrictions is that they provide a degree of human-health protection and are relatively simple to implement at low cost. Implementation avoids environmental, worker safety, and community safety issues that arise from the potential release of contaminants associated with other remedial alternatives.

The disadvantage of land-use restrictions is that they do not effectively achieve the standard remedial measures of performance, such as containment, removal, destruction, or treatment of contaminants. Land-use restrictions must be closely monitored and strictly enforced to be effective. The administrative costs of maintaining and monitoring the site are open-ended. Contamination is not contained by land-use restrictions and it may spread over time, resulting in higher costs if the contaminants do not naturally disperse, degrade, or decay. Costs for treatment of the contaminated site may later be required for a larger potential volume of contaminated soil.

5.1.2 Containment Technologies

5.1.2.1 Capping. Capping is a containment technology that places surface barriers over contaminated soils and buried waste to reduce the amount of water infiltrating through the waste. This barrier slows the spread of contamination though the vadose zone and delays or reduces contamination of the aquifer. Barriers that reduce infiltration rates also effectively stop wind and water erosion and control the release of vapors. Some cap designs also limit direct human and animal interaction with the waste and can attenuate radiation.

Cap designs generally have multiple layers for different functions. Surface layers control wind and water erosion of the cap. This layer is often soil or vegetative but can also be a coarse gravel layer. The vegetative layer has the benefit of increasing evapotranspiration. Lower layers are intended as capillary breaks, high-permeability horizontal drainage layers, biointrusion barriers, and low-permeability layers. Capillary breaks consist of a fine-grained material placed over a coarser-grained material. Water in the fine-grained material tends to remain until the material becomes highly saturated. The fine-grained material can store a significant quantity of water until evapotranspiration returns the moisture to the atmosphere. High-permeability drainage layers are constructed with coarse gravel and serve to drain water horizontally to the sides of the

contaminated soil. Biointrusion layers prevent plants and animals from destroying the integrity of the surface barrier. Low-permeability layers block most water flow into the contaminated site. These layers are constructed of compact clay soils, synthetic membranes, asphalt, or asphaltic concrete.

Three cover or capping designs are potentially applicable for remediation of the RCRA TSD units. In order of overall performance and environmental protection, they are the Modified RCRA Subtitle C Barrier, Standard RCRA Subtitle C Barrier, and the Modified RCRA Subtitle D Barrier.

The Modified RCRA Subtitle C Barrier is the baseline design for applications at sites containing dangerous waste, Category 3 low-level waste or low-level mixed waste, and Category 1 low-level mixed waste. This barrier is designed to provide long-term containment and hydrologic protection for 500 years. This design incorporates provisions to control biointrusion and human intrusion. Design criteria found in the *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas* (DOE-RL 1996d) for the Modified RCRA Subtitle C Barrier include the following:

- Ensure minimal infiltration of moisture through the cap
- Ensure multilayer cover of materials that are resistant to natural degradation processes
- Ensure minimal maintenance during design life
- Ensure functional life of 500 years
- Ensure that plants are prevented from accessing and mobilizing contamination (i.e., prevent root penetration into the waste zone)
- Ensure that burrowing animals are prevented from accessing and mobilizing contamination
- Ensure that the top of waste is at least 5 m (16.4 ft) below final grade or include design provisions to limit inadvertent human intrusion
- Facilitate drainage and minimize surface erosion by wind and water
- Ensure that the low-permeability layer of the cover has a permeability less than or equal to that of any natural subsoils present
- Prevent the migration and accumulation of topsoil material within the lateral drainage layer (i.e., prevent clogging of the lateral drainage layer)

- Ensure that for frost protection, the lateral drainage layer and a low-permeability asphalt layer are located at least 0.6 m (2 ft) below final grade.

The Standard RCRA Subtitle C Barrier is the baseline design for applications at sites containing dangerous waste. The barrier provides containment and hydrologic protection for a specified postclosure period of 30 years that includes institutional control consisting of monitoring and necessary maintenance. Design criteria for the Standard RCRA Subtitle C Barrier can be found in the *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas* (DOE-RL 1996d).

The Modified RCRA Subtitle D Barrier is the baseline design for applications at nonradiological and nonhazardous solid waste sites, as well as Category 1 low-level waste sites where no dangerous waste constituents are present. It is designed to provide limited biointrusion and limited hydrologic protection (compared to the Modified RCRA Subtitle C Barrier) for 100 years. The performance period is selected to conform to a minimum projected duration of active institutional control. Design criteria for the Modified RCRA Subtitle D Barrier can be found in the *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas* (DOE-RL 1996d).

5.1.2.2 Run-On/Run-Off Control Options. The three process options for run-on/run-off control include diversion/collection, grading, and revegetation. All three are effective for their intended applications (i.e., to control or direct surface water run-on/run-off, to prevent flooding, or to control erosion).

Diversion/collection involves surface water management by construction of dams, dikes, berms, channels, or levees. Grading will include modification of site topography to eliminate flooding, erosion, and ponding. Revegetation process will involve installing vegetation cover over areas of contamination to reduce/eliminate erosion.

5.1.3 Removal Technologies

Removal technologies involve excavating contaminated materials, removing buried solid waste debris (including concrete structures and pipelines), and processing materials through segregation and packaging to allow for proper treatment and/or disposal. Removal technologies are well suited to the observational approach for remediation where remediation is guided by data collected in the field during remediation.

The excavation and disposal processes include the following steps:

- Protect cultural and natural resources
- Remove and stockpile topsoil and clean overburden, when present, to expose the contaminated material
- Excavate and remove contaminated media using appropriate dust control measures

- Use real-time analytical field screening during excavation
- Demolish contaminated structures (including pipelines) as part of the excavation
- Support, when necessary, nearby structures affected by excavation to prevent movement
- Treat contaminated soil to reduce toxicity or volume, if necessary or appropriate (treatment technologies discussed separately)
- Transport wastes to a disposal facility
- Backfill the excavation, as required, including adequate run-on/run-off controls to prevent erosion
- Restore the site with top soil and revegetate.

The following description is the preferred option for removal and disposal of contaminated soils as described in the engineering study (BHI 1997). The removal process starts with excavation of clean overburden, which is field surveyed and set aside for later use as backfill. Excavation would be accomplished by using a trackhoe excavator equipped with an extended reach boom. Side slope benching along the trench would be performed, as necessary, to position the trackhoe, establish a laydown area, and permit transportation of packaged material (B-25 boxes or roll-on/roll-off containers). The trackhoe operator would start excavation at the side of the trench and/or crib and remove material from the bottom and side slope. When the reach of the boom is exceeded, soil cover will be placed on top of the exposed surfaces to reduce dose exposure and provide a surface for the excavator to relocate to continue removing material. Excavated material will be placed and packaged in either ERDF roll-on/roll-off containers or B-25 boxes. These containers will be staged for transport to ERDF.

Concrete panels, structural supports, and large debris will be rigged for crane removal and monitored for contamination. Removal of concrete panels and supports will be consistent with the excavation, limiting the amount of trench exposed unprotected. Material not directly in contact with the soils of the trench will be surveyed and decontaminated, as required (reasonable determination made in the field), and clean material will be staged for alternate disposal. Contaminated material will be sized in accordance with ERDF bulk waste supplemental criteria and transported to ERDF for disposal. Smaller concrete material and debris in contact with the soils or requiring significant decontamination efforts will be removed by the excavator and placed in the appropriate package or container for disposal at ERDF.

Cobble and boulder layers comprise the upper most region of the 1301-N Crib area to be remediated. The cobble layer is considered low level and will be excavated into roll-on/roll-off containers and transported to ERDF. During the excavation of the cobble, a layer of cobble will remain to provide shielding while removing the high-activity material (boulders and soil beneath

the boulders). High-activity material will be packaged directly into containers (B-25 boxes) without blending or will be proportionally blended with low-level soil into roll-on/roll-off containers.

High-activity waste material will be packaged in steel B-25 boxes for shipment and disposal in ERDF. Containing the high-activity waste in B-25 boxes will eliminate the potential for airborne contamination; however, dose considerations will need to be managed.

The low-activity waste material will be blended with slightly contaminated or uncontaminated soil to achieve a volume that will decrease the potential for airborne contamination dose to workers. The blended waste will be placed in existing ERDF containers and hauled to ERDF. Lower activity material from other sites and onsite materials from crib/trench excavation operations will be used for blending to meet this limit. Blending operations will consist of excavating and placing a predetermined amount of higher activity crib/trench soil in a standard transport and subsequently placing a predetermined amount of lower activity stockpiled soil in the container. Once the container is filled, it will be transported to ERDF for dumping. Excavation operations for this option will require the placement of clean and/or lower activity soil on the crib/trench surface soils for shielding during excavation.

Operational controls for airborne contamination at ERDF will be instituted so that ERDF plutonium-239/240 soil concentration limits can be increased to 2,000 pCi/g from the present limit of 270 pCi/g. The 2,000 pCi/g (plutonium-239/240) limit is based on dust-loading measurements. Dust-loading measurements at ERDF require maintaining dust levels below the upper limit of 100 $\mu g/m^3$ with an average loading of 50 $\mu g/m^3$ to workers. In these conditions, 2,000 pCi/g of alpha-emitting isotopes could safely be handled without exceeding target airborne concentrations during normal operating conditions.

Based on worker safety, production rates, and additional release of contamination, contaminated debris, some of which would be removed prior to excavation, is removed with several different types of equipment. It is assumed that the debris at the TSD units has fixed and removable radioactive contamination. After removal, the heterogeneous nature of debris requires additional staging, sampling/analysis, and consolidation steps. Materials are staged in different areas according to the characteristics of the waste. Debris that is not contaminated may sometimes be sold, recycled, or used for fill.

To be effective and safe, excavation and debris removal should proceed with real-time analytical field screening.

The main advantage of removal technologies is that contaminated materials are physically removed from the site. Excavation is a standard construction practice, and methods are available to handle most construction-related problems expected to occur when excavating and handling contaminated materials (even those with high radiation levels). Requirements for safety, monitoring, and sampling are generally well understood.

Removing contaminated materials can be extremely hazardous because it requires handling, transporting, and treating or disposing of contaminated materials. Control of fugitive dust and vapor transport plus radiation exposures may be of particular concern. Extensive safety procedures and monitoring plans may be required to ensure the protection of the workers and the environment. Safety and environmental concerns must be balanced against the benefits of removal.

5.1.4 In Situ Treatment Technologies

In situ treatment technologies for soils were evaluated in the 100 Area Phase 1 and 2 FS (DOE-RL 1994). Technologies discussed in this section are electrokinetic separation, biodegradation, solidification through injection or mixing, and vitrification. Additional details are provided in the 100 Area Phase 1 and 2 FS and the 100 Area Source OU FFS (DOE-RL 1995d).

5.1.4.1 Electrokinetic Separation. Electrokinetic separation applies the physical chemistry principle of electrokinetic phenomena of electrophoresis and electroosmosis to manipulate the movement of colloidal particles or macro molecules in order to separate/remove them from either the soil matrix or groundwater. Colloidal particles/molecules in a solution acquire a particle charge that is composed of a central ion with counter ions of an opposite, and fixed, charge in a layer surrounding the central ion. To maintain electrical neutrality, opposite charged ions in solution tend to surround the colloidal particle forming a diffuse layer (double layer). The diffuse layer generally tends to move with the solution rather than the particle, except when an electric potential is applied to the solution. Electrokinetic separation uses a direct-current electric field to achieve separation of contaminants and/or water from soil and sludge by causing the water and contaminants to flow between the electrodes with collection of cations at the cathode and anions at the anode.

Water becoming electrolyzed with the evolution of hydrogen gas at the cathode is a disadvantage of this technology. Another disadvantage is that the process depends on water to move ions between the electrodes. Therefore, application in unsaturated soils may require the addition of water to effect treatment. Power consumption may result in high costs for this process. As discussed above, the technology may cause potentially undesirable changes in the soil chemistry, including mineral dissolution, precipitation of secondary minerals, and a change in the soil pH. Follow-on treatment would be required for removal of contaminants from the water extracted at the electrodes prior to disposal.

Electrokinetic separation is at the demonstration stage of development. Further testing and evaluation is required before full-scale remediation can be considered.

5.1.4.2 In Situ Biodegradation. In situ biodegradation describes a wide range of process options that rely on microbial transformation of organic contaminants to effect cleanup of soils, groundwater, and/or other contaminated media. Biodegradation is a natural process by which

indigenous microorganisms either completely mineralize organics into carbon dioxide and water (and biomass) or partially transform organic molecules into specific intermediates.

Although in situ biodegradation is effective on organic contaminants in soils, it is not effective on radionuclides or inorganics. Organic contaminants are not present in soils at the TSD units.

5.1.4.3 Solidification. In situ solidification, similar to ex situ solidification or stabilization, is conducted in situ through injection or mixing of solidification agents. As a result, excavation, handling, transport, ex situ treatment, backfilling, and disposal of treated soils are not required. Because contaminated soils are not removed, the risk of exposure to workers and the surrounding environment is reduced. This is an advantage of in situ treatment technologies. The disadvantages of the in situ process are that injection of agents may be less complete or limited by soil characteristics and treatment depth, and the amount of solidifying agent per given volume is not controlled as well as ex situ processes. In addition, it is difficult to verify that soils treated in situ meet remedial goals.

The injection process involves drilling holes to the desired depth and injecting solidification/ stabilization agents into the soil with high-pressure pumps. The pressure gradient drives the solidification agent into the soil pores. Injection technologies do not mechanically mix the soil, so the high torque requirements associated with in situ mixing do not limit the treatment depth. The penetration radius of the solidification/stabilization agent depends on the hydraulic conductivity and pore size of the contaminated soil and the properties of the solidification agent (e.g., viscosity and particle size). Soils with large pore sizes and high hydraulic conductivities generally have higher penetrations.

A widely used variation of the injection process is jet grouting. Like injection grouting, a small-diameter hole (approximately 5 cm [2 in.]) is drilled to the design depth using a downward jet of air or water. However, instead of relying on the pressure gradient to force the solidification material into the soil pores, the solidification agent is pumped out laterally through jets located near the bottom of the drill pipe at pressures as high as 34,475 kPa (5,000 lb/in^2). The drill pipe is rotated continuously and drawn up at a predetermined rate. The solidification agent exiting the jets mixes with the soil and forms a cylindrical column of solidified soil. The diameter of the column is a function of the soil strength, soil composition, jetting pressure, processing rate, rotational speed, jet nozzle diameter, and solidification/stabilization agent density. Once the column diameter is determined, placement of subsequent drill holes at a spacing slightly less than the column radius allows the second column to join the unset material in the previous column. Continuing this pattern permits formation of subsurface walls or monoliths.

Solidification through shallow-soil mixing uses a crane-mounted, single-shaft auger head normally 2.4 to 3.7 m (8 to 12 ft) in diameter to mix the soil and solidifying agent. The auger is enclosed in a bottom-open cylinder for applications that require control of the fugitive dusts and gases that are generated during the mixing process. This allows for closed-system mixing of the soil and solidifying agents.

As the auger is advanced through the soil, the solidifying agent is pumped through the hollow auger shaft and injected into the soil at the pilot bit. The solidifying agent is continuously injected as the auger penetrates through the soil. Once the desired depth is reached, the auger is removed. During removal the auger continues to rotate and mix the soil. The completion of one penetration leaves a column of solidified material with a diameter approximately equal to the diameter of the original auger. After completing the column, the blades are retracted into the bottom-open cylinder, and the cylinder is removed. The cylinder is then placed adjacent to and overlapping the previous cylinder, and the process is repeated until all the waste has been treated.

The main advantage of injection processes over the in situ mixing processes is that equipment is smaller and easier to maneuver. Injection wells can be drilled in tight places and at any angle, so solidification near and under surface structures is possible. Injection of soils with large quantities of natural debris (e.g., boulders) and/or waste debris (e.g., drums and buried tanks) is also possible. However, processing rates tend to be slower, thus making the mixing equipment more cost effective for large volumes. Support equipment for the injection techniques includes water and slurry pumps, a grout plant (for grout batching and mixing), and bulk material trucks.

Both methods of solidification are considered moderately effective; however, there are uncertainties associated with the degree of mixing between the solidifying agent and the soils. Both are well developed technologies; however, the injection method has a higher cost because of drilling costs and potentially results in airborne contamination.

The most common solidifying agent is cement grout, although several pozzolanic or chemical grouts are available. For soil containing mostly dangerous waste and short-lived radionuclides (those with half-lives of hundreds of years), typical solidifying agents, such as cement, are considered to be effective. Uncertainty exists in the longevity of these agents when long-lived radionuclides, such as those with half-lives greater than thousands of years, are present.

Remote handling techniques and ALARA principles need to be considered to avoid handling soils with high radiation levels. Additionally, the high background radiation levels at the TSD units would not be reduced significantly with these technologies.

5.1.4.4 Vitrification. In situ vitrification is a thermal treatment process that destroys combustible and some toxic components of chemical constituents in contaminated soils. In addition, inorganic and nonvolatile metallic constituents are immobilized in a durable glass or glass-like crystalline product. With vitrification the soil is heated to temperatures of 1,400 to 2,000 °C (2,552 to 3,632 °F) by passing an electric current through electrodes embedded in contaminated soils, thus producing a molten glass zone to stabilize the contaminants in place.

During startup, a fume collection hood is placed over the area to be heated, and a conductive mixture of glass frit and graphite is placed on the soil surface to provide a conductive connection between the electrodes. Power is applied to the electrodes to initiate heating, which melts the soil surrounding the glass frit/graphite mixture placed on the soil surface. Once the melt begins, the molten soil becomes the electrical conductor to continue the process. When the desired depth

is reached, the power is turned off, and the melt cools to a solidified mass. The solidified mass will have a reduced volume resulting in a depression usually backfilled to ground level with clean material.

In the heating and melting process, most of the organic constituents in the soil are pyrolyzed in the melt and migrate to the surface where they are oxidized. The off-gases are collected in the hood and directed to an off-gas treatment train. Nonvolatile and semivolatile inorganics and radionuclides in the soil are incorporated into the solidified glass.

The presence of excessive moisture can limit the effectiveness and impacts the economics of in situ vitrification because of the time and energy required to eliminate the water before soil melting can occur. In addition, low alkaline soils may not be conductive and metals can short out the electrodes. However, this technology may be safe for the public and workers because it avoids excavation, material handling, contact with contaminants, and disposal. Radiation exposure considerations will be necessary for workers setting up equipment before each melting operation.

This technology is commercially available, but the energy requirements associated with the vitrification process make this a high-cost technology. However, the benefit of this technology is its permanency with respect to metals and long-lived radionuclides.

Remote handling techniques and ALARA principles need TBC to avoid handling soils with high radiation levels. Once the soil is vitrified, a smaller volume of soil/matrix remains, allowing for backfill to be placed over the matrix. The backfill can attenuate the radiation and reduce background levels at the units.

5.1.5 Ex Situ Treatment Technologies

Ex situ treatment technologies include biodegradation, encapsulation, soil washing, solidification and stabilization, and thermal desorption. Each of these technologies is briefly described in the following text; more detailed descriptions can be found in the 100 Area Phase 1 and 2 FS (DOE-RL 1994) and the 100 Area Source OU FFS (DOE-RL 1995d).

5.1.5.1 Biodegradation. Ex situ biodegradation is fundamentally identical to in situ biodegradation (Section 5.1.4.2), except the materials to be treated are excavated before treatment. As a result, excavating, handling, transporting soils to a treatment facility, and back to the site, and backfilling with treated soils must occur. This technology is used for soils containing organic contaminants, which are not present in soils at the TSD units.

5.1.5.2 Encapsulation. Wastes can be encapsulated by fixing individual particles in a solid matrix or by enclosing a volume of waste within an inert jacket or container. For example, encapsulation has been used for stable on-site storage and for land disposal in the following applications: storage of contaminated soils at remedial action and spill sites, storage of damaged drums and/or faulty containers, storage and burial of solidified liquids and sludges, storage and

disposal of incineration slag and scrubbing residues, and storage and disposal of radioactive and mixed wastes.

Encapsulating-container sizes range from less than a gallon to containers that can surround 208 L (55-gal) drums. Container sizes can be larger, especially for the disposal of low-level radioactive wastes. Typical materials of construction for containers include steel, stainless steel, lined steel, high-density polyethylene, low-density polyethylene, polypropylene, fiberglass reinforced plastics, and spray-on/brush-on resins. If intended for land disposal, containers must be designed to withstand compression due to burial depths up to 15 m (50 ft), internal and external attack by chemical wastes, biodegradation due to fungus and/or bacteria, repeated freeze/thaw cycles, sustained ultraviolet radiation exposure, internal pressures produced by the waste, and long-term creep resulting from stress loadings received during burial. If encapsulation containers are to be transported off the waste site, U.S. Department of Transportation requirements must be met.

Design-life considerations depend on the time period over which the waste remains dangerous and the unit postclosure monitoring period, which is typically 30 years or more. Design life also depends on whether land disposal is being considered for retrievable storage or permanent disposal.

5.1.5.3 Soil Washing. Soil washing is an ex situ volume-reduction technology that removes contaminants from soils through particle-size separation techniques or by eluting and/or desorbing them into a wash solution. Soil washing could potentially be used to treat both inorganic and radiological contaminants.

The concept of the physical-separation process option of soil washing is based on the theory that most contaminants tend to bind, either chemically or physically, to the fine (i.e., clay and silt) fraction of a soil. The clay and silt soil particles are, in turn, physically bound to the coarser sand and gravel particles by compaction and adhesion. Thus, separating the fine clay and silt particles from the coarser sand and gravel soil particles would effectively concentrate the contaminants into a smaller volume of soil that could then be further treated or disposed. However, the assumption that more contamination is associated with the fine-soil particles is not always correct. The distribution of contaminants throughout the soil matrix must be determined to assess the applicability of soil washing and to choose the appropriate physical separation technique.

Physical separation techniques can be enhanced by using attrition scrubbing to attain a higher particle-separation effectiveness. Attrition scrubbing helps remove and separate fine particles that otherwise would stick to the large particles and remain in the coarse fraction. Attrition scrubbing can also remove the outer surface of larger particles where contaminants can concentrate in small cracks at the surface, resulting in a better separation of contaminants into the fine fraction.

Wash waters from the soil washing process are treated using typical clarification techniques and then recycled. Clean makeup water is required to replenish water lost from the system during the

soil washing process. The only time waste water exists that may require additional treatment is when the soil washing plant is dismantled.

Treatability test results of the soil washing technology are reported in *Soil Washing Pilot Scale Treatability Test for the 100-DR-1 Operable Unit* (DOE-RL 1995e). This treatability test was conducted on 100-D Area soils to determine the effectiveness and relative cost benefits of soil washing. Except for cobalt-60 and cesium-137, the soil washing removed the radiological and inorganic contaminants to below levels of concern, resulting in an 85% volume reduction of materials requiring disposal. The recommendations from the test were that volume reduction is possible in similar soils and that other 100 Area OUs should consider the technology for applicability at specific sites. Subsequent to the treatability test, a cost-benefits analysis was performed and reported in *100 Areas Soil Washing Tradeoff Study* (BHI 1995a). This evaluation concluded that, while the volume reduction is possible, the cost for remove/dispose actions is consistently lower than the remove/treat with soil washing/dispose action. Based on this conclusion, the document recommends that soil washing not be considered for the 100 Area at this time.

5.1.5.4 Solidification and Stabilization. Solidification and stabilization are treatment technologies designed to reduce contaminant solubility through chemical changes, physically encapsulate reactive species, and reduce contaminant losses to transport media such as infiltrating water by decreasing the surface area per unit volume of the waste medium. These technologies are applicable to radiological contaminants.

For solidification, a reagent is added to transform the waste into solid-like material. Wastes that exist as liquids or semisolids are often solidified to improve the handling and physical characteristics. The chemistry of the waste is not necessarily modified by solidification; however, the waste may be microencapsulated by the solidified matrix. For stabilization, a reagent is added to transform the material so that the chemical constituents are in their least mobile or toxic form. Wastes that leach heavy metals or other contaminants are often stabilized to immobilize the chemical constituents.

Solidification and stabilization of solids can be accomplished by using inorganic or organic binding agents. The inorganic solidification and stabilization binding agents consist of cement-based materials, pozzolanic-based materials, and natural materials such as clay. The organic solidification-and-stabilization binding agents consist of thermoplastic and thermosetting materials, such as asphalt, bitumen, polyolefins, epoxies; organic polymers, such as urea formaldehyde; and others, such as activated carbon and modified clay.

Cement-based materials consist of portland cement and soluble silicates. These materials chemically react with water to form a solid cementitious matrix, which improves handling and the physical characteristics of the waste. They also raise the pH of the waste, which may help precipitate and immobilize some heavy metal contaminants. Cement-based binding agents are typically appropriate for inorganic contaminants. However, a waste with an elevated saline

content will inhibit cementitious reactions. The effectiveness of this binding agent with organic contaminants varies.

Pozzolanic-based materials consist primarily of silica from fly ash, kiln dust, pumice, or blast furnace slag, and lime, which forms a cementitious bond in the presence of water. Pozzolanic-based binding agents affect the waste like cement does. Pozzolanic reactions occur more slowly than cement reactions, but may offer economic advantages. Pozzolanic-based materials are appropriate for the same or similar wastes as cement.

Thermoplastic materials are organic polymers, such as polyethylene and bitumen, that are heated and mixed with the waste material in a molten state. After cooling, the waste is physically encapsulated by the solidified polymer. These materials do not chemically interact with the waste and, therefore, are less susceptible to waste- and binding-agent incompatibilities. However, the mixing must occur at elevated temperatures typically greater than 100 °C. Therefore, the waste cannot contain water and/or volatile contaminants. Thermoplastic materials are generally more expensive to use than inorganic solidification and stabilization binding agents, but are more successful with some organic contaminants.

Organic polymers generally consist of urea formaldehyde, polyacrylates, or polyacrylamides. They are designed to trap solid particles and allow some liquid to escape. The primary use of organic polymers is to solidify and stabilize radioactive wastes. This technology has been applied on a limited basis to dangerous wastes. Some of the organic polymers are biodegradable.

5.1.5.5 Thermal Desorption. Thermal desorption is a relatively low-temperature (150 to 425 °C [302 to 707 °F]) thermal-separation process for soils, sludges, and other solid media contaminated with organics. Thermal desorption is similar to incineration, but is directed towards the removal of organics, whereas incineration is directed towards destruction of organics.

This technology is not an effective treatment for radiologically contaminated soils. Thermal desorption has been demonstrated successfully on pilot-scale levels, but full-scale soil remediation is yet to be demonstrated. Hence, case-by-case pilot testing is essential before considering this technology for full-scale remediation.

5.1.6 Initial Screening

The process options discussed above were evaluated for implementability, effectiveness, and cost according to the CERCLA guidance for initial screening of technologies (EPA 1988). Each option was rated in terms of the difficulty of its implementation as part of a remedial action. Each option also was judged for effectiveness in protecting human health and the environment. Finally, each was given a relative cost estimate (high, moderate, or low). Results of this evaluation are presented in Table 5-1. The shaded options in Table 5-1 have been screened out.

Based on these evaluations, certain process options were carried forward to the development of alternatives in Section 5.2. Not all process options were carried through the detailed analysis due to the large number that passed the screening step. One process option was selected to represent the technology and to simplify the subsequent development and evaluation of alternatives without limiting the flexibility during remedial design (EPA 1988). The following discussion presents the screening of process options and briefly explains the reasons for selecting one option over the others for the analysis of alternatives.

The "National Oil and Hazardous Substances Pollution Contingency Plan" (NCP) (40 CFR 300) requires that a No-Action Alternative be evaluated. The No-Action Alternative represents a situation in which no restrictions, controls, or active remedial measures are applied to a site. No action implies a scenario of "walking away from the site" and allowing contaminants to dissipate through natural attenuation processes. The decision on the applicability of the No-Action Alternative is addressed on a site-by-site basis.

The No-Action Alternative requires that a site pose no threat to human health and the environment or that it has been effectively addressed in a prior action. In the context of interim action, only those sites that have contaminants below risk levels are appropriate for no action. This low risk level may result from natural degradation or a prior action that reduced contaminants to acceptable levels. The No-Action Alternative does not protect human health or the environment from the contaminants at the TSD units. However, to satisfy NCP requirements, it will be retained as an alternative and will serve as a baseline for evaluation of other alternatives.

Under the institutional controls option, access controls using signs, fences, and surveillance will be combined with land-use restrictions and considered as one technology. The institutional controls option has limited effectiveness for protecting human health and the environment, but is easily implementable and low cost. The technology will be retained and evaluated further.

Capping is the containment option that has been retained. All three RCRA caps reduce the amount of water infiltrating the units and can be implemented for moderate cost.

Based on information provided in the *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas* (DOE-RL 1996d), the Modified RCRA Subtitle C barrier, a 500-year cap, will be used for alternative development in this TSD CMS. It provides the longest design life and is therefore the most effective in protecting human health and the environment. The cap needs minimal maintenance during design life and is applicable for both TSD units (116-N-1 and 116-N-3).

The Standard RCRA Subtitle C Barrier (30 years) and Modified RCRA Subtitle D Barrier (100 years) were not retained for alternative development in this CMS. The design lives of these two barriers are much shorter than the Modified RCRA Subtitle C barrier and, therefore, provide much less protection for human health and the environment. These barriers are also less desirable because they are applicable to limited types of sites. Although initial construction costs

would likely be lower than with the 500-year barrier, replacement and maintenance costs may create higher expenses in the long run. Should a containment alternative be selected for remedial action, all caps should be reevaluated using site-specific information essential for cap selection and design. Because containment technologies leave contaminants on site, they do not accommodate future rural-residential use directly at those sites. However, selection of a containment technology as part of an alternative for a particular site would not preclude rural-residential use elsewhere in the 100-N Area.

Run-on/run-off options include diversion/collection, grading, and revegetation. These options are eliminated from further consideration because they have limited effectiveness in protecting human health and the environment. However, most of the remedial alternatives call for these three options to be implemented as a final step after remediation has occurred. At this time they will not be carried forward as a process option but will be considered a part of final reclamation.

Of the four in situ treatment options available, in situ solidification and vitrification are retained. The in situ solidification technology, which includes both injection and mixing techniques, is effective and implementable. In situ vitrification is retained primarily because of its short- and long-term effectiveness for protecting human health and the environment. It is well-suited for inorganic and radioactive contaminants in the TSD units and provides a permanent matrix that essentially will not degrade. While it has a relatively high cost, it is a commercially available technology. However, it does have the disadvantage of producing off-gas that may be dangerous and could require significant treatment.

In situ electrokinetic separation and biodegradation were not retained. Electrokinetic separation is not retained because of the lack of site-specific information to evaluate it further. Potential undesirable changes in soil chemistry, effectiveness of the technology, and costs are all unknowns. This technology is at the demonstration stage of development and requires additional technical and site-specific information to be carried further in the evaluation process. The in situ biodegradation option is applicable to organic contaminants. Because the TSD units do not have organic contaminants, this option is not applicable and is eliminated from further consideration.

Of the two process options that passed screening (solidification and in situ vitrification), in situ vitrification was selected for evaluation in the detailed analysis of alternatives. Solidification is neither as permanent nor reliable as vitrification when metals and long-lived radionuclides, such as plutonium, are present in the soil. Furthermore, with solidification, there is uncertainty associated with the complete immobilization of the contaminants. If the contaminants are not fully immobilized, the short-term effectiveness for protecting human health and the environment is greatly reduced. Likewise, the long-term effectiveness would be questionable. Should an in situ treatment alternative be selected for remedial action, the in situ technologies should be reevaluated using site-specific information essential for treatment selection and design.

Of the ex situ treatment options, only solidification and stabilization is retained for further consideration. This technology will provide a treatment option for soils that do not meet land

disposal requirements or ERDF waste acceptance criteria. It has limited applicability and a relatively high cost, but is necessary for dealing with land disposal restriction (LDR) waste.

The other ex situ treatment options are eliminated from further consideration. The biological treatment and thermal desorption options are treatments for organic contaminants. Because it is anticipated that organics are not present at the TSD units, these two options are not applicable. Likewise, encapsulation is a treatment for waste drums/containers or for extremely dangerous or reactive wastes and is not applicable to the TSD units. It is also eliminated from further consideration.

Soil washing is an ex situ treatment technology that has some potential with the contaminants in the TSD units. However, soil washing is not effective on soils with high concentrations of radionuclides, such as those in 116-N-1 and 116-N-3. Soil washing would not be effective in protecting human health and the environment at these units and is eliminated. The *100 Area Soil Washing Trade-Off Study* (BHI 1995a) performed an economic evaluation of soil washing. Results of that evaluation showed that soil washing was not cost effective at that time.

The removal technologies have been retained. The debris removal option addresses removal of concrete structures and pipelines, whereas the excavation technologies are applicable to the soils. Removal technologies use conventional construction techniques that are easily implementable, effective, relatively inexpensive, and are adaptable to handling most construction-related problems and incorporating the ALARA principles. The actual excavation techniques employed should be evaluated while considering the high radiation environment.

In summary, the following technologies were retained and process options selected for further consideration and will be carried forward into Section 5.2, where they will be used to develop remedial alternatives:

General Response Action	Remedial Technology	Process Option
No action	No action	No action
Institutional controls	Access control/land-use restrictions	Signs, fences, surveillance
Containment	Containment	Modified RCRA Subtitle C barrier
In situ treatment	In situ treatment	In situ vitrification
Ex situ treatment	Ex situ treatment	Solidification and stabilization
Remove/treat/dispose	Removal technologies	Excavation/debris removal

5.2 DESCRIPTION AND SCREENING OF ALTERNATIVES

Based on technologies screened in Section 5.1.6, remedial alternatives have been developed for potential use at 116-N-1 and 116-N-3. Alternatives are described and screened according to two exposure scenarios: rural-residential and modified CRCIA ranger/industrial. These alternatives were assembled based on the following information summarized from Section 4.0:

- Surface soils (top 3.0 to 4.5 m [10 to 15 ft] bsg) exceed PRGs for radionuclides and possibly for nitrate and mercury. The radionuclides of primary concern are cobalt-60, cesium-137, strontium-90, and plutonium-239/240. It is assumed that these surface soils are present at the 116-N-1 Crib and possibly at UPR-100-N-31.
- Plutonium-239/240, a long-lived radionuclide, is present at high concentrations in a concentrated layer beneath the 116-N-1 Crib and Trench and the 116-N-3 Crib and Trench.

- Subsurface soils (>3.0/4.5 m [10/15 ft] bsg) may exceed PRGs for tritium and nitrate. It is assumed that these contaminants may be present at the 116-N-1 Trench, 116-N-3 Crib, and 116-N-3 Trench.

- Subsurface soils (>3.0/4.5 m [10/15 ft bsg) may exceed PRGs for chromium at the 116-N-1 Trench.

5.2.1 Remedial Alternatives for Rural-Residential Exposure Scenario

Remedial alternatives for 116-N-1 and 116-N-3 have been developed on the basis of technologies carried forward from the Section 5.1.6 screening process. Table 5-2 lists the alternatives developed for these sites.

This section discusses and screens each alternative for the rural-residential exposure scenario. Section 5.2.2 discusses and screens each alternative for the modified CRCIA ranger/industrial exposure scenario. Each alternative has been given a letter and number designation indicating which exposure scenario it represents. Sections 5.2.1 and 5.2.2 more fully describe the alternatives and perform a general screening to eliminate nonapplicable alternatives. Only applicable alternatives will be carried into the detailed analysis in Section 6.0. Table 5-3 provides results of the general screening of alternatives. Shaded alternatives have been eliminated from further consideration.

5.2.1.1 No-Action Alternative (RRES-1). The NCP (40 CFR 300) requires that a No-Action Alternative be evaluated. The No-Action Alternative represents a situation in which no restrictions, controls, or active remedial measures are applied to the site. No action implies a scenario of "walking away from the site" and allowing contaminants to dissipate through natural attenuation processes. The decision on the applicability of the No-Action Alternative is addressed on a site-by-site basis.

The No-Action Alternative requires that a site pose no threat to human health and the environment or that the site has been effectively addressed in a prior action. The No-Action Alternative would not be effective for a rural-residential scenario because it does not protect human health or the environment, does not meet RAOs, and does not comply with ARARs. However, it will be retained as an alternative to satisfy NCP requirements. It will serve as a baseline for evaluation of other alternatives.

5.2.1.2 Institutional Controls Alternative (RRES-2). Access controls, in combination with land-use restrictions, would be used at the TSD units as the primary means of institutional controls. Access control may be accomplished using site security personnel, additional fencing, and/or public notices. Access control would reduce the potential for human exposure. Land-use restrictions would be accomplished through administrative controls. However, they would not necessarily prevent human access to the facilities. Volume, toxicity, and mobility of contaminants associated with soils would not be reduced by institutional controls. Fencing already provides a physical barrier to exclude humans and animals (to some extent), but would require maintenance and surveillance actions for the long term. Public notices and community relations efforts could supplement site security and fencing.

Because wastes would be left on site under this alternative, groundwater monitoring would be required to track potential changes in groundwater quality. The present network of groundwater monitoring wells is assumed to be adequate for monitoring potential impacts to groundwater.

The Institutional Controls Alternative is not applicable to the rural-residential scenario because, used alone, it would not protect human health or the environment. This alternative would neither achieve RAOs nor comply with ARARs because unacceptable concentrations of contaminants would be left in place. It also is not applicable because it would not meet the requirement of providing unrestricted land use at the waste site itself. Alternative RRES-2 will be eliminated from further consideration.

5.2.1.3 Containment Alternative (RRES-3). This Containment Alternative includes one of the surface barriers or caps described in Section 5.1.2.1 to prevent direct exposure to contaminants in surface soil and to reduce water infiltration by immobilizing contaminants in the subsurface soils that are a threat to groundwater and the Columbia River. All contaminants would be left in place. The Modified RCRA Subtitle C cap with a life of 500 years has been selected for use in this alternative.

General activities associated with this alternative include the following:

- Removing concrete structures at the 116-N-1 Trench and 116-N-3 Crib and Trench to facilitate cap installation
- Backfilling the 116-N-1 Crib boulder field to provide a stable base for the cap
- Removing pipelines

- Disposing of contaminated material at ERDF
- Backfilling as necessary to the surrounding elevation of 138.7 m (455 ft) at 116-N-1 and to 137.5 m (451 ft) at 116-N-3
- Constructing the cap at UPR-100-N-31 (if required), the 116-N-1 Crib and Trench, and the 116-N-3 Crib and Trench, with run-on/run-off controls and revegetation
- Establishing institutional controls to preserve barrier integrity
- Instituting a maintenance and monitoring program
- Controlling dust.

If a capping alternative is selected for remediation, site-specific information will be used to determine the most appropriate cap design. It has also been assumed that the concrete panels would be removed before cap installation, although other options are available: drilling holes in the panels, and filling the crib and trench with fill material and leaving the panels intact, or spraying the soil with gunnite prior to breaking the panels. For the purposes of this CMS, breaking the panels and then backfilling the trenches and cribs with soil has been included in the alternatives. The actual method used should be determined during remedial design.

There is no excavation of soils in this alternative. According to the design criteria in Section 5.1.2.1, the cap will be at least 5 m (16 ft) thick to prevent access to contaminated soils. This means that the cap would have a final grade higher than the natural surrounding topography by more than 5 m (16 ft).

In addition to the cap long-term effectiveness and appearance issue, this alternative would not provide unrestricted land use at the waste site itself under a rural-residential scenario because building, digging, and drilling could violate the cap's integrity. Institutional controls in the form of access controls and land-use restrictions would be required to preserve the cap. During the life of the cap, this alternative would be protective of human health and the environment by achieving RAOs and would comply with ARARs. However, because these activities would not support unrestricted land use at the waste site, would leave plutonium in surface soils for thousands of years, and would be installed above surrounding grade, Alternative RRES-3 will be eliminated from further consideration in this CMS. (Although this alternative would not accommodate future rural-residential use directly at those sites, selection of a containment technology as part of an alternative for a particular site would not preclude rural-residential use elsewhere in the 100-N Area.)

5.2.1.4 In Situ Treatment Alternative (RRES-4). The purpose of in situ techniques is to fulfill required treatment goals by either destroying or immobilizing contaminants in place. This alternative would immobilize or destroy contaminants in surface soils to prevent direct exposure to those contaminants. It would also immobilize contaminants in the subsurface soils that are a

threat to groundwater and the Columbia River. This alternative requires no excavation; thus, all contaminants would be left on site.

Potential benefits of in situ technologies include lower worker exposure to harmful contaminants and less site disruption than traditional excavate and dispose techniques. Remote handling and operating techniques should be used to reduce worker exposures. Essentially, the technology permanently immobilizes contaminants.

In situ vitrification has been selected as the technology for this alternative. General activities associated with this alternative include the following:

- Removing concrete structures at the 116-N-1 Trench and 116-N-3 Crib and Trench to facilitate treatment of the soil present at the base of the facilities
- Backfilling 116-N-1 Crib boulder field voids to ensure that an adequate melt occurs
- Removing pipelines
- Disposing of contaminated material at ERDF
- Backfilling as necessary to provide a level working platform
- Vitrifying soils at UPR-100-N-31 (if required), the 116-N-1 Crib and Trench, and the 116-N-3 Crib and Trench to a depth of 5.8 m (19 ft)
- Backfilling site (due to subsidence from volume reduction) with additional material to the surrounding elevation of 138.7 m (455 ft) at 116-N-1 and 137.5 m (451 ft) at 116-N-3
- Contouring site for run-on/run-off control and revegetation
- Establishing institutional controls to prevent intrusion into the monolith
- Controlling dust.

This alternative poses two problems. First, the technology has a treatment depth limitation of 5.8 m (19 ft) (EPA 1992). Backfill would be required to make an adequate platform for working over the trenches, which are more than 3.0 to 4.6 m (10 to 15 ft) below the concrete covers. As a result, 5.8 m (19 ft) might not be deep enough to vitrify all the contaminants in the concentrated layer. This might reduce the alternative's effectiveness for protecting the environment. It is unlikely that this alternative would comply with ARARs, unless a large enough area were vitrified so that the monolith would act as a cap over contaminants that were not vitrified because of the depth limitation.

Second, at the cribs and probably at the trenches, the top of the vitrified monolith would be at the same level as (or above) the surrounding grade. As a result, it would probably would not be practical or possible to backfill over the monolith and achieve a 4.6-m (15-ft) cushion of clean material. Institutional controls (e.g., land-use restrictions) would be required to protect human health and to prevent intrusion into the monolith by drilling or other means. Thus, unrestricted land use would not be possible at the waste site. (Although this alternative would not accommodate future rural-residential use directly at those sites, selection of a vitrification technology as part of an alternative for a particular site would not preclude rural-residential use elsewhere in the 100-N Area.)

The problems identified with this alternative (Alternative RRES-4) make it unacceptable. It will be eliminated from further consideration in this CMS.

5.2.1.5 Remove/No Treatment/Dispose/Backfill Alternative (RRES-5). The Remove/No Treatment/Dispose/Backfill Alternative involves the removal of contaminated surface soils to prevent direct exposures, removal of a 1.5-m (5-ft) layer of high-concentration plutonium-239/240 in subsurface soil, and removal of contaminated subsurface soils that pose a potential threat to groundwater and the Columbia River. This alternative would remove the entire volume of soils estimated for each crib and trench for the rural-residential scenario as described in Section 4.6 and would address the long-term concern of plutonium in surface soils. The estimated depths of the excavation are depicted in Figure 4-1. In addition, Figure 5-1 shows the general areas (shaded) where removal of contaminated soils will occur under this alternative. The contaminated soils are disposed of in an appropriate disposal facility, and the site will be backfilled.

General activities associated with this alternative include the following:

- Removing concrete structures at the 116-N-1 Crib and Trench and 116-N-3 Crib and Trench
- Removing boulder field at the 116-N-1 Crib
- Removing pipelines
- Disposing of contaminated material at ERDF
- Excavating clean overburden material
- Excavating contaminated surface soils to a depth of 3 m (10 ft) bsg at the 116-N-1 Crib and UPR-100-N-31 (if required)
- Excavating a 1.5-m (5-ft) concentrated layer below the bottom of the 116-N-1 Trench, 116-N-3 Crib, and 116-N-3 Trench to remove high-concentration plutonium-239/240

- Backfilling the site to surrounding elevation of 138.7 m (455 ft) at 116-N-1 and to 137.5 m (451 ft) at 116-N-3, using clean overburden and additional clean fill as required
- Contouring site for run-on/run-off control and revegetation
- Controlling dust.

It is assumed that removing surface soils and the high-concentration plutonium-239/240 layer will also remove any subsurface soil COCs as well; thus, it is assumed that additional excavation below the plutonium-239/240 layer will not be required. This assumption would be verified by sampling during remedial action. If the remaining in situ soils exceed PRGs for groundwater or the Columbia River, remedial alternatives such as additional excavation, subsurface capping, or institutional controls will be evaluated with respect to the following: (1) protection of human health and the environment; (2) impacts to ecological and cultural resources; (3) worker health and safety; (4) remediation, operation, and maintenance costs; and (5) decay of short-lived radionuclides.

The removal technology provides the opportunity to characterize and segregate the wastes as excavation proceeds, using an observational approach. Materials removed are separated as necessary for transportation to the disposal facility.

This alternative would effectively protect human health and the environment and can be implemented at the units. Remedial action objectives would be met by removing contaminated material that exceeds the remediation criteria. Long-term risks to human and ecological receptors would be eliminated by removing the contaminants from the waste site. It is likely that this alternative would comply with ARARs and would allow for unrestricted land use. It also has the added benefit of removing the long-lived plutonium-239/240 from the surface soils that are a direct exposure concern. However, it has no provisions for treatment of soils required to meet ERDF waste acceptance criteria. Although this alternative may be applicable for the rural-residential exposure scenario, Alternative RRES-6, discussed below, includes treatment if required. Alternative RRES-5 will be eliminated from further consideration as long as Alternative RRES-6 is retained.

5.2.1.6 Remove/Dispose Alternative (RRES-6). This alternative will be referred to as the Removal Alternative. Alternative RRES-6 is identical to RRES-5 except that it includes a treatment option. The treatment option is solidification/stabilization for soils that do not meet ERDF waste acceptance criteria. The Removal Alternative would remove the entire volume of soils estimated for each crib and trench for the rural-residential scenario as described in Section 4.6 and for Alternative RRES-5. Like RRES-5, this alternative addresses the long-term concern of the plutonium that is present in surface soil. The estimated depths of the excavation are depicted in Figure 4-1. In addition, Figure 5-1 shows the general areas (shaded) where removal of contaminated soils will occur under this alternative.

General activities associated with this alternative include the following:

- Removing concrete structures at the 116-N-1 Crib and Trench and 116-N-3 Crib and Trench
- Removing boulder field at the 116-N-1 Crib
- Removing pipelines
- Excavating clean overburden material
- Excavating contaminated surface soils to a depth of 4.6 m (15 ft) bsg at the 116-N-1 Crib and UPR-100-N-31 (if required)
- Excavating a 1.5-m (5-ft) concentrated layer below the bottom of the 116-N-1 Trench, 116-N-3 Crib, and 116-N-3 Trench to remove high-concentration plutonium-239/240
- Treating contaminated soils, if required
- Disposing of contaminated material at ERDF
- Backfilling the site to surrounding elevation of 138.7 m (455 ft) at 116-N-1 and to 137.5 m (451 ft) at 116-N-3, using clean overburden and additional clean fill as required
- Contouring the site for run-on/run-off control and revegetation
- Controlling dust.

Because it is assumed that removal of surface soils and the plutonium-239/240 layer will remove any subsurface soil COCs as well, it is also assumed that additional excavation below the plutonium-239/240 layer will not be required. This assumption would be verified by sampling during remedial action.

The removal technology provides the opportunity to characterize and segregate the wastes as excavation proceeds, using an observational approach. Materials removed are separated as necessary for transportation to the disposal facility.

The Removal Alternative would effectively protect human health and the environment. Remedial action objectives would be met by removing the contaminated material that exceeds the remediation criteria, and an added benefit will be the removal of the plutonium-239/240 that is present in surface and subsurface soil. Long-term risks to human and ecological receptors would be eliminated by removing the contaminants from the waste site. It is likely that this alternative would comply with ARARs and would allow for unrestricted land use. It is

applicable to TSD CMS sites for a rural-residential exposure scenario and will be retained for the detailed analysis in Section 6.0.

5.2.1.7 Remove/Dispose/Backfill/Cap Alternative (RRES-7). This alternative will be referred to as the Capping Alternative. This Capping Alternative addresses the surface soils to 4.6 m (15 ft) bsg using conventional excavation techniques to prevent direct exposures to surface soils. Figure 5-2 shows the areas (shaded) where estimated removal of contaminated soils would occur under this alternative. Only the 116-N-1 Crib and the UPR-100-N-31 spill are estimated to have contaminated soils within the first 4.6 m (15 ft) bsg. It has been assumed, based on current data, that after these soils are removed, no contaminants that pose a risk to groundwater or the Columbia River will remain at these two sites. However, if it is determined that the remaining soil exceeds PRGs, a cap, if required, could be placed over the 116-N-1 Crib and UPR-100-N-31. Contaminated soils that are removed would be treated, if required, using solidification/ stabilization prior to disposal to meet ERDF waste acceptance criteria. Likewise, if it were determined that the surface soils to be excavated could not be disposed of at ERDF, and excavation would be difficult and costly to implement, a cap could be installed at these locations without prior excavation. Clean backfill would be used to fill the excavation.

Once the surface soils have been removed, a Modified RCRA Subtitle C barrier would be built to immobilize the contaminants remaining in the 116-N-1 Trench and the 116-N-3 Crib and Trench. This cap is essentially installed to immobilize the high concentration of plutonium-239/240 and any nitrate, chromium, and tritium that may be present. The Modified RCRA Subtitle C cap, with a life of 500 years, has been selected for use in this alternative. However, if a capping alternative is selected for remediation, site-specific information will be used to determine the most appropriate cap design. Furthermore, it has also been assumed that the concrete panels would be removed before cap installation, although other options are available: (1) drilling holes in the panels and filling the crib and trench with fill material and leaving the panels intact, or (2) spraying the soil with gunnite before breaking the panels. The method of cap installation should be determined in the remedial design phase.

General activities associated with this alternative include the following:

- Removing concrete structures at the 116-N-1 Crib and Trench and 116-N-3 Crib and Trench to facilitate cap installation
- Removing boulder field at the 116-N-1 Crib
- Removing pipelines
- Excavating clean overburden material
- Excavating contaminated soils to a depth of 4.6 m (15 ft) bsg at the 116-N-1 Crib and UPR-100-N-31 (if required)

- Treating contaminated soils, if required
- Disposing of contaminated material at ERDF
- Backfilling the site to surrounding elevation of 138.7 m (455 ft) at 116-N-1, using clean overburden and additional clean fill as required
- Constructing a cap with run-on/run-off controls and revegetation over the 116-N-1 Trench and the 116-N-3 Crib and Trench
- Establishing institutional controls to preserve barrier integrity
- Instituting a maintenance and monitoring program
- Controlling dust.

This alternative would not provide unrestricted land use under a rural residential exposure scenario because building, digging, or drilling could violate the cap's integrity. Institutional controls would be required to preserve the cap's integrity. During the life of the cap, this alternative would be protective of human health and the environment by meeting RAOs and complying with ARARs. However, because these activities do not support unrestricted land use at the waste site itself, Alternative RRES-7 will be eliminated from further consideration. (Although this alternative would not accommodate future rural-residential use directly at those sites, selection of a containment technology as part of an alternative for a particular site would not preclude rural-residential use elsewhere in the 100-N Area.)

5.2.1.8 Remove/Dispose/Vitrify/Backfill Alternative (RRES-8). This alternative will be referred to as the Vitrification Alternative. The Vitrification Alternative addresses the surface soils to 4.6 m (15 ft) bsg using conventional excavation techniques to prevent direct exposures. Then, subsurface soils would be vitrified to immobilize contaminants that pose a potential threat to groundwater and the Columbia River. It has been assumed that only the 116-N-1 Trench and the 116-N-3 Crib and Trench would contain soils requiring vitrification.

Figure 5-2 shows the areas (shaded) where estimated removal of contaminated soils and vitrification would occur under this alternative. The 116-N-1 Crib and possibly the UPR-100-N-31 spill are estimated to have contaminated soils within the first 4.6 m (15 ft) bsg. Contaminated soils that are removed would be treated, if required, using stabilization/solidification prior to disposal to meet ERDF waste acceptance criteria.

Contaminated soils below 4.6 m (15 ft) (i.e., bsg) that require remediation for protection of groundwater would remain in place and would be treated with in situ vitrification to immobilize contaminants. It has been assumed that only the 116-N-1 Trench and the 116-N-3 Crib and Trench would contain soils requiring vitrification. However, if subsurface soils at the 116-N-1

Crib (and UPR-100-N-31) are determined to exceed PRGs, vitrification would occur there also. After vitrification, clean backfill would be used to fill the excavation.

General activities associated with this alternative include the following:

- Removing concrete structures at the 116-N-1 Crib and Trench and 116-N-3 Crib and Trench to facilitate vitrification at the soil base of the units
- Removing boulder field at the 116-N-1 Crib
- Removing pipelines
- Excavating clean overburden material
- Excavating contaminated soils to a depth of 4.6 m (15 ft) bsg to prevent direct exposures at UPR-100-N-31 (if required) and the 116-N-1 Crib
- Treating contaminated soils, if required
- Disposing of contaminated material at ERDF
- Vitrifying remaining contaminants in subsurface soils in place to a depth of 5.8 m (19 ft) (10.4 m [34 ft] bsg) at the 116-N-1 Trench and the 116-N-3 Crib and Trench
- Backfilling the site (due to subsidence from volume reduction) to surrounding elevation of 138.7 m (455 ft) at 116-N-1 and to 137.5 m (451 ft) at 116-N-3, using clean overburden and additional clean fill as required
- Contouring of the site for run-on/run-off control and revegetation
- Establishing institutional controls to prevent intrusion into the monolith
- Controlling dust.

This alternative would be very effective in protecting human health and the environment by achieving RAOs and complying with ARARs. However, institutional controls would be required to prevent intrusion into the monolith, and unrestricted land use would not be possible at the waste site itself. As a result, this alternative is eliminated from further consideration. (Although this alternative would not accommodate future rural-residential use directly at those sites, selection of a vitrification technology as part of an alternative for a particular site would not preclude rural-residential use elsewhere in the 100-N Area.)

5.2.2 Remedial Alternatives for Modified CRCIA Ranger/Industrial Exposure Scenario

This section discusses and screens each remedial alternative for the modified CRCIA ranger/industrial exposure scenario. Accordingly, each alternative has been given a letter and number designation indicating the land-use scenario it represents.

5.2.2.1 No-Action Alternative (MCRIS-1). The NCP (40 CFR 300) requires that a No-Action Alternative be evaluated. The No-Action Alternative represents a situation in which no restrictions, controls, or active remedial measures are applied to the site. No action implies a scenario of "walking away from the site" and allowing contaminants to dissipate through natural attenuation processes. The decision on the applicability of the No-Action Alternative is addressed on a site-by-site basis.

The No-Action Alternative requires that a site pose no threat to human health and the environment or that the site has been effectively addressed in a prior action. It is unlikely that this alternative would comply with ARARs. The No-Action Alternative would not be effective for the modified CRCIA ranger/industrial scenario because it does not protect human health or the environment. However, it will be retained as an alternative to satisfy NCP requirements. It will serve as a baseline for evaluation of other alternatives.

5.2.2.2 Institutional Controls Alternative (MCRIS-2). Access controls in combination with land-use restrictions will be used at the units as the primary means of institutional controls. Access control may be accomplished using site security personnel, additional fencing, and/or public notices. Access control would reduce the potential for human exposure. Land-use restrictions would be accomplished through administrative controls. However, they would not necessarily prevent human access to the facilities. Volume, toxicity, and mobility of contaminants associated with soils would not be reduced by institutional controls. Fencing already provides a physical barrier to exclude humans and animals (to some extent), but would require maintenance and surveillance actions for the long term. Public notices and community relations efforts could supplement site security and fencing.

Because wastes would be left on site under this alternative, groundwater monitoring would be required to track potential changes in groundwater quality. The present network of groundwater monitoring wells is assumed to be adequate for monitoring potential impacts to groundwater. The Institutional Controls Alternative is not applicable to the modified CRCIA ranger/industrial scenario because, used alone, it would not protect human health or the environment. This alternative would neither achieve RAOs nor comply with ARARs because unacceptable concentrations of contaminants would be left in place. It also is not applicable because it would not meet the requirement of providing land use compatible with a recreation scenario. Alternative MCRIS-2 will be eliminated from further consideration.

5.2.2.3 Containment Alternative (MCRIS-3). The Containment Alternative includes the surface barriers or caps described in Section 5.1.2.1 to prevent direct exposure to contaminants in surface soil and to reduce water infiltration by immobilizing contaminants in the subsurface soils

that are a threat to groundwater and the Columbia River. The Modified Subtitle RCRA C cap, which has a life of 500 years, has been selected for use in this alternative.

General activities associated with this alternative include the following:

- Removing concrete structures at the 116-N-1 Trench and 116-N-3 Crib and Trench to facilitate cap installation
- Backfilling of 116-N-1 Crib boulder field voids to provide a stable base for the cap
- Removing pipelines
- Disposing of contaminated material at ERDF
- Backfilling as necessary to the surrounding elevation of 138.7 m (455 ft) at 116-N-1 and to 137.5 m (451 ft) at 116-N-3
- Constructing the cap at UPR-100-N-31 (if required), the 116-N-1 Crib and Trench, and the 116-N-3 Crib and Trench with run-on/run-off controls and revegetation
- Establishing institutional controls to preserve barrier integrity
- Instituting a maintenance and monitoring program
- Controlling dust.

If a capping alternative is selected for remediation, site-specific information will be used to determine the most appropriate cap design. Furthermore, it has been assumed the concrete panels would be removed before cap installation, although other options are available: (1) drilling holes in the panels and filling the crib and trench with fill material and leaving the panels intact, or (2) spraying the soil with gunnite before breaking the panels. For the purposes of this CMS, removing the panels and then backfilling the trenches and cribs with soil has been included in the alternatives. The actual method used should be determined during remedial design.

There is no excavation of soils in this alternative. The design thickness of the cap, as described in Section 5.1.2.1, is 5 m (16 ft) thick, which prevents access to contaminated soils. This means that the cap would have a final grade slightly higher than the natural surrounding topography by more than 5 m (16 ft).

A capping alternative is applicable under the modified CRCIA ranger/industrial exposure scenario because institutional controls required by the modified CRCIA ranger/industrial scenario may be sufficient to protect the cap's integrity. During the life of the cap, this alternative would be protective of human health and the environment by achieving RAOs and complying

with ARARs. However, the cap would have to be maintained for thousands of years to prevent direct access to the high-concentration plutonium that is present in surface soils. This may not be effective for the long term and may prove to be costly. Because of the ineffectiveness of the cap to protect human health and the environment from high-concentration and long-lived radionuclides, this MCRIS-3 alternative will be eliminated from further consideration in this CMS.

Another capping alternative, Alternative MCRIS-7, described below, would be easier to implement and more effective in protecting the environment. It was not deemed as important to maintain the integrity of the cap to protect groundwater and the Columbia River from the plutonium that is present in the subsurface soil as it would be to protect direct exposure to surface soils.

5.2.2.4 In Situ Treatment Alternative (MCRIS-4). The purpose of in situ techniques is to fulfill required treatment goals by either destroying or immobilizing contaminants in place. This alternative would immobilize or destroy contaminants in surface soils to prevent direct exposure to those contaminants. It would also immobilize contaminants in the subsurface soils that are a threat to groundwater and the Columbia River. This alternative requires no excavation.

Potential benefits of in situ technologies include lower worker exposure to harmful contaminants and less site disruption than traditional excavate-and-dispose techniques. Remote handling and operating techniques should be used to reduce worker exposures.

In situ vitrification, which permanently destroys or immobilizes contaminants, is the technology utilized in this alternative. General activities associated with this alternative include the following:

- Removing concrete structures at the 116-N-1 Trench and 116-N-3 Crib and Trench to facilitate treatment of the soil present at the base of the facilities
- Backfilling of 116-N-1 Crib boulder field voids to ensure that an adequate melt occurs
- Removing pipelines
- Disposing of contaminated material at ERDF
- Backfilling as necessary to provide a level working platform
- Vitrifying soils to a depth of 5.8 m (19 ft) bsg at UPR-100-N-31 (if required), the 116-N-1 Crib and Trench, and the 116-N-1 Crib and Trench
- Backfilling site (due to subsidence from volume reduction) with additional material to surrounding elevation of 138.7 m (455 ft) at 116-N-1 and to 137.5 m (451 ft) at 116-N-3

- Contouring the site for run-on/run-off control and revegetation
- Establishing institutional controls to prevent intrusion into the monolith
- Controlling dust.

Two problems exist with this alternative. First, the technology has a treatment depth limitation of 5.8 m (19 ft) (EPA 1992). Backfill would be required to make an adequate platform for working over the trench. As a result, 5.8 m (19 ft) might not be deep enough to vitrify all the contaminants in the concentrated layer. This might reduce the alternative's effectiveness in protecting the environment. It is unlikely this alternative would comply with ARARs, unless a large enough area were vitrified so that the monolith would act as a cap over contaminants that were not vitrified because of the depth limitation.

Second, at the cribs and probably at the trenches, the top of the vitrified monolith would be at the same level as (or above) the surrounding grade. As a result, it would probably not be possible or practical to backfill over the monolith and achieve a 3.0-m (10-ft) cushion of clean material.

Institutional controls (e.g., land-use restrictions) would be required to protect human health and to prevent intrusion into the monolith by drilling or other means.

The institutional controls provided by the modified CRCIA ranger/industrial exposure scenario would be adequate. However, the problems identified with this alternative (Alternative MCRIS-4) make it unacceptable. It will be eliminated from further consideration.

5.2.2.5 Remove/No Treatment/Dispose/Backfill Alternative (MCRIS-5). The Remove/No Treatment/Dispose/Backfill Alternative involves removing contaminated surface soils to prevent direct exposures, removing a 1.5-m (5-ft) layer of high-concentration plutonium-239/240 in subsurface soils, and removing contaminated subsurface soils that pose a potential threat to groundwater and the Columbia River. This alternative would remove the entire volume of soils estimated for each crib and trench for the modified CRCIA ranger/industrial scenario as described in Section 4.6. The estimated depths of the excavation are depicted in Figure 4-1. In addition, Figure 5-1 shows the general areas (shaded) where removal of contaminated soils will occur under this alternative. The contaminated soils would be disposed of in an appropriate disposal facility, and the site would be backfilled.

General activities associated with this alternative include the following:

- Removing concrete structures at the 116-N-1 Crib and Trench and 116-N-3 Crib and Trench
- Removing boulder field at the 116-N-1 Crib
- Removing pipelines

- Excavating clean overburden material
- Excavating contaminated surface soils to a depth of 3 m (10 ft) bsg (116-N-1 Crib and UPR-100-N-31, if required)
- Excavating a 1.5-m (5-ft) concentrated layer below the bottom of the 116-N-1 Trench, 116-N-3 Crib, and 116-N-3 Trench to remove high-concentration plutonium-239/240
- Disposing of contaminated material at ERDF
- Backfilling the site to the surrounding elevation of 138.7 m (455 ft) at 116-N-1 and 137.5 m (451 ft) at 116-N-3, using clean overburden and additional clean fill as required
- Contouring the site for run-on/run-off control and revegetation
- Controlling dust.

It is assumed that removal of surface soils and the high-concentration plutonium-239/240 layer will remove any subsurface soil COCs; thus, it is assumed that additional excavation below the plutonium-239/240 layer will not be required. This assumption would be verified by sampling during remedial action. If the remaining in situ soils exceed PRGs for groundwater or the Columbia River, remedial alternatives such as additional excavation, subsurface capping, or institutional controls will be evaluated with respect to the following: (1) protection of human health and the environment; (2) impacts to ecological and cultural resources; (3) worker health and safety; (4) remediation, operation, and maintenance costs; and (5) decay of short-lived radionuclides.

The removal technology provides the opportunity to characterize and segregate the wastes as excavation proceeds, using an observational approach. Materials removed would be separated as necessary for transportation to the disposal facility.

Remedial action objectives would be met by removing contaminated material that exceeds the remediation criteria. Long-term risks to human and ecological receptors would be eliminated by removing the contaminants from the waste site.

This alternative would effectively protect human health and the environment. It is likely that this alternative would comply with ARARs and also would be compatible with the restrictions required for recreational land use. However, it has no provisions for treatment of soils required to meet LDRs. The next alternative, Alternative MCRIS-6, is exactly the same as MCRIS-5, but includes treatment, if it is required. Alternative MCRIS-5 will be eliminated from further consideration as long as Alternative MCRIS-6 is retained.

5.2.2.6 Remove/Dispose Alternative (MCRIS-6). This alternative will be referred to as the Removal Alternative. Alternative MCRIS-6 is identical to MCRIS-5, except that it includes the

treatment option of solidification/stabilization for soils that do not meet ERDF waste acceptance criteria. This alternative would remove the entire volume of soils estimated for each crib and trench for the modified CRCIA ranger/industrial scenario as described in Section 4.6. The estimated depths of the excavation are depicted in Figure 4-1. In addition, Figure 5-1 shows the general areas (shaded) where removal of contaminated soils will occur under this alternative.

General activities associated with this alternative include the following:

- Removing concrete structures at the 116-N-1 Crib and Trench and 116-N-3 Crib and Trench
- Removing boulder field at the 116-N-1 Crib
- Removing pipelines
- Excavating clean overburden material
- Excavating contaminated surface soils to a depth of 3 m (10 ft) bsg at the 116-N-1 Crib and UPR-100-N-31 (if required)
- Excavating a 1.5-m (5-ft) concentrated layer below the bottom of the 116-N-1 Trench, 116-N-3 Crib, and 116-N-3 Trench to remove high-concentration plutonium-239/240
- Treating contaminated soils, if required
- Disposing of contaminated material at ERDF
- Backfilling the site to surrounding elevation of 138.7 m (455 ft) at 116-N-1 and 137.5 m (451 ft) at 116-N-3, using clean overburden and additional clean fill as required
- Contouring the site for run-on/run-off control and revegetation
- Controlling dust.

It is assumed that removal of surface soils and the high-concentration plutonium-239/240 layer will remove any subsurface soil COCs as well; thus, it is assumed that additional excavation below the plutonium-239/240 layer will not be required. This assumption would be verified by sampling during remedial action. If the remaining in situ soils exceed PRGs for groundwater or the Columbia River, remedial alternatives such as additional excavation, subsurface capping, or institutional controls will be evaluated with respect to the following: (1) protection of human health and the environment; (2) impacts to ecological and cultural resources; (3) worker health and safety; (4) remediation, operation, and maintenance costs; and (5) decay of short-lived radionuclides.

The removal technology provides the opportunity to characterize and segregate the wastes as excavation proceeds, using an observational approach. Materials removed are separated as necessary for transportation to the disposal facility.

This alternative would effectively protect human health and the environment. Remedial action objectives would be met by removing contaminated material that exceeds the remediation criteria. Long-term risks to human and ecological receptors would be eliminated by removing the contaminants from the waste site. It is likely that this alternative would comply with ARARs and also would be compatible with recreational land use. It will be retained for the detailed analysis in Section 6.0.

5.2.2.7 Remove/Dispose/Backfill/Cap Alternative (MCRIS-7). This alternative will be referred to as the Capping Alternative. This Capping Alternative addresses the surface soils to 3.0 m (10 ft) bsg using conventional excavation techniques to prevent direct exposures to surface soils. Figure 5-2 shows the areas (shaded) where estimated removal of contaminated soils would occur under this alternative. Only the 116-N-1 Crib and the UPR-100-N-31 spill are estimated to have contaminated soils within the first 3.0 m (10 ft) bsg. It has been assumed, based on current data, that after these soils are removed no contaminants will remain at these two sites that pose a risk to groundwater or the Columbia River. However, if it is determined that the remaining soil exceeded PRGs, a cap, if required, could be placed over the 116-N-1 Crib and UPR-100-N-31. Contaminated soils that are removed would be treated, if required, using solidification/ stabilization prior to disposal to meet ERDF waste acceptance criteria. Likewise, if it were determined that the surface soils to be excavated could not be disposed of at ERDF and excavation would be difficult and costly to implement, a cap could be installed at these locations without prior excavation. Clean backfill would be used to fill the excavation.

Once the surface soils are removed, a Modified RCRA Subtitle C barrier would be built to immobilize the contaminants remaining in the 116-N-1 Trench and the 116-N-3 Crib and Trench. This cap is essentially installed to immobilize the high-concentration plutonium-239/240 and any nitrate, chromium, and tritium that may be present. The Modified RCRA Subtitle C cap with a life of 500 years has been selected for use in this alternative. However, if a capping alternative is selected for remediation, site-specific information will be used to determine the most appropriate cap design. Furthermore, it has been assumed the concrete panels would be removed prior to cap installation, although other options are available: (1) drilling holes in the panels and filling the crib and trench with fill material and leaving the panels intact, or (2) spraying the soil with gunnite prior to breaking the panels. The method of cap installation should be determined in the remedial design phase.

General activities associated with this alternative include the following:

- Removing concrete structures at the 116-N-1 Crib and Trench and 116-N-3 Crib and Trench to facilitate cap installation

- Removing boulder field at the 116-N-1 Crib

- Removing pipelines
- Excavating clean overburden material
- Excavating contaminated soils to a depth of 3.0 m (10 ft) bsg at the 116-N-1 Crib and UPR-100-N-31 (if required)
- Treating contaminated soils, if required
- Disposing of contaminated material at ERDF
- Backfilling the site to the surrounding elevation of 138.7 m (455 ft) at 116-N-1, using clean overburden and additional clean fill as required
- Constructing a cap with run-on/run-off controls and revegetation over the 116-N-1 Trench and the 116-N-3 Crib and Trench
- Establishing institutional controls to preserve barrier integrity
- Instituting a maintenance and monitoring program
- Controlling dust.

If excavation at the 116-N-1 Crib and UPR-100-N-31 were determined to not be implementable (e.g., in the unlikely event that transuranic waste was present and the soil could not be disposed of at ERDF) or cost effective, the area of the cap could, if required, be extended over these locations. The integrity of the cap would have to be maintained for thousands of years to prevent direct exposure to long-lived radionuclides (especially the high-concentration plutonium-239/240). Additionally, this cap would be above surrounding grade.

During the life of the cap, this alternative would be protective of human health and the environment by meeting RAOs and complying with ARARs. Institutional controls would be required to preserve the cap's integrity. These controls would consist of a combination of access controls and land-use restrictions that would be consistent with the modified CRCIA ranger/industrial exposure scenario. Alternative MCRIS-7 will be retained.

5.2.2.8 Remove/Dispose/Vitrify/Backfill Alternative (MCRIS-8). This alternative will be referred to as the Vitrification Alternative. The Vitrification Alternative addresses the surface soils to 3.0 m (10 ft) bsg using conventional excavation techniques to prevent direct exposures. Then, subsurface soils would be vitrified to immobilize contaminants that pose a potential threat to groundwater and the Columbia River. It has been assumed that only the 116-N-1 Trench and the 116-N-3 Crib and Trench would contain soils requiring vitrification.

Figure 5-2 shows the areas (shaded) where estimated removal of contaminated soils and vitrification would occur under this alternative. The 116-N-1 Crib and possibly the UPR-100-N-31 spill are estimated to have contaminated soils within the first 3.0 m (10 ft) bsg. Contaminated soils that are removed would be treated using stabilization/solidification, if required, before disposal to meet ERDF waste acceptance criteria.

Contaminated soils below 3.0 m (10 ft) (i.e., bsg) that require remediation for protection of groundwater would remain in place and would be treated with in situ vitrification to immobilize contaminants. It has been assumed that only the 116-N-1 Trench and the 116-N-3 Crib and Trench would contain soils requiring vitrification. However, if subsurface soils at the 116-N-1 Crib (and UPR-100-N-31) are determined to exceed PRGs, then vitrification would occur there also. After vitrification, clean backfill would be used to fill the excavation.

General activities associated with this alternative include the following:

- Removing concrete structures at the 116-N-1 Crib and Trench and 116-N-3 Crib and Trench to facilitate vitrification at the soil base of the units
- Removing boulder field at the 116-N-1 Crib
- Removing pipelines
- Excavating clean overburden material
- Excavating contaminated soils to a depth of 3.0 m (10 ft) bsg at the 116-N-1 Crib and UPR-100-N-31 (if required) to prevent direct exposure
- Treating contaminated soils, if required
- Disposing of contaminated material at ERDF
- Vitrifying remaining contaminants in subsurface soils in place to a depth of 5.8 m (19 ft) bsg at the 116-N-1 Trench and the 116-N-3 Crib and Trench
- Backfilling the site (due to subsidence from volume reduction) to the surrounding elevation of 138.7 m (455 ft) at 116-N-1 and to 137.5 m (451 ft) at 116-N-3, using clean overburden and additional clean fill as required
- Contouring the site for run-on/run-off control and revegetation
- Establishing institutional controls to prevent intrusion into the monolith
- Controlling dust.

It is likely that this alternative would comply with ARARs and achieve RAOs. This alternative would effectively protect human health and the environment, but institutional controls would be necessary to prevent drilling through the vitrified monolith. These controls would, however, be consistent with the modified CRCIA ranger/industrial exposure scenario at the waste site itself. This alternative is applicable to TSD CMS sites for the modified CRCIA ranger/industrial scenario and will be retained.

5.3 SUMMARY OF ALTERNATIVES SELECTED FOR SOIL REMEDIATION

Based upon above descriptions and preliminary screening, the following alternatives are retained for further analysis in Section 6.0.

Rural-Residential

- No-Action Alternative (MCRIS-1)
- Removal Alternative (MCRIS-6)

Modified CRCIA Ranger/Industrial

- No-Action Alternative (MCRIS-1)
- Removal Alternative (MCRIS- 6)
- Capping Alternative (MCRIS-7)
- Vitrification Alternative (MCRIS-8)

Table 5-3 shows the final results of the alternative screening. The alternatives retained will be carried forward to the detailed analysis, which will be performed in Section 6.0.

Figure 5-1. Remediation Areas for Alternatives RRES-5, RRES-6, MCRIS-5 and MCRIS-6.

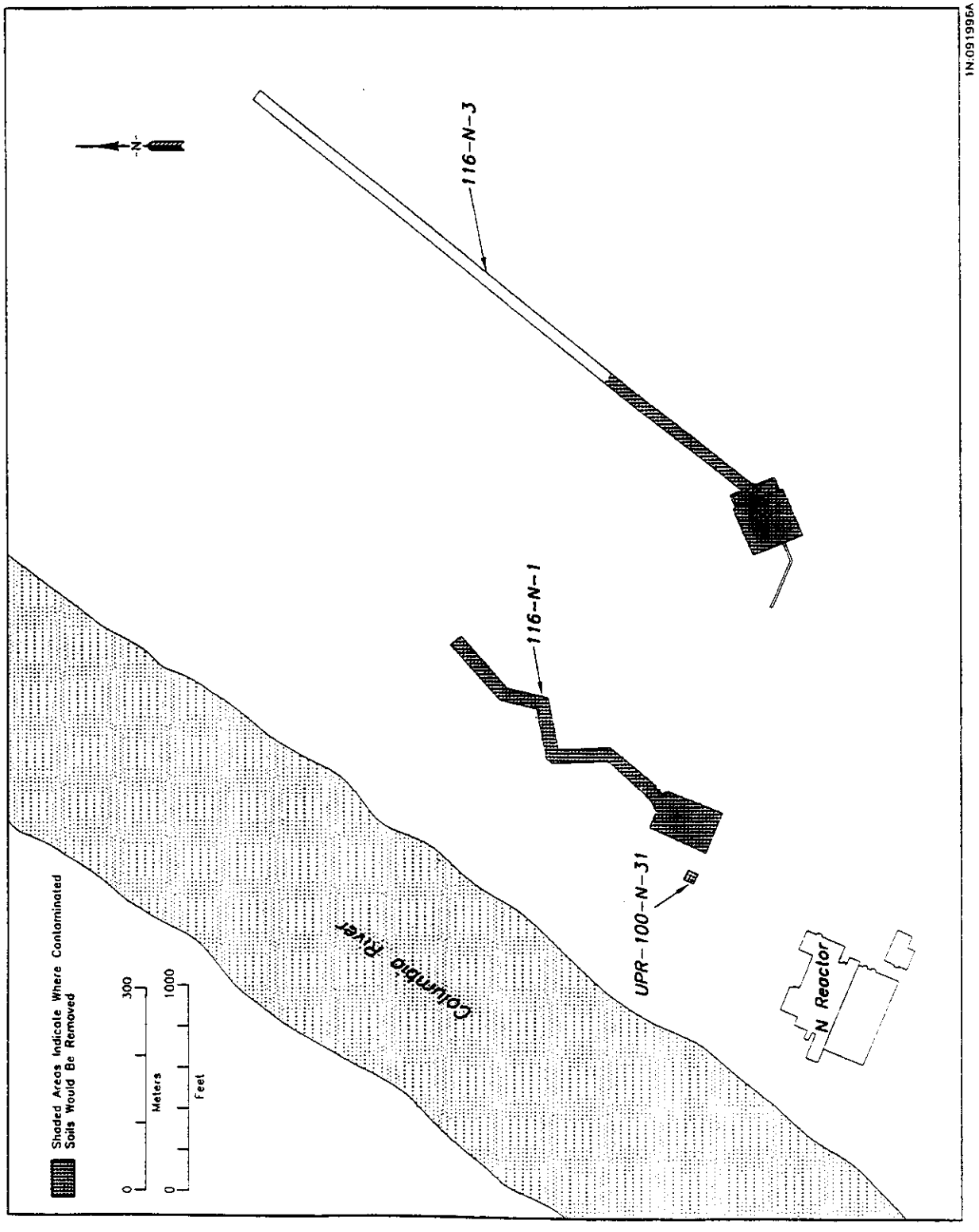


Figure 5-2. Remediation Areas for Alternatives RRES-7, RRES-8, MCRIS-7, and MCRIS-8.

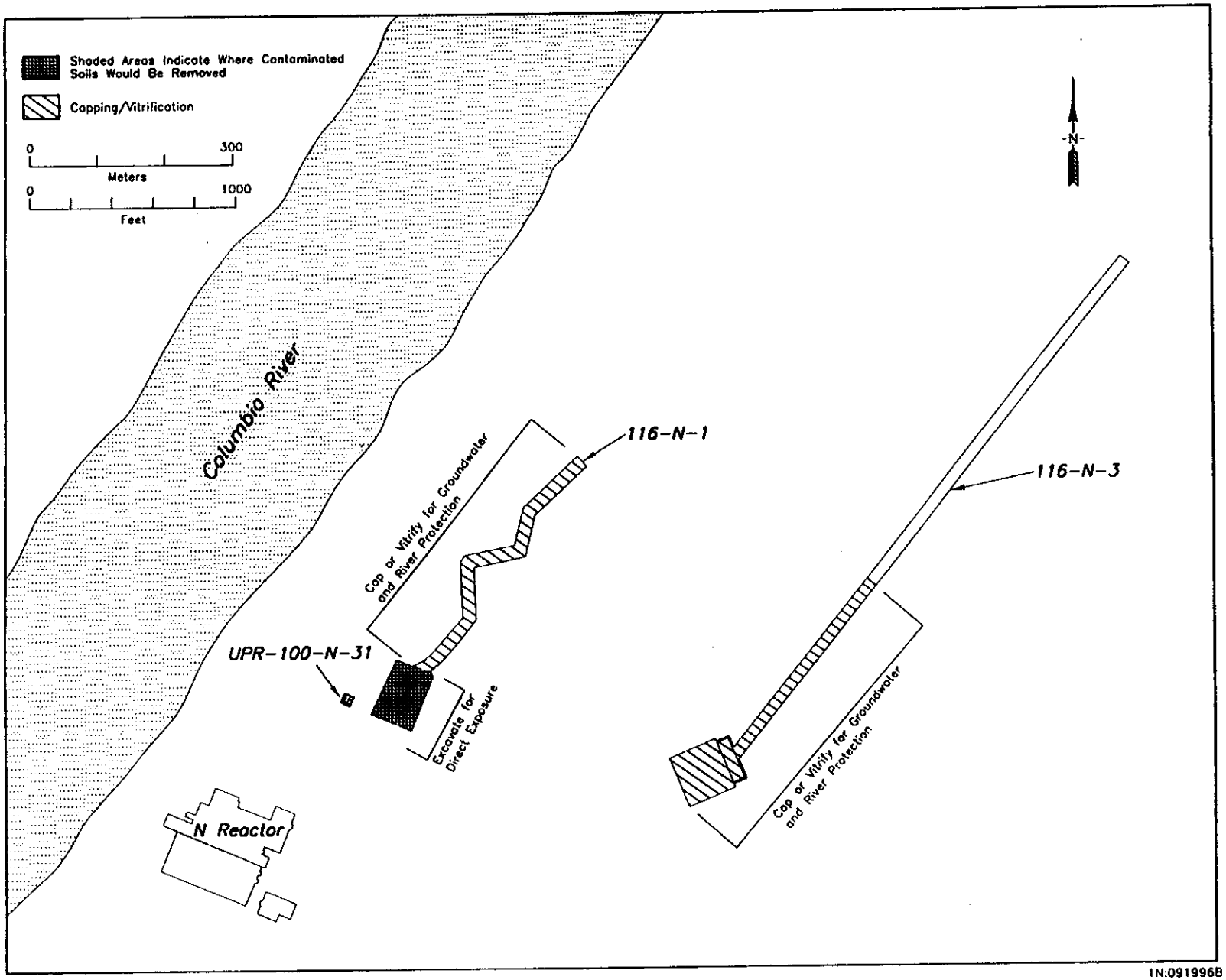


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Table 5-1. Implementability, Effectiveness, and Cost Screening of Process Options for Soil. (Page 1 of 2)

Soil General Response Actions	Remedial Technology	Process Option	Implementability	Effectiveness	Cost
Institutional Controls	Access Control	Signs, Fencing, Surveillance	Easy - Currently used in TSD units.	Limited. Provides a barrier but does not prevent access to restricted areas.	Low - Inexpensive materials, easy installation
	Land-Use Restrictions	Recreational, Residential, Industrial, or Agricultural designations	Easy - Visual monitoring required. Hanford Site is currently controlled by DOE, Richland Operations.	Limited - Effective in short term, uncertain in long term	Low - Minimal resources required
Containment	Capping	Modified RCRA Subtitle C Barrier (500 years)	Implementable. Provides long-term containment and hydrologic protection. Applicable for sites containing dangerous waste, Category 3 low-level waste or low-level mixed waste, and Category 1 low-level waste.	High - Effective over long term	Moderate - mostly natural materials
		Standard RCRA Subtitle C Barrier (30 years)	Implementable. Provides containment and hydrologic protection for a specified postclosure period. Applicable for sites containing dangerous waste.	Limited - Long-term performance is uncertain.	Moderate
		Modified RCRA Subtitle D Barrier (100 years)	Implementable. Provides limited biointrusion and limited hydrologic protection. Applicable at nonradiological and nondangerous solid waste sites, as well as Category 1 low-level waste sites where no dangerous waste constituents are present.	Limited - Long term performance is uncertain	Moderate
	Run-On/Run-Off Control	Diversion/Collection	Easy - Well-developed techniques	Moderate - Effectiveness depends on frequent maintenance	Moderate - Low capital, high O&M
		Grading	Easy - Widely used techniques.	Limited - Effective in preventing pooling; does not divert or prevent run-on/run-off	Low- Easy to implement, minimal resource requirements
		Revegetation	Easy - Commonly used for site reclamation.	Moderate - Effective in preventing erosion	Low - Once in place, no O&M required
In Situ Treatment	In Situ Treatment	Electrokinetic Separation	This in situ treatment is at demonstration stage of development.	May cause undesirable changes in soil chemistry	High - Not economically feasible

Table 5-1. Implementability, Effectiveness, and Cost Screening of Process Options for Soil. (Page 2 of 2)

Soil General Response Actions	Remedial Technology	Process Option	Implementability	Effectiveness	Cost
In Situ Treatment	In Situ Treatment	In Situ Biodegradation	Good application for organic contaminants. Not applicable to TSD sites, due to nature of contaminants.	Limited	Moderate
		In Situ Solidification (Injection/Mixing)	Implementable.	Limited by soil characteristics and treatment depth. Mixing may be less complete and it is difficult to verify that the in situ treated soils meet all waste form criteria.	Moderate
		In Situ Vitrification	Implementable.	Effective treatment of metals and radionuclides. Problems with off-gas.	High
Ex Situ Treatment	Ex Situ Treatment	Biological Treatment	Good application for organic contaminants. May not be applicable to TSD sites due to nature of contaminants.	Limited	Moderate
		Encapsulation	May not be applicable to TSD sites because it is intended for waste materials difficult to stabilize or extremely dangerous/and or reactive. That is not the case with TSD units.	Limited	High
		Soil Washing	Limited to soils with low contaminant concentrations.	Limited	High
		Solidification and Stabilization	Applicable to LDR wastes.	Limited	Moderate to high
		Thermal Desorption	Same as for In Situ Biodegradation.	Limited	Moderate
Remove, Treat, and Dispose	Removal Technologies	Excavation	A proven technology applicable at the TSD units.	High	Low - Inexpensive
		Debris Removal	A proven technology applicable to concrete structures and pipelines at the TSD units.	High	Moderate

Shaded options have been screened out and are not considered for further analysis.

DOE = U.S. Department of Energy
O&M = operations and maintenance
TSD = treatment, storage, and disposal
LDR = land disposal restriction
RCRA = Resource Conservation and Recovery Act of 1976

Table 5-2. Remedial Alternatives for Radioactive Sites.

Remedial Alternative	Land-Use Scenario	
	Rural-Residential (Alternative Number)	**MCRIS (Alternative Number)**
No-Action Alternative	RRES-1	MCRIS-1
Institutional Controls Alternative	RRES-2	MCRIS-2
Containment Alternative	RRES-3	MCRIS-3
In Situ Treatment Alternative	RRES-4	MCRIS-4
Remove/No Treatment/Dispose/Backfill Alternative	RRES-5	MCRIS-5
Removal Alternative (Remove/Dispose/Backfill)	RRES-6	MCRIS-6
Capping Alternative (Remove/Dispose/ Backfill/Cap)	RRES-7	MCRIS-7
Vitrification Alternative (Remove/Dispose/Vitrify/ Backfill)	RRES-8	MCRIS-8

MCRIS = Modified Columbia River Comprehensive Impact Assessment ranger/industrial scenario.

Table 5-3. Screening of Remedial Alternatives for Radioactive Sites.

Remedial Alternative	Exposure Scenario	
	Rural-Residential (Alternative Number)	MCRIS (Alternative Number)
No-Action Alternative	RRES-1	MCRIS-1
Institutional Controls Alternative	RRES-2	MCRIS-2
Containment Alternative	RRES-3	MCRIS-3
In Situ Treatment Alternative	RRES-4	MCRIS-4
Remove/No Treatment/Dispose/Backfill Alternative	RRES-5	MCRIS-5
Removal Alternative (Remove/Dispose/Backfill)	RRES-6	MCRIS-6
Capping Alternative (Remove/Dispose/Backfill/Cap)	RRES-7	MCRIS-7
Vitrification Alternative (Remove/Dispose/Vitrify/ Backfill)	RRES-8	MCRIS-8

Shaded alternatives have been eliminated from further analysis.
MCRIS = Modified Columbia River Comprehensive Impact Assessment ranger/industrial scenario

6.0 DETAILED ANALYSIS OF ALTERNATIVES

This section evaluates the expected performance of each alternative in terms of evaluation criteria defined in the NCP (40 CFR 300) and discussed in EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988). The evaluation methodology is described in Section 6.1. The CERCLA criteria are described in Section 6.2, and the detailed analyses of the remedial alternatives are presented in Section 6.3. Six remedial alternatives were developed in Section 5.3 to provide the appropriate variety of remedial actions for addressing the contaminants in the 116-N-1 and 116-N-3 Crib and Trench. Two of the four alternatives evaluated for the modified CRCIA ranger/industrial exposure scenario are the same as the two rural-residential exposure scenario alternatives.

6.1 EVALUATION METHODOLOGY AND CRITERIA

Each of the remedial alternatives will be evaluated using established criteria discussed below to determine the preferred remedy for each site addressed in this TSD CMS. Nine evaluation criteria have been developed to address the CERCLA requirements and considerations listed above and to address the additional technical and policy considerations that have proven to be important for selecting remedial alternatives (Table 6-1). These evaluation criteria serve as the basis for conducting the detailed analyses during the FS. Some of the criteria used in the detailed analysis of alternatives are similar to those used for technology screening (i.e., implementability, effectiveness, and cost). However, in the detailed analysis, the alternatives are evaluated against these criteria in more detail and more site-specific conditions are considered. These criteria are viewed with regard to the integrated remedial solution rather than to just a portion of the solution.

The evaluation criteria with the associated statutory considerations are discussed in the following sections. The first two criteria, overall protection of human health and environment and compliance with ARARs, are categorized as threshold criteria, and each alternative must meet these criteria TBC an acceptable remedial action. The following five CERCLA criteria represent primary balancing criteria upon which the analysis is based: long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost. The final two CERCLA criteria, state acceptance and community acceptance, are not discussed here and are not used in the detailed or comparative analyses; they will, however, be evaluated following public comment on this TSD CMS. To the extent possible in accordance with DOE policy, the alternatives are also evaluated against NEPA values.

6.1.1 Overall Protection of Human Health and Environment

This evaluation criterion assesses whether each alternative provides adequate protection of human health and the environment. The assessment draws on the evaluations conducted under

other criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Evaluation of the overall protectiveness of an alternative includes a description of how site risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering, or institutional controls. The evaluation also considers any unacceptable short-term or cross-media impacts.

6.1.2 Compliance With ARARs

This criterion evaluates whether each alternative will meet all of the corresponding federal and state ARARs (as defined in CERCLA Section 1.2.1). Compliance with chemical-specific ARARs (e.g., MCLs), location-specific ARARs (e.g., preservation of historic sites), and action-specific ARARs (e.g., RCRA minimum technology standards) is addressed for each alternative. These ARARs are presented in Appendix C.

6.1.3 Long-Term Effectiveness and Permanence

The evaluation of alternatives under this criterion addresses the results of a remedial action in terms of the risk remaining at the site after response objectives have been 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 wastes remaining at the site after RAOs have been met. The following components of the criterion for each alternative are addressed:

- Magnitude of residual risk: This factor assesses the residual risk remaining from untreated waste or treatment residuals at the conclusion of remedial activities, (e.g., after source/soil containment and/or treatment are complete, or after groundwater plume management activities are concluded).

- Adequacy and reliability of controls: This factor assesses the adequacy and suitability of controls, if any, that are used to manage treatment residuals or untreated wastes that remain at the site.

6.1.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

This evaluation 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. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, reduction of contaminant mobility, reduction of the total mass of toxic contaminants, and/or irreversible reduction of total volume of contaminated media. When evaluating this criterion, an assessment is made as to whether treatment is used to reduce principal threats, including the extent to which toxicity, mobility, or volume may be reduced either alone or in combination.

6.1.5 Short-Term Effectiveness

This evaluation criterion addresses the potential effects of short-term effectiveness on human health and the environment during the construction and implementation phase. The following factors are addressed as appropriate for each alternative:

- Protection of community during remedial actions: This factor addresses any risk that results from implementation of the proposed remedial action, such as dust from excavation, transportation of hazardous materials, or air-quality impacts from off-gas treatment that may affect human health.

- Protection of workers during remedial actions: This factor assesses threats that may be posed to workers, and the effectiveness and reliability of protective measures that may be taken.

- Environmental impacts: This factor addresses the potential adverse environmental impacts that may result from the construction and implementation of an alternative. It also evaluates the reliability of the available mitigation measures in preventing or reducing the potential impacts.

- Time until remedial response objectives are achieved: This factor includes an estimate of the time required to achieve protection for either the entire action or individual elements of the action targeted to specific site areas or threats.

6.1.6 Implementability

The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. This criterion also involves analysis of the following factors:

- Technical feasibility: Construction and operation, reliability of the technology, and ease of undertaking the remedial action

  Administrative feasibility: Activities needed to coordinate with other offices and agencies (e.g., obtaining permits for off-site activities or rights-of-way for construction)

- Availability of services and materials.

6.1.7 Costs

A comprehensive discussion of costing procedures for CERCLA sites is contained in the *Remedial Action Costing Procedures Manual* (EPA 1985). The capital and operations and management costs are presented for each alternative. Appendix E provides details for each cost estimate. All costs are total, present value 1998 costs and are based on the cost estimates

developed in the engineering study (BHI 1997). The Micro Computer Aided Cost Estimating System (MCACES)™ was used for estimating piping removal, capping, and in situ vitrification cost elements using the standard remediation models for these cost elements. These models are run on the MCACES™ software (Release 5.30A) developed by Building Systems Design, Inc. for the U.S. Army Corp of Engineers. These cost estimates are not intended to be inclusive, but do have an accuracy acceptable for feasibility studies of plus 50% and minus 30%. Because assumptions from one alternative to another are consistent, the estimates are appropriate for comparison purposes. However, actual costs to complete remedial action could vary significantly when the assumptions that are used in this report change. The most significant factors in determining costs for remediation are the radiological conditions at each site. This study made many assumptions regarding the radiological conditions, and these assumptions are generally conservative. Additional soil and sludge sampling is likely to show that the actual radiological conditions are much better than assumed and this could provide the basis for a reduction in the actual cost for remediation.

6.1.8 Integration of the National Environmental Policy Act of 1969

In accordance with DOE orders and NEPA policy, DOE CERCLA documents incorporate NEPA values such as analysis of cumulative, off-site, ecological, and socioeconomic impacts to the practical extent. Several of the CERCLA evaluation criteria discussed in the preceding section involve consideration of environmental resources, but the emphasis is frequently directed at the potential effects of chemical contaminants on living organisms. The NEPA regulations (40 CFR §1502.16) specify evaluation of the environmental consequences of the proposed alternatives. These include potential effects on transportation resources, air quality, cultural and historical resources, noise, visual and aesthetic effects, environmental justice, and the socioeconomic aspects of implementation. The NEPA process also involves consideration of several issues such as cumulative impacts (direct and indirect), mitigation of adversely impacted resources, and the irreversible and irretrievable commitment of resources. The NEPA-related resources and values are described in the following sections.

6.1.8.1 Transportation Impacts. Implementation of a remedial action may have short-term and/or long-term impacts on local traffic and the surrounding region. These may result from hauling wastes and clean fill, from supplying equipment and materials to the site, or from increases in the work-force traffic. Transportation is generally considered a component of short-term effectiveness or implementability.

6.1.8.2 Air Quality. Most air quality concerns raised by the alternatives are due to the potential for causing fugitive dust during implementation, the potential for releasing volatile gases, or the need for emission controls. Air quality is a consideration in the overall protection of human health and the environment and in the implementability of an alternative.

6.1.8.3 Natural, Cultural, and Historical Resources. Lands within and around the 100-N Area contain cultural resources that must be considered in planning and implementing remedial actions (DOE-RL 1996c). Sites in the vicinity of the 100-N Area include Native American

cultural resources such as rock cairns, housepits, and fishing camps. One of these sites has been determined eligible for listing on the National Register. *Mooli Mooli*, a named fishing site and traditional-use area is situated to the north and east of the 100-N Area. Natural resources include terrestrial, riparian, and aquatic resources, including groundwater. Each of the remedial alternatives is evaluated relative to its effect on natural, cultural, and historical resources, including the following:

- Environmental benefits to the waste site being remediated
- Importance of the resource(s) that may be impacted
- Ability to protect the resources and mitigate impacts
- Contaminants left in place at or near valued resources
- Effects on future use of the Columbia River and adjacent lands.

6.1.8.4 Noise, Visual, and Aesthetic Effects. Each alternative is evaluated relative to increasing noise levels or impairment of visual and aesthetic values. These values are generally considered in both the overall protection of human health and the environment, and in regard to short-term effectiveness and implementability (e.g., noise during implementation and its impact on wildlife, and visual and aesthetic values with respect to religious sites and traditional-use sites for Native Americans).

6.1.8.5 Socioeconomic Impacts. Socioeconomic impacts pertain to employment, income, other services (e.g., water and power utilities), and how the implementation of the remedial alternative affects the availability of services and materials. This is generally considered in the implementability of the alternative.

6.1.8.6 Environmental Justice. Environmental justice refers to fair treatment of all races, cultures, and income levels with respect to laws, policies, and government actions. The implementation of each remedial alternative is evaluated based on any inappropriately or disproportionately high and adverse human health or environmental effects to minority or low-income populations.

6.1.8.7 Cumulative Impact (Direct and Indirect). Implementing a remedial alternative may have cumulative impacts to natural, cultural, and/or historical resources. Construction and excavation activities at several contiguous sites could directly impact the resources. Indirect impacts could result from the prolonged duration of an alternative or as a result of interactions with projects outside the 100-N Area (e.g., restoration actions, future land-use decisions).

6.1.8.8 Mitigation. If adverse impacts cannot be avoided, remedial-action planning should minimize them to the practicable extent. Mitigation measures include stockpiling topsoil for reuse in other areas, minimizing the size of construction areas, transplanting native plant material before grubbing and clearing, and planning activities to avoid nesting and breeding cycles of birds and mammals. In some cases, mitigation may be difficult or not feasible. These are generally considered during the evaluation of overall protection of human health and the environment, long-term effectiveness and permanence, and short-term effectiveness.

6.1.8.9 Irreversible and Irretrievable Commitment of Resources. This criterion evaluates the use of nonrenewable resources and the effects the resource consumption would have on future generations. When a resource (e.g., energy, minerals, water, or wetland) is used or destroyed and cannot be replaced within a reasonable amount of time, its use is considered irreversible. Examples include gravel and soil for barriers; consumables such as fuel, electricity, and chemicals; the disturbance of a cultural site; and the extinction of a species. Because irreversible commitments cannot always be avoided, the evaluation examines the nature and amount of resources that would be irreversibly committed.

6.2 DETAILED ANALYSIS

In accordance with the CERCLA FS process (EPA 1988), each alternative retained after the screening step in Section 5.2 was evaluated in detail against established criteria. As concluded in Section 5.0, the following two alternatives (with an added descriptor to indicate the main component of the alternative) were retained for the rural-residential exposure scenario:

- No-Action Alternative (RRES-1)
- Removal Alternative (RRES-6).

In addition, the following four alternatives were retained for the modified CRCIA ranger/industrial exposure scenario:

- No-Action Alternative (MCRIS-1)
- Removal Alternative (MCRIS-6)
- Capping Alternative (MCRIS-7)
- Vitrification Alternative (MCRIS-8).

6.2.1 RRES-1 and MCRIS-1 Alternative Analysis

RRES-1 and MCRIS-1 are the No-Action Alternatives retained for the detailed analysis.

6.2.1.1 Overall Protection of Human Health and the Environment. Human health is not protected by the RRES-1 and MCRIS-1 Alternatives because contaminants would be left on site at concentrations exceeding the PRGs and access to the site and those contaminants would not be controlled. These contaminants include cesium-137, cobalt-60, europium-154, europium-155, plutonium-239/240, strontium-90, and possibly tritium, chromium, mercury, and nitrate (Table 4-15). Contaminants have the potential to migrate to groundwater and ultimately discharge to the Columbia River.

With no restrictions on the use of contaminated groundwater, additional human exposure could result through consumption and/or use of groundwater for irrigation. Furthermore, the pipelines, concrete structures, and miscellaneous debris would remain in place. Radionuclide contaminants

will decay, but concentrations of plutonium-239/240, which has a half-life of 24,100 years, would remain for thousands of years.

The RRES-1 and MCRIS-1 Alternatives could result in significant environmental impacts. Animals that currently have limited access to the units, due to fences and intrusion barriers, would have unrestricted access; thus, they would be exposed to the contaminants and could spread them further. Contaminated areas that currently have little or no vegetation would slowly revegetate themselves by natural processes. This would result in contaminant uptake in plant roots and, as the plants are blown by wind or consumed by animals, spread the contaminants further. Contamination spread would also result from wind erosion.

The RRES-1 and MCRIS-1 Alternatives would not have any direct physical impact on cultural or historical resources because no remedial actions or restoration activities would be undertaken, and the area would not be disturbed. Contaminants would remain at the waste units and could pose a risk to people who may enter the area to access traditional-use areas or cultural resources.

Depending on the contaminants present, the time required to achieve acceptable contaminant levels in soil with no action would be variable. Plutonium-239/240 would not decay to acceptable levels for thousands of years, and inorganic contaminants would never attenuate.

Although the RRES-1 and MCRIS-1 Alternatives are believed, at this time, not to be protective of human health and the environment for any of the units, it is possible that additional data acquired prior to remediation may determine that no action is appropriate for the UPR-100-N-31 spill site. This site was previously remediated and may now meet remedial goals; however, existing data are not sufficient to draw that conclusion.

6.2.1.2 Compliance with ARARs. Because no action would be taken, these alternatives would not meet ARARs for protection of human health and the environment. The potential for receiving waivers from any of these ARARs, especially chemical-specific ARARs, under the RRES-1 and MCRIS-1 Alternatives is considered to be very low.

6.2.1.3 Long-Term Effectiveness and Permanence. Both radioactive and nonradioactive contaminants at 116-N-1 and 116-N-3, and presumably UPR-100-N-31, would remain in surface and subsurface soils above levels protective of human health and the environment. The potential for contaminants to migrate to groundwater and the Columbia River would also remain.

There would be no access restrictions to the site with these alternatives; therefore, the risk for exposure to contaminants by the public, and for the spread of those contaminants, would be very high. Significant radiation doses could occur due to the high-activity levels that currently exist, and would continue to exist for some time, at 116-N-1 and 116-N-3. This is especially true for the long-lived radionuclides, such as plutonium-239/240, that are present at high concentrations in the near surface at both units. The alternative excludes placement of barriers at the site to control migration of, or exposure to, contaminants. It includes no commitment to maintain land-use controls or to conduct any type of operations and maintenance activities.

The concrete panels covering the 116-N-1 Trench and the 116-N-3 Crib and Trench also present a potential hazard to the public. The manholes, which provide access for workers, might be inviting to children as a place to play and hide. In addition, the potential safety risks resulting from deteriorating panels would only increase with time. As the panels deteriorate, the chances increase for someone to fall through and be trapped or crushed by falling panels and/or support beams. The pipelines would also remain in place and could be inadvertently uncovered by intrusion to the subsurface.

The long-term environmental effects would depend, to some extent, on natural plant invasion and plant succession processes that would eventually revegetate the area. Under the No-Action Alternative, there would be no active revegetation. The low precipitation in the area would result in very slow migration of contaminants to groundwater. However, in the case of inorganic contaminants or radionuclide contaminants with long half-lives, they would eventually reach groundwater, even though it may take thousands of years.

6.2.1.4 Reduction of Toxicity, Mobility, or Volume. Under the RRES-1 and MCRIS-1 Alternatives, there would be no opportunity for reduction of toxicity, mobility, or volume of the contaminants because no treatment or other action would be conducted. Radionuclides would naturally decay, thereby reducing toxicity of those contaminants over time, but it would be thousands of years before the long-lived radionuclides, such as plutonium-239/240, reach acceptable levels in surface soil. Likewise, no opportunity exists for recycling or reuse.

6.2.1.5 Short-Term Effectiveness. There would be no short-term risks associated with these alternatives because no remedial activities would be conducted. Consequently, there would be no potential for worker exposures despite the very high activity levels that currently exist.

6.2.1.6 Implementability. The RRES-1 and MCRIS-1 Alternatives are readily implementable from a technical standpoint. All administrative actions at the site, such as maintaining the fencing, keeping the gates locked, and controlling access, would cease. Implementation of No Action would be inconsistent with closure requirements (see Appendix A), DOE's long-range Hanford goals, and regulatory agency goals. These alternatives have been carried through this analysis only because it is required by the NCP.

6.2.1.7 NEPA Values. This alternative would irreversibly or irretrievably commit natural resources. The resources that would be considered committed, at least until contaminants naturally attenuate, include soils and vegetation at 116-N-1 and 116-N-3.

These alternatives would not have any transportation, air quality, noise, visual, cultural, historical, or aesthetic impacts on sites because no remedial activities would be conducted at sites. There would be no socioeconomic impacts associated with these alternatives, but because contaminants remain on site, significant exposure risks would exist for anyone using the area. This exposure potential would tend to limit the value and useability of the land. There may be a disproportionate impact on Native Americans who traditionally used this land, as they have expressed a strong desire to resume that use.

There would be no cumulative impacts as a result of implementing this alternative. However, indirect impacts could occur as a result of interactions with projects outside the unit boundaries. For example, deciding not to remediate or revegetate at these units could indirectly influence the benefits of remediating or revegetating other adjacent waste sites.

6.2.1.8 Cost. There would be essentially no cost associated with these alternatives, because no remedial action would be performed. Consequently, there were no cost model estimates performed for them.

6.2.2 RRES-6 Alternative Analysis

This section presents the detailed analyses for the Removal Alternative RRES-6. Under the rural-residential Removal Alternative (RRES-6), 73,600 bcm (96,300 bcy) of soil (contaminated and overburden), 1,765 m (5,790 ft) of pipelines, and 5,418 m^3 (191,358 ft^3) of demolition waste would be removed from the site. Treatment of excavated soils to meet ERDF waste acceptance criteria by stabilization/solidification may be required.

6.2.2.1 Overall Protection of Human Health and the Environment. This alternative would be protective of human health and the environment by removing contaminated soil with concentrations above PRGs to prevent direct exposures and to protect groundwater and the Columbia River, and disposing of the soil in an approved disposal facility. Excavation and removal of wastes from the units would eliminate any further migration of contaminants from the subsurface soil to groundwater. Excavated soils designated as "dangerous waste" would be treated, if required, to meet ERDF waste acceptance criteria before disposal. Long-term waste management activities would be needed only at ERDF, a facility designated to receive and manage wastes from most reactor and industrial areas of the Hanford Site.

Because treatment to meet ERDF waste acceptance criteria is not expected to be necessary, treatment costs have not been included. If significant volumes of soils requiring treatment are encountered during remediation, it may be prudent to re-evaluate the alternatives. Furthermore, to remove the high-concentration plutonium-239/240 and to protect groundwater possibly from chromium, tritium, and nitrate, an additional 1.5 m (5 ft) would be removed at the 116-N-1 Trench and the 116-N-3 Crib and Trench. The actual volume of soil to be addressed by remedial action (i.e., the areal extent and depth) would be evaluated with respect to the following balancing criteria: (1) protection of human health and the environment, (2) presence of ecological and cultural resources, (3) worker safety, (4) remediation costs, (5) decay of short-lived radionuclides, (6) sizing of ERDF, (7) the use of institutional controls, and (8) long-term monitoring costs. During remediation, if contamination is found either (1) below the assumed depth (3 m [10 ft] bsg) at the 116-N-1 Crib and UPR-100-N-31, or (2) below the assumed depth of 1.5 m (5 ft) into the soil at the 116-N-1 Trench, 116-N-3 Crib, and 116-N-3 Trench for plutonium-239/240 removal, a site-specific evaluation will be conducted to define the appropriate remediation. This evaluation may also be required if the soil removed does not meet ERDF waste acceptance criteria or if it is not beneficial or possible to treat the soil before

disposal. Options may include leaving some of the contamination in place, capping, or institutional controls.

At UPR-100-N-31, RAOs may already be met due to the previous remedial action (excavation) performed at the site. Confirmatory samples should be collected to verify the absence of contaminants in concentrations exceeding PRGs.

This alternative would benefit environmental resources because all wastes would be removed or treated, and revegetation and restoration activities will be an integral part of the alternative. Biological resources, in the long-term, would be returned to natural conditions, or conditions appropriate for unrestricted use. If treatment for ERDF waste acceptance criteria is included in the remedial response, the recovery of the area may take longer or involve more area, but the long-term benefits of this alternative should be the same, whether or not treatment is required.

Although the units have already been disturbed, excavation required by this alternative may potentially have a high impact on cultural or historical resources. Treatment operations, if required, and transportation of the wastes could impact cultural resources in adjacent areas, but these impacts can be avoided or mitigated. If cultural resources are encountered during excavation, cultural resource management plans would be followed, and state and federal agencies and Native Americans would be consulted.

The Removal Alternative RRES-6 would be overall protective of air and water quality in the area. Dust control measures would be used during remediation to control short-term dust and airborne radionuclide release problems. This alternative would benefit the environment overall and meet RCRA closure requirements by restoring surface topography to conditions consistent with the surrounding environment. This would be accomplished through backfilling, recontouring, and revegetation. Some physical and biological resources would be impacted by operations at the borrow pit from which clean backfill is taken.

The RRES-6 Alternative may require several years to attain RAOs. If the remedial action is limited to excavation and disposal, remedial goals at the site would be expected to be achieved faster than if treatment for ERDF waste acceptance criteria is involved. If treatment is included, additional time may be required depending on which treatment technology is selected, the lead time required to build a treatment facility, and the amount of material to be treated.

6.2.2.2 Compliance with ARARs. The RRES-6 Alternative would meet the chemical-specific, location-specific, and action-specific ARARs. This alternative would remove contaminants from the site that are a potential threat to direct surface exposure and to groundwater and the Columbia River and dispose of them in an approved disposal facility. Potentially large quantities of soil and demolition waste would be generated. Although it is expected that treatment to meet ERDF waste acceptance criteria would not be required, it is included as a contingency. The best available radionuclide control technology would be used at the site to control air emissions. Appendix C provides additional details about specific categories of ARARs and how they apply to each alternative.

6.2.2.3 Long-Term Effectiveness and Permanence. Contaminated soils above PRGs would be removed from 116-N-1, 116-N-3, and UPR-100-N-31 and placed in an approved disposal facility. Therefore, no residual contaminants above acceptable levels would be left on the site. Furthermore, structures, debris, and pipelines would also be removed and disposed of. This precludes the exposure of humans, plants, and animals to contaminants after remediation. If treatment is included in the alternative, treated wastes would be disposed similarly.

The long-term environmental effects of this alternative would be beneficial. Wastes would be removed, land use would be restored, and natural habitats could be restored. Although revegetation in a semi-arid environment takes time, this initial revegetation practice will eventually yield a stable plant community that can develop into a late-seral community. The progress and success of revegetation activities would be monitored.

Because wastes would be removed from the units by this remedial action, no long-term operation and maintenance would be required except at ERDF. Monitoring of the progress and success of revegetation activities may take some time, but long-term site monitoring would not be required.

Excavation and on-site treatment (if required) and transportation of wastes would disturb areas beyond the waste site boundaries, but this short-term impact would be offset by the long-term benefits. Importing clean fill and soil to the site would impact borrow areas.

6.2.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment. The toxicity, mobility, and volume of the soil are not anticipated to be reduced by treatment. However, if excavated soil is designated as dangerous waste (or could not meet ERDF waste acceptance criteria), it would be treated to meet ERDF waste acceptance criteria before disposal. In the case of treatment, the mobility of the contaminants would be reduced and the volume of the soil increased due to the addition of materials for stabilization and solidification. All treated soils would be disposed of at an approved disposal facility.

6.2.2.5 Short-Term Effectiveness. The short-term effectiveness of the Removal Alternative depends on controlling worker exposures to radiation and controlling the spread of contaminants disturbed by excavation. Worker exposures to radiation were estimated based on measured concentrations of radionuclides in the soils. Appendix C of the engineering study (BHI 1997) presents the assumptions and methodology used in developing the work exposures. Because of radioactive decay, the total person-rem exposure to workers depends on when remediation activities are started. For remediation beginning in July of 2000, the estimated total exposure received by workers would be 28.4 person-rem for 116-N-1 and 116-N-3 (26.1 person-rem for 116-N-1 and 2.3 person-rem for 116-N-3) under the rural-residential Removal Alternative RRES-6. Careful planning and implementation of remediation activities will keep worker exposure to a minimum. Special attention to ALARA principles would be required during remedial design, which includes time, distance, and shielding considerations.

If soil treatment were required to meet ERDF waste acceptance criteria, worker exposure to contaminants would increase due to increased material handling.

Other short-term worker risks associated with excavation and disposal activities would include potential industrial accidents and exposure to fugitive dust and radioactive particle releases. Accidents would be controlled through a comprehensive health and safety program, and fugitive dust would be controlled during remediation using conventional dust-suppression techniques. The best available radionuclide control technology would be used at the site to control air emission and minimize off-site releases.

A preliminary estimate of the potential off-site dose that would occur in the year 2000 was calculated. Using conservative assumptions concerning such things as the volume of particulates resuspended, the project duration, the meteorological conditions, and the time an individual would be exposed, the dose to the maximum exposed individual (MEI) was evaluated. The calculations show an MEI would be exposed to a potential dose rate of 0.99 mrem during the 10 months required for excavation of the 116-N-1 Crib and Trench, and 0.41 mrem during the 8 months required for excavation of the 116-N-3 Crib and Trench. The potential for off-site releases will be evaluated in more detail and mitigated in the remedial design phase before excavation.

Physical disturbance of the units during excavation, increased human activity and noise, and generation of fugitive dust would impact the local environment. Potential short-term environmental impacts would include clearing areas for the following: equipment staging, material handling, excavation, and treatment facilities. Increased site activities and noise could disrupt wildlife. These impacts could be significant if they occurred during critical breeding seasons or during the winter months when bald eagles, if any, should roost along the Columbia River at the 100 Area. However, short-term risks to biological resources would be mitigated by restricting construction activities to areas already disturbed or devoid of vegetation and by scheduling activities to avoid breeding seasons and the bald eagle winter roosting season.

Although extensive disturbance already exists within the units, there would be a high potential to impact cultural, historical, or traditional-use areas due to the need for extensive excavation of previously undisturbed areas adjacent to the units (e.g., lay-back of side walls for worker safety). Known cultural resources and traditional use areas would be avoided whenever possible. This may prove difficult because the units are surrounded by culturally sensitive formations, known as *Mooli Mooli* (little stacked hills). If cultural resources were encountered during excavation, the State Historic Preservation Office and Native American tribes would be consulted to assist in minimizing impacts and to ensure appropriate actions for documentation or recovery.

Transportation activities at the site would increase as a result of mobilizing and demobilizing equipment, hauling contaminated soils to disposal, and hauling clean backfill to the 100-N Area. Transportation impacts outside the Hanford Site would be low. Construction, waste excavation, and transportation activities would be expected to require several years.

6.2.2.6 Implementability. The field activities required to implement the excavation, transportation, and disposal elements of this alternative employ standard construction techniques that have little likelihood of failure. Current remedial actions at the 100-B/C Reactor involve successfully excavating, transporting, and disposing of radioactive wastes. However, consideration of the site-specific conditions during remedial design would be essential to ensure successful implementation.

The 116-N-1 Crib boulders would be removed as part of this alternative. The use of special remote equipment, or equipment with a large boom (for additional distance between the worker and the contamination), may be required because of the physical characteristics of the boulders, the levels of contamination, and the radionuclides that make up that contamination. The necessary equipment would be evaluated during the remedial design phase.

This alternative would require that the concrete panels on the 116-N-1 Trench and the 116-N-3 Crib and Trench would be removed, thus eliminating any future safety problems. However, before the panels could be removed, several issues would need to be addressed during the remedial design phase: Can the panels be cut along the joints and removed without breaking them? Would the panels have to be crushed for removal? How much of a dust problem would this create?

The potential for technical problems and operational delays is largely dependent on worker exposure issues. Adequate planning during remedial design would help reduce these delays.

The solidification and stabilization treatment option associated with this alternative to meet ERDF waste acceptance criteria would likely require bench-scale treatability tests to support design and would include testing the treated wastes before disposal. Although the technologies for solidification and stabilization may require additional design steps, they have been used successfully throughout the waste management industry.

Coordination with agencies and local governments would be required for all phases of the operation. This coordination would be required not only for the permitting phase, but during planning and implementation phases also.

6.2.2.7 NEPA Values. The Removal Alternative RRES-6 would have an irreversible or irretrievable commitment of natural resources. The natural resources that would be committed include the land area within ERDF required for disposal of the contaminated wastes, geologic resources for backfill, and petroleum products, such as diesel fuel and gasoline. Additionally, there would be a commitment of federal dollars to implement this alternative.

Remediation wastes would be transported to the disposal site by truck, thus increasing Hanford truck traffic. The traffic and excavation activities would increase exhaust emissions and could increase dust and airborne particulate levels. The mitigation of these factors would be addressed during the remedial design phase. During remediation there would also be noise from the construction equipment.

The remediation activity would be for a relatively short duration (estimated at about 2 years) and would not be expected to have any significant socioeconomic impact. This alternative does not involve commitment of significant resources, except space at ERDF for the soil, pipelines, and demolition wastes.

Once the remediation activity has been completed, the site would be restored to blend in with the surrounding areas. After restoration, the site would be accessible to all site users.

Cumulative impacts would potentially occur at borrow sites and along transportation routes used for purposes other than servicing the 100-N Area. Indirect impacts may occur as a result of interactions with projects outside the unit boundaries. This could include restoration actions, land-use decisions, and indirect effects to wildlife posed by the duration of the construction and implementation of this alternative.

6.2.2.8 Cost. Table 6-2 provides the cost for this alternative. Appendix E presents additional details regarding the cost estimates. The total cost for RRES-6 ($37.6 million) is low relative to the MCRIS-8 alternative, but high with respect to the other remedial alternatives. The alternative consists of basic, well-established construction activities using equipment that is readily available from a variety of sources. This cost assumed disposal of material to ERDF. If the material were disposed at the Hanford W025 trench, the cost could increase by as much as $127.9 million for a total cost of $154.3 million. The cost to dispose to W025 was estimated based on information provided by WHC in September 1996.

The addition of a treatment step would impact these costs. The extent of the impact would depend on factors such as the type of treatment, the amount of soils being treated, the cost of treatment (including capital), the percent volume reduction or increase achieved through treatment, and the amount and types of residual wastes resulting from treatment. At this time, treatment is not anticipated, so treatment costs have not been estimated.

As discussed in Section 6.1.7, the actual costs for remediation are expected to be less because of the conservative assumptions that were made regarding the radiological conditions at these units.

6.2.3 MCRIS-6 Alternative Analysis

This section presents the detailed analyses for the Removal Alternative MCRIS-6. Under the MCRIS Removal Alternative, the total excavated soil volume would be 65,500 bcm (85,700 bcy); in addition, 1,765 m (5,790 ft) of pipelines, and 5,418 m^3 (191,358 ft^3) of demolition waste would be removed from the site. Treatment of excavated soils for ERDF waste acceptance criteria by stabilization/solidification may be required.

6.2.3.1 Overall Protection of Human Health and the Environment. This alternative would be protective of human health and the environment by removing contaminated soil with concentrations above PRGs to prevent direct exposures and to protect groundwater and the Columbia River, and disposing of the soil in an approved disposal facility. Excavation and

removal of wastes from the units would eliminate any further migration of contaminants from the subsurface soil to groundwater. Excavated soils designated as "dangerous waste" would be treated, if required, to meet ERDF waste acceptance criteria before disposal. Long-term waste management activities would be needed only at ERDF, a facility designated to receive and manage wastes from most reactor and industrial areas of the Hanford Site.

Because treatment to meet ERDF waste acceptance criteria is not expected to be necessary, treatment costs have not been included. If significant volumes of soils requiring treatment are encountered during remediation, it may be prudent to reevaluate the alternatives.

For this alternative, it has been assumed that soil excavation would occur at depths below 3 m (10 ft) bsg. Furthermore, to remove the high-concentration plutonium-239/240 and to protect groundwater possibly from chromium, tritium, and nitrate, an additional 1.5 m (5 ft) would be removed at the 116-N-1 Trench and the 116-N-3 Crib and Trench. The actual volume of soil to be addressed by remedial action (i.e., the areal extent and depth) would be evaluated with respect to the following balancing criteria: (1) protection of human health and the environment, (2) presence of ecological and cultural resources, (3) worker safety, (4) remediation costs, (5) decay of short-lived radionuclides, (6) sizing of ERDF, (7) the use of institutional controls, and (8) long-term monitoring costs. During remediation, if contamination is found below the assumed depth at either (1) 3 m (10 ft) bsg at the 116-N-1 Crib and UPR-100-N-31 or (2) 1.5 m (5 ft) into the soil at the 116-N-1 Trench, 116-N-3 Crib, and 116-N-3 Trench for plutonium-239/240 removal, a site-specific evaluation will be conducted to define the appropriate remediation. This evaluation may also be required if the soil removed does not meet ERDF waste acceptance criteria or if it is not beneficial or possible to treat the soil prior to disposal. Options may include leaving some of the contamination in place, capping, or institutional controls.

At UPR-100-N-31, RAOs may already be met due to the previous remedial action (excavation) performed at the site. Confirmatory samples should be collected to verify the absence of contaminants in concentrations exceeding PRGs.

This alternative would benefit environmental resources because all wastes would be removed or treated, and revegetation and restoration activities will be an integral part of the alternative. Biological resources, in the long term, would be returned to natural conditions, or conditions appropriate for unrestricted use. If treatment for ERDF waste acceptance criteria is included in the remedial response, the recovery of the area may take longer or involve more area, but the long-term benefits of this alternative should be the same whether or not treatment is required.

Although the units have already been disturbed, excavation required by this alternative may potentially have a high impact on cultural or historical resources. Treatment operations, if required, and transportation of the wastes could impact cultural resources in adjacent areas, but these impacts can be avoided or mitigated. If cultural resources are encountered during excavation, cultural resource management plans would be followed, and state and federal agencies and Native Americans would be consulted.

The Removal Alternative MCRIS-6 would be overall protective of air and water quality in the area. Dust control measures would be used during remediation to control short-term dust and airborne radionuclide release problems. This alternative would benefit the environment overall and meet RCRA closure requirements by restoring surface topography to conditions consistent with the surrounding environment. This would be accomplished through backfilling, recontouring, and revegetation. Some physical and biological resources would be impacted by operations at the borrow pit from which clean backfill is taken.

The MCRIS-6 Alternative may require several years to attain RAOs. If the remedial action is limited to excavation and disposal, remedial goals at the site would be expected to be achieved faster than if treatment for ERDF waste acceptance criteria is involved. If treatment is included, additional time may be required, depending on which treatment technology is selected, the lead time required to build a treatment facility, and the amount of material to be treated.

6.2.3.2 Compliance with ARARs. The MCRIS-6 Alternative would meet the chemical-specific, location-specific, and action-specific ARARs. This alternative would remove contaminants from the site that are a potential threat to direct surface exposure and to groundwater and the Columbia River and would dispose of them in an approved disposal facility. Potentially large quantities of soil and demolition waste would be generated. Although it is expected that treatment to meet ERDF waste acceptance criteria would not be required, it is included as a contingency. The best available radionuclide control technology would be used at the site to control air emissions. Appendix C provides additional details about specific categories of ARARs and how they apply to the alternative.

6.2.3.3 Long-Term Effectiveness and Permanence. Contaminated soils above PRGs would be removed from 116-N-1, 116-N-3, and UPR-100-N-31 and placed in an approved disposal facility. Therefore, there would be no residual contaminants above acceptable levels left on site. Furthermore, structures, debris, and pipelines would also be removed and disposed of. This precludes the exposure of humans, plants, and animals to contaminants after remediation. If treatment is included in the alternative, treated wastes would be disposed similarly.

The long-term environmental effects of this alternative would be beneficial. Wastes would be removed, land use would be restored, and natural habitats could be restored. Revegetation in a semi-arid environment takes time, and the progress and success of revegetation activities would be monitored. Initial revegetation practices will eventually yield a stable plant community that can develop into a late-seral community.

Because wastes would be removed from the units by this remedial action, no long-term operation and maintenance would be required except at ERDF. Monitoring of the progress and success of revegetation activities may take some time, but long-term site monitoring would not be required.

Excavation, on-site treatment (if required), and transportation of wastes would disturb areas beyond the waste site boundaries, but this short-term impact would be offset by the long-term benefits. Importing clean fill and soil to the site would impact borrow areas.

6.2.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment. The toxicity, mobility, and volume of the soil are not anticipated to be reduced by treatment. However, if excavated soil is designated as dangerous waste (or could not meet ERDF disposal requirements), it would be treated to meet ERDF waste acceptance criteria before disposal. In the case of treatment, the mobility of the contaminants would be reduced and the volume of the soil increased due to the addition of materials for stabilization and solidification. All treated soils would be disposed of at an approved disposal facility.

6.2.3.5 Short-Term Effectiveness. The short-term effectiveness of MCRIS-6 depends on controlling worker exposures to radiation and controlling the spread of contaminants disturbed by excavation. Worker exposures to radiation were estimated based on measured concentrations of radionuclides in the soils. Appendix C of the engineering study (BHI 1997) presents the assumptions and methodology used in developing the work exposures. Because of radioactive decay, the total person-rem exposure for workers depends on when remediation activities are started. For remediation beginning in July of 2000, the estimated total exposure received by workers would be 28.4 person-rem for 116-N-1 and 116-N-3 (26.1 person-rem for 116-N-1 and 2.3 person-rem for 116-N-3) under the rural-residential Removal Alternative RRES-6. Careful planning and implementation of remediation activities will keep worker exposure to a minimum. Special attention to ALARA principles would be required during remedial design which includes time, distance, and shielding considerations.

Worker exposure for the MCRIS-6 Alternative was not calculated. However, exposure is expected to be slightly less than that for the RRES-6 Alternative because a smaller volume of contaminated soils would be removed and the overall duration of the project would be less. Special attention to ALARA principles during remedial design would be required to keep worker exposures to a minimum. These can include time, distance, and shielding. If soil treatment were required to meet ERDF waste acceptance criteria, worker exposure to contaminants would increase due to increased material handling.

Other short-term worker risks associated with excavation and disposal activities would include potential industrial accidents and exposure to fugitive dust and radioactive particle releases. Accidents would be controlled through a comprehensive health and safety program, and fugitive dust would be controlled during remediation using conventional dust-suppression techniques. The best available radionuclide control technology would be used at the site to control air emission and minimize off-site releases.

A preliminary estimate of the potential off-site dose that would occur in the year 2000 was calculated. Using conservative assumptions concerning such things as the volume of particulates resuspended, the project duration, the meteorological conditions, and the time an individual would be exposed, the dose to the MEI was evaluated. The calculations show an MEI would be exposed to a potential does rate of 0.90 mrem during the 5 months required for excavation of the 116-N-1 Crib and Trench and 0.41 during the 8 months required for excavation of the 116-N-3 Crib and Trench. The potential for off-site releases will be evaluated in more detail and mitigated in the remediation design phase before excavation.

Physical disturbance of the units during excavation, increased human activity and noise, and generation of fugitive dust would impact the local environment. Potential short-term environmental impacts would include clearing areas for the following: equipment staging, material handling, excavation, and treatment facilities. Increased site activities and noise could disrupt wildlife. These impacts could be significant if they occurred during critical breeding seasons or during the winter months when bald eagles, if any, should roost along the Columbia River at the 100 Area. However, short-term risks to biological resources would be mitigated by restricting construction activities to areas already disturbed or devoid of vegetation and by scheduling activities to avoid breeding seasons and the bald eagle winter roosting season.

Although extensive disturbance already exists within the units, there would be a high potential to impact cultural, historical, or traditional-use areas due to the need for extensive excavation of previously undisturbed areas adjacent to the units (e.g., lay-back of side walls for worker safety). Known cultural resources and traditional use areas would be avoided whenever possible. This may prove difficult since the units are surrounded by culturally sensitive formations, known as *Mooli Mooli* (little stacked hills). If cultural resources were encountered during excavation, the State Historic Preservation Office and Native American tribes would be consulted to assist in minimizing impacts and to ensure appropriate actions for documentation or recovery.

Transportation activities at the site would increase as a result of mobilizing and demobilizing equipment, hauling contaminated soils to disposal, and hauling clean backfill to the 100-N Area. Transportation impacts outside the Hanford Site would be low. Construction, waste excavation, and transportation activities would be expected to require several years.

6.2.3.6 Implementability. The field activities required to implement the excavation, transportation, and disposal elements of this alternative employ standard construction techniques that have little likelihood of failure. Current remedial actions at the 100-B/C Reactor involve successfully excavating, transporting, and disposing of radioactive wastes. However, consideration of the site-specific conditions during remedial design would be essential to ensure successful implementation (see Sections 2.4.1 and 2.4.3).

The 116-N-1 Crib boulders would be removed as part of this alternative. Because of the physical characteristics of the boulders, the levels of contamination, and the radionuclides that make up that contamination, the use of special remote equipment or equipment with a large boom (for additional distance between the worker and the contamination) may be required. The necessary equipment would be evaluated during the remedial design phase.

This alternative would require that the concrete panels on the 116-N-1 Trench and the 116-N-3 Crib and Trench would be removed, thus eliminating any future safety problems. However, before the panels could be removed, several issues would need to be addressed during the remedial design phase: Can the panels be cut along the joints and removed without breaking them? Would the panels have to be crushed for removal? How much of a dust problem would this create?

The potential for technical problems and operational delays is largely dependent on worker exposure issues. Adequate planning during remedial design would help reduce these delays.

The solidification and stabilization treatment option associated with this alternative for wastes that do not meet ERDF waste acceptance criteria would likely require bench-scale treatability tests to support design and would include testing the treated wastes before disposal. Although the technologies for solidification and stabilization may require additional design steps, they have been used successfully throughout the waste management industry.

Coordination with agencies and local governments would be required for all phases of the operation. This coordination would be required not only for the permitting phase, but during planning and implementation phases also.

6.2.3.7 NEPA Values. The Removal Alternative MCRIS-6 would have an irreversible or irretrievable commitment of natural resources. The natural resources that would be committed include the land area within ERDF required for disposal of the contaminated wastes, geologic resources for backfill, and petroleum products, such as diesel fuel and gasoline. Additionally, there would be a commitment of federal dollars to implement this alternative.

Remediation wastes would be transported to the disposal site by truck, thus increasing Hanford truck traffic. The traffic and excavation activities would increase exhaust emissions and could increase dust and airborne particulate levels. The mitigation of these factors would be addressed during the remedial design phase. During remediation there would also be noise from the construction equipment.

The remediation activity would be for a relatively short duration (estimated at about 2 years) and would not be expected to have any significant socioeconomic impact. This alternative does not involve commitment of significant resources, except space at ERDF for the soil, pipelines, and demolition wastes.

Once the remediation activity has been completed, the site would be restored to blend in with the surrounding areas. After restoration, the site would be accessible to all site users.

Cumulative impacts would potentially occur at borrow sites and along transportation routes used for purposes other than servicing the 100-N Area. Indirect impacts may occur as a result of interactions with projects outside the unit boundaries. This could include restoration actions, land-use decisions, and indirect effects on wildlife posed by the duration of the construction and implementation of this alternative.

6.2.3.8 Cost. Table 6-2 provides the cost for this alternative. Appendix E presents additional details regarding the cost estimates. The total cost for MCRIS-6 ($35.9 million) is low relative to the other remedial alternatives, excluding the RRES-1 and MCRIS-1 (No Action) Alternatives. This alternative consists of basic, well-established construction activities using equipment that is readily available from a variety of sources. This cost assumed disposal of

material to ERDF. If the material was disposed at the Hanford W025 trench, the cost would increase by $87.1 million, for a total cost of $103.5 million. The cost to dispose to W025 was estimated based on information provided by WHC in September 1996. Their assumptions include a cost of about $825 per cubic meter ($631 per cubic yard) for the 116-N-1 Crib soil, and about $92 per cubic meter ($70 per cubic yard) for the rest of the material. The crib soil would have to be stabilized and packaged in 208-L (55-gal) drums prior to disposal. Furthermore, a new facility would have to be built for every 21,420 cubic meters (28,000 cubic yards) of material. For this MCRIS-6 alternative, more than 95,625 cubic meters (125,000 cubic yards) of soil alone would be disposed, which does not account for swelling from excavation, stabilization of crib soil, pipelines, and demolition debris.

The addition of a treatment step would impact these costs. The extent of the impact would depend on factors such as the type of treatment, the amount of soils being treated, the cost of treatment (including capital), the percent volume reduction or increase achieved through treatment, and the amount and types of residual wastes resulting from treatment. At this time, treatment is not anticipated; therefore, treatment costs have not been estimated.

As discussed in Section 6.1.7, the actual costs for remediation are expected to be less because of the conservative assumptions that were made regarding the radiological conditions at these units.

6.2.4 MCRIS-7 Alternative Analysis

This section presents the detailed analysis for the Capping Alternative (MCRIS-7). Under this alternative, 12,800 bcm (16,800 bcy) of soil (contaminated and uncontaminated), 1,765 m (5,790 ft) of pipelines, and 5,418 m^3 (191,358 ft^3) of demolition waste would be removed from the site. The area to be capped for dangerous waste constituents would be 34,131 m^2 (367,200 ft^2). Treatment of excavated soils for LDR by stabilization/solidification may be required. The results of the evaluation of the Removal Alternatives (RRES-6 and MCRIS-6) would be the same for the excavation component of the Capping Alternative (MCRIS-7). Additional factors or exceptions for this alternative are described under each of the criteria listed below.

6.2.4.1 Overall Protection of Human Health and the Environment. Once implemented, this alternative would meet RAOs and would, therefore, be protective of human health and the environment. First, soil in the top 3 m (10 ft) bsg would be removed from the 116-N-1 Crib and UPR-100-N-31 to prevent direct exposures to radionuclides (especially the high-concentration cobalt-60, cesium-137, strontium-90, and long-lived plutonium-239/240) and possibly nitrate and mercury. Additionally, structures, pipelines, and debris would be removed.

To protect groundwater and the Columbia River from radionuclides and inorganics, plus prevent inadvertent direct exposure to plutonium-239/240 at the base of the facilities, a cap would be placed over the 116-N-1 Trench, 116-N-3 Crib, and 116-N-3 Trench. Capping would eliminate potential risks to groundwater associated with the contaminants remaining in place as long as the integrity of the cap was maintained. It is assumed that removal of soil at the 116-N-1 Crib would

also remove the soil that may be a threat to groundwater and the river, and that a cap is not required.

However, if it were determined that a cap is required at the 116-N-1 Crib (and UPR-100-N-31) to protect groundwater or the Columbia River, or if it were cost prohibitive and not effective or implementable to excavate in these areas, a cap could be placed at these sites. Conditions that could occur that would indicate excavation would be cost prohibitive or not implementable or effective include, but are not limited to, the unlikely event that the soil could not meet ERDF waste acceptance criteria (e.g., soil was classified as transuranic waste). If a cap were required, it would also be protective of human health and the environment, although to a lesser extent than excavation, which removes the soil from the site. Restrictions to reduce and possibly prevent intrusion into and access onto the cap would likely be required to maintain cap integrity until RAOs are achieved (thousands of years). At the 116-N-1 Crib, the maintenance of the cap (if required) without prior excavation becomes a crucial issue because of the high-concentration and long-lived plutonium-239/240 that is present at the surface. Again, based on the information collected to date, this situation is unlikely. At UPR-100-N-31, RAOs may already be met due to the previous remedial action (excavation) performed at the site.

Although excavation, pipeline removal, and capping are all proven and well-developed technologies, some uncertainties exist concerning the long-term durability and effectiveness of the cap. There would be residual risks associated with contaminants left in place if the cap were to fail. There is the potential for considerable worker exposures, especially during the 116-N-1 Crib and concrete panel removal. Remote material placement techniques may assist in reducing exposures when installing the cap.

6.2.4.2 Compliance with ARARs. This Capping Alternative would meet the potential chemical-specific, location-specific, and action-specific ARARs. The alternative would remove contaminants from the 116-N-1 Crib and UPR-100-N-31 and dispose of them in an approved disposal facility. This will prevent direct surface exposure to soil concentrations exceeding PRGs. Although it is expected that treatment to meet LDRs would not be required, it is included as a contingency. Additionally, structures, pipelines, and debris would be removed. Furthermore, it would provide an approved barrier over the 116-N-1 Trench and the 116-N-3 Crib and Trench to reduce the amount of water infiltration and immobilize contaminants that are a potential threat to groundwater. After excavation of the 116-N-1 Crib, it may be necessary to place a cap over the crib if concentrations left in soil exceed groundwater and river protection PRGs. At this time, it is assumed that this additional capping is not required. Because excavation would occur only at the 116-N-1 Crib and some contaminants would remain in the soil, the potential exists that at the end of the life of the cap, those contaminants could still be in concentrations exceeding ARARs. These contaminants include mainly metals and long-lived radionuclides. The cap should be replaced until RAOs are achieved. Appendix C provides additional details about specific categories of ARARs and how they apply to this alternative.

6.2.4.3 Long-Term Effectiveness and Permanence. For the 116-N-1 Crib, where contaminants would be removed, the long-term effectiveness would be the same as the Removal Alternative (MCRIS-6). However, long-term effectiveness would be different for the areas that

would be capped. Caps are proven and reliable for short periods to prevent direct exposure and significantly reduce water infiltration, but data on long-term caps (thousands of years) are insufficient for a thorough evaluation. There would be residual risks associated with the use of a cap, and the risks become more significant as the cap approaches its design life.

If it were determined that a cap were required on the 116-N-1 Crib, the uncertainty of the long-term effectiveness of a cap to prevent direct exposure to plutonium-239/240 (and metals that do not attenuate) is a key concern. However, these long-term concerns may be outweighed by the risk to workers, implementability, and cost of excavation. It is assumed that this issue would arise during remedial action using the observational approach unless significant soil characterization were performed prior to remedial action, which is unlikely due to the cost, timing, and high radiation exposures that would be incurred.

The residual risks left in place after capping are associated with the contaminants, such as metals, that will not appreciably degrade. Fortunately, cobalt-60, cesium-137, and strontium-90 (the key radionuclide COCs) do not migrate appreciably in soil and would decay before reaching groundwater (DOE-RL 1996b); therefore, they would not present a residual risk. Additionally, plutonium-239/240 would not reach groundwater for thousands of years, if at all (modeling past 1,000 years is uncertain). Groundwater monitoring would be required to assess the cap's effectiveness at preventing mobilization of contaminants. It would be necessary to restrict subsurface intrusion at the cap to prevent premature erosion and extend the cap's life.

The cap and surrounding area would be revegetated. Plant and animal controls may be required as a part of the design to inhibit deep-rooting plants and burrowing animals and to protect the cap's integrity.

6.2.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment. Capping would reduce the mobility of the contaminants by placing an engineered barrier over the waste, but not by treatment. If the soil excavated from the 116-N-1 Crib requires treatment for LDR, there would be a reduction in mobility of the constituents to be treated. Due to the addition of other constituents, treatment may increase the waste volume requiring disposal. This treatment would not reduce the toxicity of the contaminants.

6.2.4.5 Short-Term Effectiveness. As with the Removal Alternatives, the Capping Alternative (MCRIS-7) could pose considerable potential for worker exposure. Because the volume of contaminated soils removed would be less, the potential for exposure should be considerably less. This exposure could still be significant and must be addressed during remedial design. The highest concentrations of radionuclides are expected on the crib boulders; remote handling techniques would decrease the potential for high exposures.

Potential construction accidents and inadvertent exposures to contaminants are also a concern. Removal of soils containing radioactive material is currently being conducted at the 100-B/C Reactor area, and worker safety is being properly controlled through the application of stringent health and safety procedures and through engineering controls. There is potential for release of

fugitive dust and contaminants during crib excavation and material handling. Controls to minimize these releases would be addressed during the remedial design phase.

A preliminary estimate of the potential off-site dose that would occur in the year 2000 from this alternative was calculated. Using conservative assumptions concerning such things as the volume of particulates resuspended, the project duration, the meteorological conditions, and the the time an individual would be exposed, the dose to the MEI was evaluated. The calculations show an MEI would receive a dose of -10.90 mrem during the 5 months required for excavation under the MCRIS-7 Alternative. This is above the established threshold value of 1×10^{-1} mrem/yr (40 CFR 61). The potential for off-site releases can be evaluated in more detail and mitigated in the remedial design phase before excavation.

Removing the concrete panels from the 116-N-1 Trench and the 116-N-3 Crib and Trench to allow for cap placement may also contribute some short-term risks to workers. The underside of the panels are likely contaminated with removable and fixed radioactive contamination. It is not known whether the panels could be removed intact (due to the presence of rebar) or whether they would have to be broken, thus creating an air emission concern. Once the site is backfilled and the cap placed over the site, the cap would provide shielding from radioactive contaminants that remain in place.

Short-term risks to biological resources would be similar to those already discussed for the Removal Alternatives. These risks can be mitigated by restricting construction activities, such as staging areas, to areas already disturbed or devoid of vegetation. The risks can also be mitigated by scheduling activities to avoid breeding seasons and the bald eagle winter roosting season. The area surrounding 116-N-1 and 116-N-3 has already been heavily disturbed. There is some potential to disturb cultural resources during the 116-N-1 Crib and UPR-100-N-31 excavation. If cultural resources are encountered, the State Historic Preservation Office and Native American tribes would be consulted to assist in minimizing impacts and to take appropriate actions for documentation or recovery.

Transportation activities at 116-N-1 and 116-N-3 would increase as a result of bringing construction equipment to the site, taking contaminated soils to ERDF, and bringing clean fill and cap materials on site.

6.2.4.6 Implementability. As discussed in the Removal Alternatives, RRES-6 and MCRIS-6, excavation can be implemented for soils at the 116-N-1 Crib and UPR-100-N-31, for pipelines, and for debris.

However, if excavation were determined to be cost prohibitive and not implementable because the soil cannot be disposed in ERDF (i.e., transuranic levels are detected), a cap could be placed over these areas.

Cap construction technology is well developed, and implementation of this alternative should not be complicated. Capping technologies have been thoroughly tested, and the risk of failure for the

alternative or one of its components is low. However, consideration of the site-specific conditions during remedial design is essential to ensure successful implementation. As discussed earlier, problems associated with removal of the boulders and the concrete panels must be addressed during remedial design. Once the boulders and panels have been removed, any potential future problems will be eliminated. Uncertainty exists regarding the duration for which a cap is required. Metals do not degrade with time and would, therefore, remain in soil at concentrations exceeding PRGs. Additionally, the plutonium-239/240 present in surface and subsurface soil will remain in high concentrations for thousands of years. Fortunately, plutonium-239/240 is not very mobile in the environment. The cap is designed to meet performance requirements for 500 years. Downgradient monitoring should detect any failures of the cap that result in an increase in groundwater concentrations. When the cap fails, replacement or repairs would be required for adequate protection to human health and the environment to continue.

6.2.4.7 NEPA Values. The NEPA values associated with the Capping Alternative are very similar to those for the Removal Alternatives. The Capping Alternative would have an irreversible and irretrievable commitment of natural resources in the form of land use loss, until such time that contaminants decay to acceptable levels. The natural resources that would be committed include the land area within ERDF required for disposal of the contaminated wastes and geological resources for backfill and cap material.

There would be an increase in the traffic flow in the area during the construction period. There would likely be a small increase in off-site traffic as a result of bringing in capping materials and an irreversible commitment of resources in terms of the borrow pits that would supply materials for the cap.

Design requirements for the cap would determine the appearance of the topography at the completion of remediation. It is anticipated that the cap would be visible and distinguishable, but it would not detract from the natural surrounding areas. The exception would be if a cap were placed over the 116-N-1 Crib and UPR-100-N-31 without prior excavation. The cap would be more than 5 m (14.6 ft) above the surrounding topography. Because cultural resources may exist at the units, Native Americans may perceive this as a disproportionate impact because of the land-use limits on the cap and the removal of cap materials. Most cap construction materials are available on site and are expected to be easily accessible and in sufficient quantities, so supplies would not be affected.

6.2.4.8 Cost. Table 6-2 provides costs for this alternative. Appendix E presents additional details regarding the cost estimates. The total cost for MCRIS-7 is approximately $22.1 million. This includes excavating soil, removing pipelines and debris, and capping the units. Cap construction costs are offset by minimal waste disposal costs due to the small quantity of contaminated soils that are actually removed from the site. The alternative consists of basic, well-established construction activities that uses equipment readily available from a variety of sources. This cost assumed disposal of material to ERDF. If the material were disposed at the Hanford W025 trench, the cost could increase by as much as $61.4 million for a total cost of

$79.6 million. The cost to dispose to W025 was estimated based on information provided by WHC in September 1996.

The addition of a treatment step for LDR soils would impact these costs. The extent of the impact would depend on factors such as the type of treatment, the amount of soils being treated, the cost of treatment (including capital), the percent volume reduction or increase achieved through treatment, and the amount and types of residual wastes resulting from treatment. Because treatment is not anticipated to be required, treatment costs were not estimated.

As discussed in Section 6.1.7, the actual costs for remediation are expected to be less because of the conservative assumptions that were made regarding ~~T~~the radiological conditions at these units.

6.2.5 MCRIS-8 Alternative Analysis

This section presents detailed analysis for the Vitrification Alternative (MCRIS-8). This alternative would remove 12,800 bcm (16,800 bcy) of soil (contaminated and uncontaminated) from the 116-N-1 Crib and UPR-100-N-31 to prevent direct exposure; remove 1,765 m (5,790 ft) of pipelines; remove 34,131 m^3 (191,358 ft^3) of demolition waste; and vitrify soil at the 116-N-1 Trench and 116-N-3 Crib and Trench over an area of 12,046 m^2 (129,600 ft^2) to a depth of 5.8 m (19 ft) to protect groundwater and the Columbia River. The results of the CERCLA criteria for Removal Alternatives (RRES-6 and MCRIS-6), described in Section 6.3.3, are the same for this alternative. Components of this Vitrification Alternative are described under each of the criteria listed below.

6.2.5.1 Overall Protection of Human Health and the Environment. The MCRIS-8 Alternative is protective of human health and the environment through the use of excavation to prevent direct exposure to contaminants. This alternative also uses treatment by vitrification to remediate contaminants in the subsurface soil that are a potential threat to groundwater and the Columbia River. Vitrification, which is more permanent than a cap, is used to restrict contaminant mobility. There would be a significant reduction in contaminant mobility (nearly 100%) and a reduction in volume (20% to 40%).

The site conditions are conducive to vitrification. Some uncertainty exists with ensuring that contaminated sand lenses are vitrified. Sand lenses that are not vitrified would continue to pose a risk to human health and the environment. Additionally, there is potential for considerable exposures to workers installing the equipment over the contaminated area and for potential off-gas problems and possibly off-site releases from volatile metals and radionuclides such as mercury and cesium. Treatability and possibly pilot-scale tests may need to be conducted. At UPR-100-N-31, RAOs may already be met due to the previous remedial action (excavation) performed at the site.

Once the soil was vitrified, clean fill would be placed over the glass and the sites, and access to the surface would be unrestricted. Some restrictions would be necessary to prevent intrusion into the vitrified contaminants.

Although it has been assumed that excavation at the 116-N-1 Crib and possibly at UPR-100-N-31 is required, situations arising during remedial action could indicate that excavation would no longer be feasible. Although this situation is unlikely, based on the information known to date, if it did occur vitrification could be implemented at these locations as well. The alternative would still be protective of human health and the environment, but to a lesser extent than if excavation had occurred.

6.2.5.2 Compliance with ARARs. This alternative is similar to the others. It would comply with all ARARs by removing contamination from the site to eliminate direct surface exposure and by treating the subsurface soil that is a potential threat to groundwater and the Columbia River. Although it is expected that treatment to meet LDRs would not be required, it is included as a contingency. There is a possibility that not all contaminated soil would be vitrified due to lateral distribution of contaminants that may go undetected, but the potential for this to occur is considered to be low. A discussion of how this alternative is anticipated to comply with ARARs is presented in Appendix C.

6.2.5.3 Long-Term Effectiveness and Permanence. The long-term effectiveness for removal of the boulders in the 116-N-1 Crib is identical for this alternative as for the others.

This site has positive attributes for vitrification that support long-term effectiveness: low moisture soils, relatively deep aquifer, spacious and flat areas for equipment, absence of underground structures and utilities, and no organic contaminants present in the soil. Vitrification provides long-term reliability in immobilizing contaminants. The technology has the ability to treat a variety of wastes, including all those present at these units, namely metals and radionuclides that are retained in the melt.

The life expectancy of vitrified soils exceeds thousands of years, up to some estimates of a million years. However, the time required to vitrify the soils at the sites could take several years at a high cost. The maximum width at which the electrodes could be placed is about 10.6 m (35 ft). This would require more than 240 electrode placements at the 116-N-1 Trench and the 116-N-1 Crib and Trench. Usually four electrodes at a time are used to vitrify the soil. Therefore, it would take more than 200 runs, each taking 7 to 10 days, to vitrify the area. This time does not include mobilization and demobilization. There is a potential that not all contaminants would be vitrified, especially those associated with sand lenses (that are located outside of the vitrification area) or those below the bottom of the melt zone. Long-term maintenance checks, groundwater monitoring, and land-use restrictions regarding subsurface intrusion would be required.

6.2.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment. There is a significant reduction in the mobility and volume of contaminated soil through treatment. If the soil excavated from the 116-N-1 Crib and UPR-100-N-31 required treatment for LDR, there

would be an additional reduction in mobility. Due to the addition of other constituents (for stabilization/solidification), treatment would increase the waste volume requiring disposal. This treatment would not reduce the toxicity of the contaminants.

The vitrification process treats the contaminants to a depth of approximately 5.8 m (19 ft). The treatment would reduce the mobility of contaminants by vitrifying the soil and contaminants into a glass. The volume and mass may be reduced significantly (20% to 40%) by evaporation of moisture and consolidation of the soil into a dense glass. There would be no reduction in toxicity. Off-gas vapors would be treated during vitrification. These off-gas vapors could include volatile metals (lead, mercury, and cadmium) and radionuclides. The vitrification treatment is irreversible as the contaminants and soil become a monolith of glass.

6.2.5.5 Short-Term Effectiveness. Similar to the Removal Alternatives, there is the potential for considerable worker exposure associated with this alternative. Because the volume of contaminated soils removed would be less, the exposure associated with the removal of the soils should be considerably less. This exposure could still be significant and must be addressed during remedial design. The highest concentrations of radionuclides are expected on the crib boulders; remote handling techniques would decrease the potential for high exposures.

However, unlike the Capping Alternative, the vitrification process may require workers to be positioned closer to contaminated soils that remain in place, thus increasing worker exposure. Additionally, the off-gas may contain radon, cesium, and other volatile radionuclides that may represent an exposure concern to workers at high concentrations. Furthermore, mercury, lead, and other volatile inorganics create an exposure and treatment concern. Tests would likely be required to evaluate the volatility, treatment, and exposure concerns from the contaminants and off-gas.

Contingency plans for unexpected conditions in the off-gas would be developed before implementation. The overall potential for worker exposure would still be significant and would be addressed during remedial design. Remote techniques have been used at other sites to place most of the treatment equipment over the contaminated soil, which would aid in keeping exposures ALARA.

Potential construction accidents and inadvertent exposures to contaminants are also a concern. A stringent health and safety program will help to mitigate these concerns. There is also a potential for release of fugitive dust and contaminants during crib excavation and material handling. Controls to minimize these releases would be addressed during the remedial design phase.

A preliminary estimate of the potential off-site dose that would occur in the year 2000 from this alternative was calculated. Using conservative assumptions concerning such things as the volume of particulates resuspended, the project duration, the meteorological conditions, and the the time an individual would be exposed, the dose to the MEI was evaluated. The calculations show an MEI would receive a dose of 0.90 mrem during the 5 months required for excavation under the MCRIS-8 Alternative. This is above the established threshold value of 1×10^{-1}

mrem/yr (40 CFR 61). The potential for off-site releases can be evaluated in more detail and mitigated in the remedial design phase before excavation.

Removing concrete panels from the 116-N-1 Trench and the 116-N-3 Crib and Trench to allow for vitrification also contributes some short-term risks to workers. The undersides of the panels are likely contaminated with removable and fixed radioactive contamination. It is not known whether the panels could be removed intact (due to the presence of rebar) or whether they would have to be broken, thus creating an air emission concern. Once the panels are removed from the site, backfill may have to be placed over the vitrification area to shield workers and provide a level working surface.

Short-term risks to biological resources would be similar to those already discussed for the Removal Alternatives. These risks can be mitigated by restricting construction activities, such as staging areas, to areas already disturbed or devoid of vegetation. The area surrounding 116-N-1 and 116-N-3 is heavily disturbed. There is some potential to disturb cultural resources during excavation. If cultural resources were to be encountered during the 116-N-1 Crib and UPR-100-N-31 excavation, the State Historic Preservation Office and Native American tribes would be consulted to assist in minimizing impacts and to take appropriate actions for documentation or recovery. There may be tribal issues regarding the use of an in situ remediation technology in proximity to a traditional-use site, such as the one surrounding the units.

Transportation activities at 116-N-1 and 116-N-3 would increase as a result of bringing construction equipment to the site, taking contaminated soils to ERDF, and bringing clean fill on site.

6.2.5.6 Implementability. Implementation of this alternative would be the most difficult of all the alternatives due to the concerns presented above. Treatability and pilot-scale tests may be required to confirm soil composition for soil and off-gas treatment. Off-gas treatment is proven; however, the accumulation of volatile contaminants, particularly mercury and radionuclides, creates concerns regarding potential on-site and off-site particulate release and exposure. While remote techniques to position portions of the off-gas hood and treatment system over the waste site are available, activities may require direct worker involvement, which would increase exposure. Placing clean fill over the vitrification area may be required to protect the workers from radiation exposures and to provide a level working surface. It may be possible to excavate clean soils from the side slopes of the units and use it as fill.

Concerns regarding power requirements and the availability of sufficient supply to meet those requirements would also need to be addressed. This power is currently not available at the units but could be installed from nearby sources.

6.2.5.7 NEPA Values. The NEPA values associated with this alternative are very similar to those of the other alternatives. The Vitrification Alternative would have an irreversible and irretrievable commitment of natural resources. The natural resources that would be committed

include the land area within ERDF required for disposal of the contaminated wastes and geological materials for backfill.

There would be an increase in traffic in the area, but it would be limited because of the small quantity of contaminated soils requiring disposal. Noise and visual impacts would be present during the remediation. The impacts would occur for a relatively short period of time. At the completion of the remediation period, the site would be restored to blend with the surrounding area and would be accessible to all people.

Long-term maintenance checks, groundwater monitoring, and land-use restrictions to prevent intrusion into the monolith would be required. Because the volume of the soil could be reduced by 40%, clean fill may be added over the vitrified soil to return the site to surrounding grade and allow for revegetation.

There would be significant power requirements for this alternative. Although the impact to natural resources is expected to be minimal, consideration must be given to the method of supplying this power.

Land would be an irretrievable or irreversible resource. The glass structure left in place at the units essentially precludes full unrestricted land use.

6.2.5.8 Cost. The total cost for the Vitrification Alternative (MCRIS-8) is relatively high (approximately $72.8 million). This is due to the high cost of the vitrification treatment ($58.3 million). Table 6-2 provides a summary of costs for this alternative. Appendix E presents additional details regarding the cost estimates. This cost assumed disposal of material to ERDF. If the material was disposed at the Hanford W025 trench, the cost could increase by as much as $61.4 million, for a total cost of $97.4 million. The cost to dispose to W025 was estimated based on information provided by WHC in September 1996.

The addition of a treatment step for LDR soils would impact these costs. The extent of the impact would depend on factors such as the type of treatment, the amount of soils being treated, the cost of treatment (including capital), the percent volume reduction or increase achieved through treatment, and the amount and types of residual wastes resulting from treatment. It is anticipated that treatment would not be required, so treatment costs were not estimated.

As discussed in Section 6.1.7, the actual costs for remediation are expected to be less because of the conservative assumptions that were made regarding the radiological conditions at these units.

Table 6-1. Criteria for Detailed Analysis of Alternatives.

Threshold Criteria	
Overall Protection of Human Health and the Environment	**Compliance with ARARs**
• How alternative protects human health and the environment	• Compliance with chemical-specific ARARs • Compliance with action-specific ARARs • Compliance with location-specific ARARs • Compliance with other criteria, advisories, and guidelines that agencies agree are TBC.

Primary Criteria				
Long-Term Effectiveness and Permanence	**Reduction of Toxicity, Mobility, and Volume through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost**
• Magnitude of residual risk • Adequacy and reliability of controls on remaining wastes	• Amount of hazardous materials destroyed or treated • Degree of expected reductions in toxicity, mobility, and volume • Degree to which treatment is irreversible • Type and quantity of residuals remaining after treatment	• Protection of community during remedial actions • Protection of workers involved with the remedial action • Environmental and cultural impacts of the remedial action • Time until remedial action is completed	• Ability to construct and operate the technology • Reliability of the technology • Ease of undertaking additional remedial actions, if necessary • Ability to monitor effectiveness of remedy • Ability to obtain approvals from other agencies • Coordination with other agencies • Availability of off-site treatment, storage, and disposal services and capacity • Availability of necessary equipment and specialists • Availability of prospective technologies	

Modifying Criteria	
State Acceptance	**Community Acceptance**
• Addressed following public comment on the CMS and the proposed plan when record of decision is prepared.	• Addressed following public comment on the CMS and the proposed plan when record of decision is prepared.

ARAR = applicable or relevant and appropriate requirements
CMS = corrective measures study
TBC = to be considered

Table 6-2. Summary of Cost Estimates.

Exposure Scenario	Remedial Alternative	Alternative Description	Estimated Cost
Rural-Residential	RRES-1	No Action	$0
	RRES-6	Removal	$37,600,000
Modified CRCIA Ranger/ Industrial	MCRIS-1	No Action	$0
	MCRIS-6	Removal	$37,900,000
	MCRIS-7	Capping	$22,100,000
	MCRIS-8	Vitrification	$72,800,000

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7.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents the results of a comparative analysis of remedial alternatives for 116-N-1, 116-N-3, and UPR-100-N-31. Each individual alternative was evaluated in Section 6.0, "Detailed Analysis of Alternatives."

7.1 COMPARATIVE ANALYSIS: RURAL-RESIDENTIAL ALTERNATIVES

The rural-residential exposure scenario considers two alternatives:

- No Action (RRES-1)
- Removal (RRES-6).

The following is a comparative analysis of the two remedial alternatives for the rural-residential exposure scenario.

7.1.1 Overall Protection of Human Health and the Environment

The Removal Alternative (RRES-6) would be more protective of human health and the environment by meeting RAOs and complying with ARARs. This alternative would remove contaminated soil from 116-N-1, 116-N-3, and UPR-100-N-31. It would also remove pipelines and structures, allowing for long-term access to the site. Short-term risks regarding worker exposure to radionuclides exist, but would be managed as described in the detailed analysis. The long-term benefits of this alternative outweigh the short-term risks.

On the other hand, the No-Action Alternative (RRES-1) would not be protective of human health or the environment. The RRES-1 Alternative would result in significant environmental impacts by leaving contaminants in place at concentrations exceeding PRGs, and the alternative would not comply with ARARs or meet RAOs.

7.1.2 Compliance with ARARs

The Removal Alternative (RRES-6) would meet ARARs through excavation, backfill, and revegetation. The RRES-6 Alternative would comply with the chemical-specific ARARs by removing all contaminants above PRGs and disposing of them in an engineered disposal facility. The No-Action Alternative (RRES-1) does not meet chemical-specific ARARs because contaminants would be left in place at concentrations exceeding PRGs. It is not likely that an ARAR waiver would be given for the RRES-1 Alternative.

7.1.3 Long-Term Effectiveness and Permanence

The Removal Alternative (RRES-6) would provide a high degree of long-term effectiveness and permanence because it would remove the contaminated materials from the site and place them in an engineered, long-term disposal Facility. The No-Action Alternative (RRES-1) would not be effective because it would leave contaminated soils in place at concentrations above levels protective of human health and the environment. No revegetation or restoration efforts would be performed with the No-Action Alternative.

7.1.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

Neither the Removal nor the No-Action Alternative would provide a reduction of toxicity, mobility, and volume through treatment, unless excavated soil required treatment to meet LDR standards in RRES-6. If treatment should be required, there would be a reduction in mobility and an increase in volume from stabilization/solidification.

7.1.5 Short-Term Effectiveness

Because no action would be taken by RRES-1, there would be no short-term risk to workers associated with this alternative. The Removal Alternative (RRES-6) has more potential for short-term risk. This risk would be associated with removal of concrete panels, contaminated boulders, and contaminated soils. Preliminary estimates [Appendix C of the engineering study (BHI 1997)] indicate that the exposures to workers could be kept within administrative limits. For remediation beginning in July of 2000, the estimated total exposure received by workers would be 28.4 person-rem for 116-N-1 and 116-N-3 (26.1 person-rem for 116-N-1 and 2.3 person-rem for 116-N-3) under the rural-residential Removal Alternative RRES-6.

Potential exists for off-site airborne releases of contaminants for the RRES-6 Alternative. There is no off-site dose associated with the RRES-1 Alternative because no action is taken. The potential for off-site releases will be evaluated in more detail and mitigated in the remediation design phase before excavation. These releases would be mitigated by proven dust control measures and the best available radionuclide control technology.

7.1.6 Implementability

From a technical standpoint, the No-Action Alternative (RRES-1) would be the most implementable because no action would be taken at the site. However, implementation may not be administratively feasible because no action would not be an acceptable option to the regulators or the public. The Removal Alternative (RRES-6) would be implemented with proven technologies. During the remedial design, implementation concerns, especially those due to high radiation levels, would be addressed and resolved.

7.1.7 NEPA Values

Both alternatives have NEPA concerns. However, the increase in Hanford truck traffic and other impacts coincident with Removal Alternative (RRES-6) activities would cease when remediation is complete. The No-Action Alternative (RRES-1) would present long-term NEPA concerns because all contamination would remain at the units with unrestricted access.

7.1.8 Cost

There would be no cost associated with No Action. The Removal Alternative is estimated to cost $37.6 million.

7.2 COMPARATIVE ANALYSIS: MODIFIED CRCIA RANGER/INDUSTRIAL ALTERNATIVES

The modified CRCIA ranger/industrial exposure scenario considers four alternatives:

- No Action (MCRIS-1)
- Removal (MCRIS-6)
- Capping (MCRIS-7)
- Vitrification (MCRIS-8).

The following is a comparative analysis for the modified CRCIA ranger/industrial exposure scenario based on these four alternatives.

7.2.1 Overall Protection of Human Health and the Environment

The Removal Alternative (MCRIS-6) would be the most protective of human health and the environment. This alternative would meet RAOs, comply with ARARs, and provide long-term access to the units for recreational purposes. The Removal Alternative prevents direct surface exposure and protects the groundwater and the Columbia River by removing 47,400 bcm (62,000 bcy) of contaminated soil from 116-N-1, 116-N-3, and UPR-100-N-31; removing 1,765 m (5,790 ft) of pipelines; and removing 5,418 m^3 (191,358 ft^3) of demolition waste; and disposing of them in an engineered disposal facility. The long-term benefits associated with this alternative outweigh the short-term risks associated with excavating highly radioactive soil. These risks can be minimized significantly by delaying excavation until the radionuclide inventory in the units decays.

The Capping Alternative (MCRIS-7) removes less contaminated soil (11,300 bcm [14,800 bcy] from the 116-N-1 Crib and UPR-100-N-31) to prevent direct exposure to contaminants. The MCRIS-7 Alternative removes the same pipelines and demolition waste as MCRIS-6. An engineered cap covering 34,131 m^2 (367,200 ft^2) is then placed over the 116-N-1 Trench and the 116-N-3 Crib and Trench to protect groundwater and the Columbia River. During remedial

action, it may be determined that a cap should also be placed over the 116-N-1 Crib and UPR-100-N-31, although it is unlikely. The Vitrification Alternative (MCRIS-8) removes the same amount of soil, pipelines, and demolition waste as the Capping Alternative, but vitrifies the soil instead of capping. The Vitrification Alternative would be more long-term and permanent than Capping and would include treatment as a principal element.

Therefore, Capping (MCRIS-7) and Vitrification (MCRIS-8) are the second most protective because they meet RAOs and comply with ARARs but have uncertainties associated with them. There is uncertainty associated with the long-term effectiveness of a cap especially when metals that do not attenuate and long-lived, high-concentration radionuclides are present in the soil for thousands of years. There are also uncertainties associated with implementing vitrification in soils that have volatile metals (i.e., mercury) and radionuclides (i.e., cesium) and the potential for these to be released off site.

The No-Action Alternative (MCRIS-1) would not be protective of human health or the environment. The MCRIS-1 Alternative would result in significant environmental impacts by leaving contaminants in place at concentrations exceeding PRGs, and the alternative would not comply with ARARs or meet RAOs.

7.2.2 Compliance with ARARs

The Removal (MCRIS-6), Capping (MCRIS-7), and Vitrification (MCRIS-8) Alternatives would comply with ARARs. The Removal Alternative complies with chemical-specific ARARs by removing contaminants above PRGs from the site and disposing of them in an engineered disposal facility. The Capping Alternative (MCRIS-7) removes contaminants from the site to prevent direct surface exposure and caps the units to protect the groundwater and Columbia River from contaminants that are left in place. The Vitrification Alternative (MCRIS-8) also removes soil to prevent direct surface exposure and treats the contaminated soils left in place to immobilize the contaminants to protect groundwater and the Columbia River.

The No-Action Alternative (MCRIS-1) does not meet chemical-specific ARARs because contaminants would be left in place at concentrations exceeding PRGs. It is not likely that an ARAR waiver would be given.

All of the alternatives that take action would meet the location- and action-specific ARARs.

7.2.3 Long-Term Effectiveness and Permanence

The Removal Alternative (MCRIS-6) would have the highest long-term effectiveness because it would remove the contaminated material from the site and place it in a disposal facility designed for long-term storage. The Capping (MCRIS-7) and Vitrification (MCRIS-8) Alternatives would be less protective than Removal (MCRIS-6), but more protective than No Action (MCRIS-1). The Capping Alternative is proven and reliable as long as the integrity of the cap is maintained. Uncertainty concerning the Capping Alternative's long-term effectiveness exists beyond the

cap's designed life. Additionally, in the unlikely event that a cap was required over the 116-N-1 Crib without prior excavation, the uncertainties associated in the long term with preventing direct exposure to surface soil become a key issue. In this case, vitrification at the 116-N-1 Crib would be more protective and permanent than capping.

The Vitrification Alternative's long-term effectiveness is high for soils that are vitrified. However, the potential for some contaminated sand lenses to be missed, and questions about the effectiveness of off-gas treatment, introduces uncertainty about the alternative's overall long-term effectiveness. Removal and Vitrification would not require long-term operation and maintenance, unlike Capping that requires frequent monitoring. No Action (MCRIS-1) would not be effective because it would leave contaminated soils in place. Furthermore, neither restoration nor revegetation efforts would be performed under the MCRIS-1 Alternative.

7.2.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

The Vitrification Alternative (MCRIS-8) would provide the most reduction in mobility and volume through treatment. For excavated soils, all the action alternatives (MCRIS-6, MCRIS-7, and MCRIS-8) would reduce contaminant mobility through treatment of soils that do not meet LDR standards.

The MCRIS-1 Alternative would provide no treatment, and thus provides no reduction in toxicity, mobility, and volume through treatment.

7.2.5 Short-Term Effectiveness

The No-Action Alternative (MCRIS-1) would pose no short-term risk to workers because no remedial activities would be conducted. The Capping Alternative would pose some short-term risk to workers; however, backfilling operations would keep that risk to a minimum by providing shielding from radiation. The Removal (MCRIS-6) and Vitrification (MCRIS-8) Alternatives would pose the highest potential for risk to workers due to radiation exposure. These risks could be minimized significantly by delaying remediation until the radionuclide inventory in the units decays (see Figure 7-1). Access to the site is currently restricted by a fence, locked gates, administrative procedures, and animal intrusion barriers (the concrete panels). For remediation beginning in July of 2000, the estimated total exposure received by workers would be 28.4 person-rem for 116-N-1 and 116-N-3 (26.1 person rem for 116-N-1 and2.3 person-rem for 116-N-3) under the rural-residential Removal Alternative RRES-6.

The Removal, Capping, and Vitrification Alternatives would have the potential for off-site releases during excavation, which would be mitigated during the remedial design phase and by dust suppression during excavation. The Vitrification Alternative has the highest potential for significant off-gas releases due to the presence of volatile metals and radionuclides in soil. The best available radionuclide control technology would be used at the site to minimize these releases.

Potential exists for off-site airborne releases of contaminants for all of the MCRIS Alternatives that involve excavation. There is no off-site dose associated with the MCRIS-1 Alternative because no action is taken. The potential for off-site releases will be evaluated in more detail and mitigated in the remediation design phase before excavation.

7.2.6 Implementability

The No-Action Alternative (MCRIS-1) would be the most implementable, from a technical standpoint, because no action would be taken at the site. The Removal (MCRIS-6) and Capping (MCRIS-7) Alternatives would be implementable using proven technologies. The Vitrification Alternative (MCRIS-8) has more complex issues regarding implementation due to vitrifying contaminated soils that have high radiation dose rates and due to treating and controlling the off-gas. During remedial design, the implementation concerns, especially those due to high radiation levels, would be addressed and resolved.

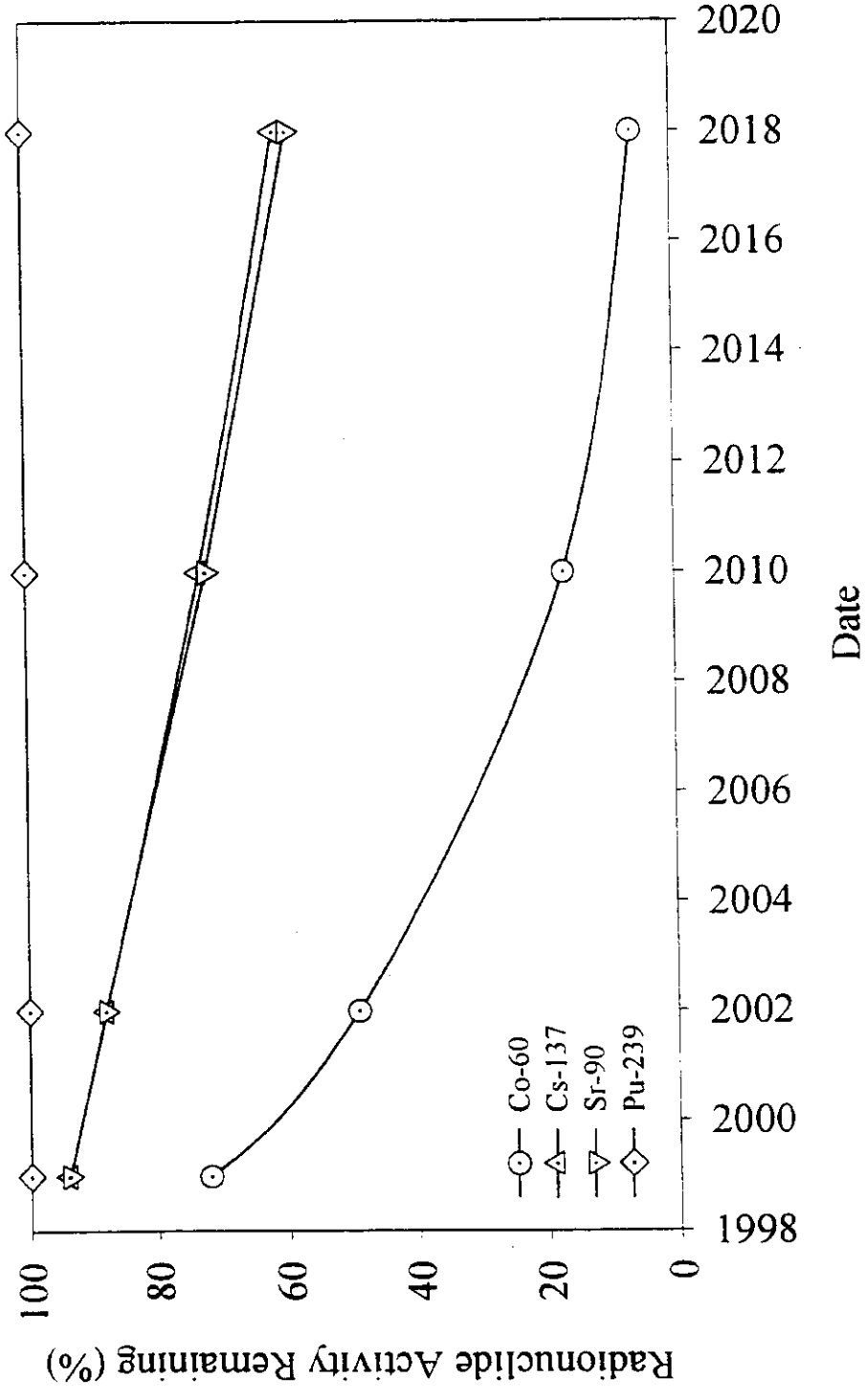
7.2.7 NEPA Values

All alternatives would have NEPA concerns. Concerns associated with Removal (MCRIS-6) would be short term, such as increased Hanford truck traffic, and would be resolved at the end of remediation. All of the alternatives have irretrievable and irreversible commitments of resources in terms of land that would be committed to ERDF and the borrow pits that would supply clean fill. The Capping Alternative (MCRIS-7) and Vitrification (MCRIS-8) would have more NEPA concerns than Removal (MCRIS-6), but generally these are resolved for the long term. Vitrification and capping would have irretrievable or irreversible commitments of resources in terms of land; the glass or cup structure left in place at the units essentially precludes full unrestricted land use. NEPA concerns with No Action (MCRIS-1) are long term because all contamination remains at the units with unrestricted access.

7.2.8 Cost

The total costs for the Removal Alternative (MCRIS-6) is significantly higher than for Capping (MCRIS-7) $(35.9 and $22.1 million, respectively). Total costs for Vitrification (MCRIS-8) are considerably higher at $72.8 million (approximately four times higher), which is mainly the result of the in situ vitrification treatment ($58.2 million). There is no cost associated with No Action (MCRIS-1).

Figure 7-1. Summary of Radiation Exposure and Remediation Dates for the Rural-Residential Removal Alternative (RRES-6).



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APPENDIX A

1301-N AND 1325-N LIQUID WASTE DISPOSAL FACILITIES CLOSURE PLAN

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ABBREVIATIONS AND ACRONYMS

ASTM	American Society for Testing and Materials
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CMS	corrective measures study
COC	contaminants of concern
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
LFI	limited field investigation
LWDF	liquid waste disposal facility
MTCA	*Model Toxics Control Act*
OU	operable unit
Permit	Hanford Facility Dangerous Waste Permit
QA	quality assurance
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
SEPA	State Environmental Policy Act
TOC	total organic carbon
TOX	total organic halogen
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*

A1.0 INTRODUCTION

Appendix A presents the closure plan for the 1301-N Liquid Waste Disposal Facility (LWDF) (1301-N), also known by the designation 116-N-1, and for the 1325-N LWDF (1325-N), also known by the designation 116-N-3. The 1301-N and 1325-N terminology will be used throughout this appendix because the LWDFs are identified as such in their interim status Part A Permit Applications. These radioactive dangerous waste units operated as soil column disposal units, most recently under the authority of the *Washington Administrative Code* (WAC) 173-303. Closure of these units will commence pursuant to WAC 173-303-610 and the Hanford Facility Dangerous Waste Permit (Permit). Modification of the Permit to include this closure plan is scheduled to occur in calendar year 1999. However, because of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) milestone that requires one document be submitted to address the four treatment, storage, and disposal units this closure plan will be incorporated into the Permit Modification in December 1998.

This closure plan is part of the 100-NR-1 Treatment, Storage, and Disposal Corrective Measures Study (TSD CMS). Approval of this closure plan will be obtained through the Permit modification process. Contaminated groundwater associated with 1301-N and 1325-N TSD operations is defined as the 100-NR-2 Operable Unit (OU). Remedial alternatives associated with contaminated groundwater are defined in the 100-NR-1/NR-2 TSD CMS. Chosen remedial actions for 100-NR-2 groundwater will be defined in a separate ROD and, again, incorporated into the Permit through Permit modification. Actual closure activities necessary to close these units are not known at this time because the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) alternative selection process has not been completed. Therefore, this closure plan contains closure activities that may be required for the range of 1301-N and 1325-N remedial alternatives presented in Section 5.0 of this TSD CMS. This range includes two closure options available to dangerous waste units under WAC 173-303 and the Permit: modified closure or landfill closure.

Because this plan is provided as an appendix, closure plan sections that contain redundant information refer to the main body of the TSD CMS report.

A1.1 REGULATORY BACKGROUND

The 1301-N and 1325-N units are operated by the U.S. Department of Energy (DOE), Richland Operations Office (RL), and co-operated by Bechtel Hanford, Inc. Although the U.S. Government holds legal title to this facility, the RL, for purposes of regulation under WAC 173-303, is considered the legal owner of the facility under existing U.S. Environmental Protection Agency (EPA) interpretive regulations (51 Federal Register 7722).

The Part A, Form 3, dangerous waste permit application documentation for 1301-N originally was submitted to the Washington State Department of Ecology (Ecology) and the EPA in August 1986. Documentation for the 1325-N LWDF originally was submitted in February 1987.

Seven revisions of the Part A, Form 3, dangerous waste permit application documentation for these TSD units have been submitted. The latest revision (Revision 7) of each unit Part A is attached to this appendix (Attachments A-1 and A-2). Also, a State Environmental Policy Act (SEPA) checklist, pursuant to WAC 197-11-960, will be approved prior to incorporation of this closure plan into the Permit. A draft SEPA checklist is attached to this appendix (Attachment A-3).

The Part A identifies the listed waste spent solvent, methanol (F003), as being disposed to 1301-N and 1325-N. Any media or debris that came into contact with wastewaters disposed to these units may also, by definition, be considered to be a listed dangerous waste in lieu of an approved contained-in determination. The reason this is not stated definitively is because, federally, F003 spent solvents are no longer listed if they do not exhibit the characteristic of ignitability (40 CFR 261.3[a][2][iii]), however, a similar "exclusion" does not exist in State regulation. It may be determined by Ecology that soils and debris generated during remediation of these units would not be defined as listed F003 waste if they are not ignitable.

Should the F003 waste code be attached to remediation-generated soils and debris, a contained-in request would be developed for generated waste in order to alleviate the need to comply with all substantive dangerous waste management standards. Methanol is not anticipated to be detectable in soils. An approved contained-in determination would redefine media and debris generated during closure activities as nonlisted waste where methanol concentrations are below a prescribed concentration considered protective of human health and the environment. A decision on the contained-in request would be needed prior to initiation of remediation activities. In a letter from Tom Eaton, Ecology, dated February 19, 1993, a contained-in policy was presented that will be used to formulate the request. Contained-in determinations have been granted at other TSD units on the Hanford Site under this policy.

The Hanford Site Dangerous Waste Permit contains a schedule for incorporation of closure plans into the Permit. The closure plan for 1301-N and 1325-N are scheduled for incorporation in 1999. However, because of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) milestone that requires one document be submitted to address the four treatment, storage, and disposal units this closure plan will be incorporated into the Permit Modification in December 1998.

A1.2 CLOSURE PLAN AND CORRECTIVE MEASURES STUDY INTEGRATION

Closure of the 1301-N and 1325-N units will occur under the authority of WAC 173-303. These units are also defined under the 100-NR-1 OU and are part of this TSD CMS. Integrated TSD and OU closure actions will be necessary to remediate contaminated soil and groundwater. Actions taken to remediate these TSDs will comply with the provisions of both CERCLA and RCRA. The CERCLA public involvement, including public notice and opportunity to comment, has been enhanced to concurrently satisfy the RCRA closure process. The remedy selected under CERCLA will be incorporated into the Hanford Facility RCRA Permit as the RCRA closure action after issuance of the public notice and comment process.

It is anticipated that the CERCLA ROD will be issued subsequent to the Hanford Facility RCRA Permit modification. Should the CERCLA ROD contain provisions inconsistent with the approved RCRA modifications, the Hanford Facility RCRA Permit will be again modified to reconcile these differences during the next permit modification cycle.

Closure options available under WAC 173-303-610 and the Permit are as follows:

Clean closure - requires that groundwater be uncontaminated by dangerous waste constituents (as evidenced through compliance with WAC 173-303-645) and that soils contain concentrations of dangerous waste constituents below *Model Toxics Control Act* (MTCA) Method B direct soil exposure and groundwater protection levels (WAC 173-303-610[2][b][I] and Permit Condition II.K.1). This closure option is compatible with both exposure scenarios presented in this TSD CMS, rural-residential and the modified CRCIA Ranger/Industrial Scenario because it allows for unrestricted use of the units after closure. Because it is unclear at this time whether the groundwater under 1301-N and 1325-N has been contaminated with dangerous waste constituents from past operation of these units, as defined under WAC 173-303-645, this closure option has not been identified as available to 1301-N and 1325-N in this closure plan. Should a clean soil column be attained and future groundwater monitoring indicate levels of dangerous waste constituents are below MTCA Method B levels, this option will be revisited through Permit modification.

Modified closure - requires that soil concentrations of dangerous waste constituents not exceed MTCA Method C direct soil exposure and groundwater protection levels. Groundwater may or may not be contaminated by dangerous waste constituents (Permit Condition II.K.3). This closure option is only compatible with modified CRCIA ranger/industrial uses of the land (as defined for the purposes of this TSD CMS) because institutional controls would be required in order to limit access to the contaminated media.

Landfill closure - required when soils contain concentrations of dangerous waste constituents above MTCA Method C direct soil exposure and groundwater protection levels. Groundwater may or may not be contaminated by dangerous waste constituents (Permit Condition II.K.4). This closure option is only compatible with modified CRCIA ranger/industrial uses of the land because capping and other institutional controls would be required in order to limit access to the contaminated media.

Closure option decisions at 1301-N and 1325-N will be driven by decisions made pursuant to a CERCLA ROD for these units. Remedial alternatives compared in this TSD CMS encompass modified and landfill closure options available under WAC 173-303-610 and the Permit. Therefore, information is contained in this appendix that addresses compliance with all potential closure options. Remedial alternatives compared in this TSD CMS are presented below:

- No Action under a rural residential or modified CRCIA ranger/industrial exposure scenario (RRES-1), (MCRIS-1)

- Remove/Treat if Required/Dispose/Backfill under a residential or modified CRCIA ranger/industrial exposure scenario (RRES-6), (MCRIS-6)

- Remove to 3.0 m (10 ft) below ground surface (bgs)/Treat if Required/Dispose/Backfill/ Cap for Groundwater Protection under a modified CRCIA ranger/industrial exposure scenario (MCRIS-7)

- Remove to 3.0 m (10 ft) bgs/Treat if Required/Dispose/Vitrify for Groundwater Protection/Backfill under a modified CRCIA ranger/industrial exposure scenario (MCRIS-8).

The RRES-1 and MCRIS-1 Alternatives are presented in the TSD CMS for baseline comparison but are not considered viable alternatives for 1301-N and 1325-N. MCRIS-6 and MCRIS-8 Alternatives may result in a modified closure decision, depending upon the concentrations of dangerous waste constituents left in the units after excavation is completed. Landfill closure is precluded by the RRES-6, MCRIS-6, and MCRIS-8 Alternatives because they do not include placement of a final cover over the units. The MCRIS-7 Alternative may result in a modified closure or landfill closure decision depending upon the concentrations of dangerous waste constituents left after excavation. Although unlikely, a modified closure option may still be viable for the MCRIS-7 Alternative because capping of these units may be required for purposes unrelated to closure of these units under WAC 173-303-610, i.e., protection of the groundwater from radiological contaminants remaining in soils below 3.0 m (10 ft).

A1.3 CLOSURE PERFORMANCE STANDARDS

The closure performance standards of WAC 173-303-610(2) require that the owner/operator of a TSD unit close the unit in a manner that (1) minimizes the need for further maintenance; (2) controls, minimizes, or eliminates postclosure escape of dangerous waste to the extent necessary to protect human health and the environment; and (3) returns the land to the appearance and use of surrounding land areas.

A1.3.1 Minimize the Need for Further Maintenance

The extent of future site maintenance depends on the closure option chosen for 1301-N and 1325-N (i.e., modified, or landfill closure). Maintenance, monitoring, and inspections necessary to minimize the need for further maintenance of the units under a modified or landfill closure option are defined in Section A5.0.

A1.3.2 Control Dangerous Waste Escape to Protect Human Health and the Environment

Closure activities defined in Section A4.0 will ensure the control of dangerous waste during closure activities. Because these activities cannot be fully defined until a remedial alternative is chosen through a ROD and remedial design is defined, these activities describe a range of activities that may be undertaken in order to achieve modified or landfill closure. Closure

activities will meet the remedial action objectives for soils as defined in Section 3.0 of this TSD CMS. Remedial action objectives for contaminated groundwater associated with 1301-N and 1325-N operations are defined in Section 4.0 of the *Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units* (100-NR-1/NR-2 CMS) (DOE-RL 1996a). These objectives are designed to protect both human health and the environment.

A1.3.3 Return Land to Appearance and Use of Surrounding Area

The appearance and use of 1301-N and 1325-N after closure will be consistent with the future use of the 100-N Area. This TSD CMS defines two possible exposure scenarios: rural-residential and modified CRCIA ranger/industrial. All alternatives include the commitment to revegetate the surface soils.

A2.0 UNIT DESCRIPTION

This section provides a general description of the 1301-N and 1325-N LWDFs. This description is intended to provide an overview of these units.

A2.1 GENERAL DESCRIPTION OF UNITS

The 1301-N and 1325-N surface soils and subsoils, including the UPR-100-N-31 spill, and associated structures and piping that have been contaminated by dangerous waste constituents from these units are subject to this WAC 173-303 closure action.

The 1301-N and 1325-N units were the primary LWDFs for the N Reactor. Wastes disposed included reactor coolant, spent fuel storage basin, and periphery cooling systems bleed off. Also included were reactor primary coolant loop decontamination rinse solution and discharges from building drains containing radioactive wastes generated in reactor support facilities. The 1301-N unit was operated from December 1963 until September 1985. The 1325-N unit was operated from October 1983 until April 1991. From October 1983 to September 1985, both units were in operation.

For a general discussion on the N Reactor facility background and more in-depth description of these units, refer to Section 2.0 of the TSD CMS.

A2.1.1 Topographical Maps

General topographical maps for the area surrounding the 1301-N and 1325-N units are provided in Figures 2-16 and 2-23 of the TSD CMS report.

A2.1.2 Floodplain

The U.S. Army Corp of Engineers (Jamison 1982) has calculated the probable maximum flood based on the upper limit of precipitation falling on a drainage area and other hydrologic factors such as antecedent moisture conditions, snowmelt, and tributary conditions that could lead to a maximum runoff. The probable maximum flood for the Columbia River below Priest Rapids Dam has been calculated to be 41 million L/s (1.4 million ft^3/s). The floodplain associated with the probable maximum flood is shown in Figure A-1 (Jamison 1982). The 1301-N and 1325-N units would not be affected by the probable maximum flood.

A2.1.3 Traffic

The majority of traffic inside the Hanford Site boundaries consists of light-duty vehicles used to transport employees to work areas. The 1301-N and 1325-N units are located within the Hanford Controlled Access Area where roadways cannot be accessed by the general public. These facilities are isolated from the nearest public highway, State Highway 24, by approximately 6 km (4 mi). Vehicle traffic around the units is restricted and is minimal, as the area is enclosed by a fenced with locked gates and is posted as a radiation zone. Section 2.4 of the TSD CMS provides additional details about the current postings on the perimeter fence.

A2.1.4 General Hydrogeologic Conditions

Section 2.3.2 of the TSD CMS provides information on the geology and hydrogeology underlying the 1301-N and 1325-N units.

A2.1.5 Physical Dimensions of the Units

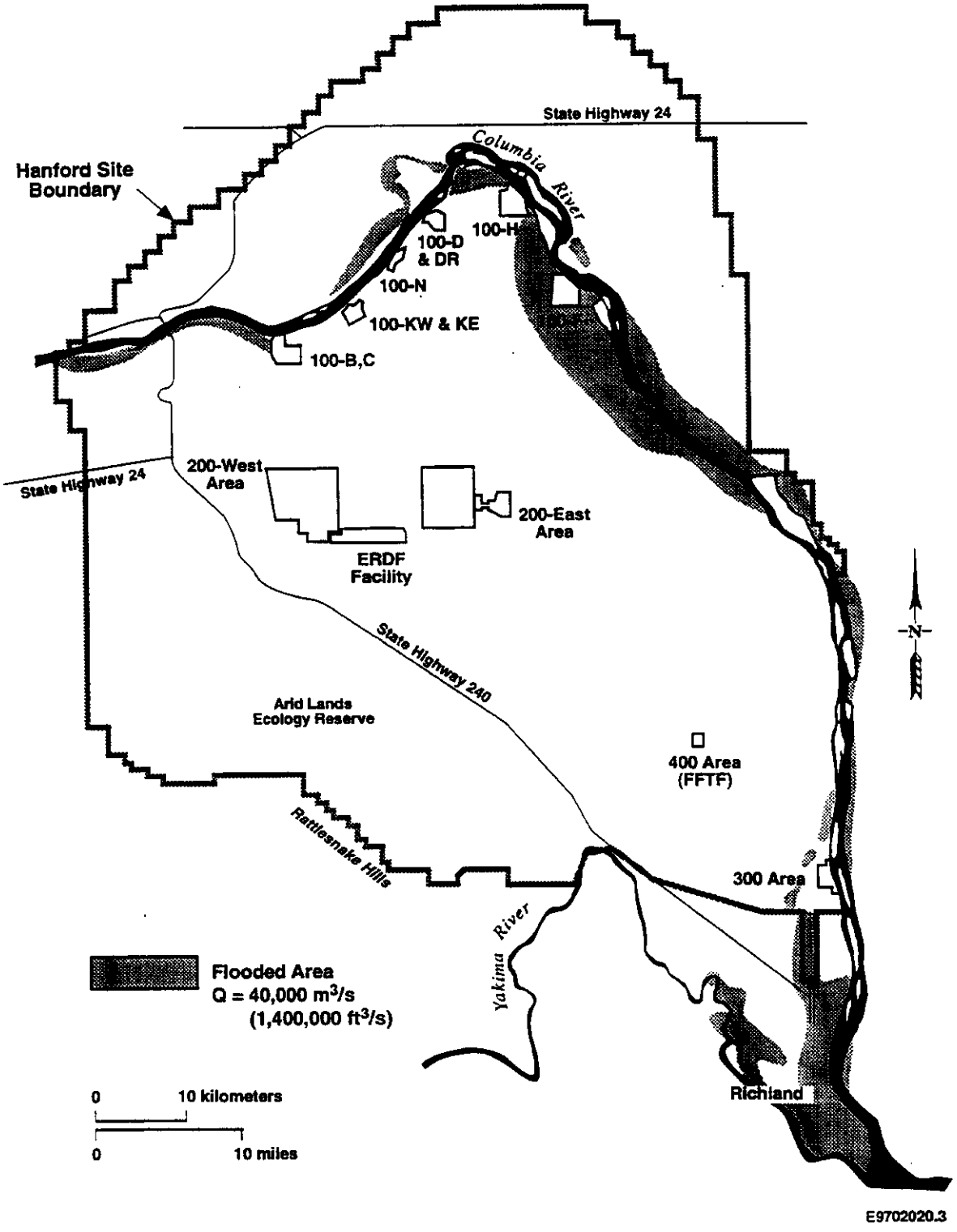
The 1301-N unit consists of a 16-m by 3.7-m (52- by 12-ft) weir box inside a 38- by 88-m (125-by 290-ft) rectangular basin (crib). A zig-zag extension trench, approximately 490 m (1,600 ft) long, 15 m (50 ft) wide, and 3.7 m (12 ft) deep, was added to the crib.

The 1325-N unit includes a concrete header box inside a 73- by 76-m (240- by 250-ft) rectangular basin (crib). A straight extension trench, approximately 914 m (3,000 ft) long, 16.8 m (55 ft) wide, and 3.0 m (10 ft) deep, was also added to this crib.

A2.1.6 Design Capacity

Both the 1301-N and 1325-N LWDFs were designed with a discharge capacity of 11,400 L/min (3,000 gal/min). The average flow rate was approximately 6,400 L/min (1,700 gal/min).

Figure A-1. Probable Maximum Flood Area.



A2.1.7 Ancillary Equipment

The 1301-N and 1325-N units are passive liquid waste disposal facilities that do not rely on active systems for operations support. The units consist of transfer piping, concrete effluent distribution structures, and soils to distribute liquid wastes.

A2.1.8 Containment Systems

The 1301-N and 1325-N units do not include any containment systems.

A2.1.9 Structures and Piping Requiring Removal or Characterization as Clean

The structures in the 1301-N and 1325-N LWDFs include concrete structures and earthen basins and trenches. The 1301-N unit consists of a 16- by 3.7-m (52- by 12-ft) weir box, a 38- by 88-m (125- by 290-ft) rectangular basin (crib), and a zigzag extension trench, approximately 490 m (1,600 ft) long, 15 m (50 ft) wide, and 3.7 m (12 ft) deep.

The 1325-N unit includes a concrete header box, a 73- by 76-m (240- by 250-ft) rectangular basin (crib), a tie-in structure, and a straight extension trench, approximately 914 m (3,000 ft) long, 16.8 m (55 ft) wide, and 3.0 m (10 ft) deep.

Figure 2-14 in Section 2.0 shows the pipelines to be removed or characterized as clean between the 1722-N Building and 1301-N and between 1310-N and 1301-N. Figure 2-21 in Section 2.0 shows the piping between the 1301-N Crib and the 1325-N Crib. Pipe lengths and map references are provided in Appendix D of the TSD CMS.

Refer to Section A4.0, "Closure Activities," for a more in-depth discussion on the removal of structures.

A2.1.10 Security

The entire Hanford Site is a controlled-access area. The Hanford Site maintains around-the-clock surveillance to restrict unauthorized access for the protection of the public and of government property, classified information, and special nuclear materials. The Hanford Patrol maintains a continuous presence of protective force personnel to provide Hanford Site security.

Within the Hanford Site are operational areas, including 100-N, to which access is restricted. There is a staffed checkpoint at the Wye Barricade (Figure 1-1 of this TSD CMS) through which access to the 100-N Area is allowed only to authorized personnel. Authorized personnel are those individuals with a DOE-issued security identification badge indicating the appropriate authorization. Such personnel are subject to a search of items carried into or out of controlled areas. Unknowing entry to the 100-N Area is administratively prevented by postings on access roads that allow authorized access only. To preclude unknowing access into the 1301-N and 1325-N units and to minimize the possibility of entry by animals or by unauthorized individuals,

the unit is surrounded by a chain link fence that has locked gate access. Also, posted at the unit are placards that read "Danger -- Unauthorized Personnel Keep Out."

A2.2 WASTE CHARACTERISTICS

A2.2.1 Liquid Waste Discharges

The wastes disposed in 1301-N and 1325-N were generated from N Reactor operations. The waste streams included the following:

- Reactor coolant system bleed off
- Spent fuel storage basin cooling water overflow
- Reactor periphery cooling systems bleed off
- Reactor primary coolant loop decontamination rinse solution
- Building drains serving reactor support facilities.

The combination of these waste streams resulted in an average flow of approximately 6,400 L/min (1,700 gal/min). Results of influent sampling and analysis (Table A-1) did not indicate the characteristics of a dangerous waste.

A2.2.1.1 Reactor Primary Coolant System. The reactor primary coolant system was supplied by demineralized water with chemicals added for water quality control (QC). Ammonium hydroxide was used for pH control and was injected at a concentration of approximately 40 ppm to maintain a pH of 10.2 to 10.4 standard units. Hydrazine was introduced for oxygen control at a concentration of 0.04 ppm.

A2.2.1.2 Fuel Storage Basin Cooling Water. The spent fuel storage basin was supplied by filtered water with chlorine added as an algicide. A trace amount of residual chlorine was maintained to ensure complete treatment.

A2.2.1.3 Reactor Periphery Cooling Systems. Reactor periphery cooling systems that discharged bleed-off wastes to 1301-N and 1325-N include the following:

- Graphite and shield cooling
- Reactor control rod cooling
- Reactor secondary coolant loop.

As with other reactor cooling systems, bleed off and spillage from the periphery cooling systems resulted in small continuous discharge.

Table A-1. 1301-N and 1325-N Effluent Analysis. (Page 1 of 2)

Parameter (MDL)	Sample			
	1	2	3	Average
pH (standard units)	6.58	6.56	6.97	6.70
Conductivity (micromhos)	148	155	190	164
Mercury (.001 ppm)	ND	ND	ND	ND
Ethylene glycol (10 ppm)	ND	ND	ND	ND
Enhanced thiourea (.2 ppm)	ND	ND	ND	ND
TOC (1 ppm)	0.0018	0.002	0.002	0.0019
Cyanide (.01 ppm)	ND	ND	ND	ND
Barium (.006 ppm)	0.03	0.027	0.027	0.028
Cadmium (.002 ppm)	ND	ND	ND	ND
Chromium (.01 ppm)	ND	ND	ND	ND
Lead (.03 ppm)	ND	ND	ND	ND
Silver (.01 ppm)	ND	ND	ND	ND
Sodium (.1 ppm)	1.831	1.819	1.781	1.810
Nickel (.01 ppm)	ND	ND	ND	ND
Copper (.01 ppm)	ND	ND	ND	ND
Vanadium (.005 ppm)	ND	ND	ND	ND
Antimony (.1 ppm)	ND	ND	ND	ND
Aluminum (.15 ppm)	ND	ND	ND	ND
Manganese (.005 ppm)	ND	ND	ND	ND
Potassium (.1 ppm)	0.647	0.608	0.606	0.620
Iron (.05 ppm)	0.081	0.077	0.050	0.069
Beryllium (.005 ppm)	ND	ND	ND	ND
Osmium (.3 ppm)	ND	ND	ND	ND
Strontium (.3 ppm)	ND	ND	ND	ND
Zinc (.005 ppm)	ND	ND	ND	ND
Calcium (.05 ppm)	14.40	13.97	14.05	14.14
Nitrate (.5 ppm)	ND	ND	ND	ND

Table A-1. 1301-N and 1325-N Effluent Analysis. (Page 2 of 2)

Parameter (MDL)	Sample			
	1	2	3	Average
Sulphate (.5 ppm)	12.41	11.53	11.97	11.97
Fluoride (.5 ppm)	ND	ND	ND	ND
Chloride (.5 ppm)	1.57	1.48	1.53	1.53
Phosphate (1 ppm)	ND	ND	ND	ND
Phosphorus Pesticides (.005 ppm)	ND	ND	ND	ND
Chlorinated Pesticides (.001 ppm)	ND	ND	ND	ND
Enhanced ABN List	ND	ND	ND	ND
Citrus Red (1 ppm)	ND	ND	ND	ND
Arsenic (.005 ppm)	ND	ND	ND	ND
Ammonium Ion (.05 ppm)	ND	ND	ND	ND
Coliform (3 MPN)	---	0.023	0.009	0.016
Selenium (.005 ppm)	ND	ND	ND	ND
Thallium (.01 ppm)	ND	ND	ND	ND

ND = Not Detected
MDL = Minimum Detection Limit
Data obtained from samples taken August 1985
Diediker and Hall. (1987)

Graphite and Shield Cooling. The graphite and shield cooling system was supplied by demineralized water with chemicals added for water QC. Ammonium hydroxide was injected at a concentration of approximately 40 ppm to maintain a pH of 10.0 to 10.2 standard units. Hydrazine was injected for oxygen control at a concentration of 0.04 ppm.

Reactor Control Rod Cooling. The reactor control rod cooling system was supplied by demineralized water with chemicals added for water QC. Ammonium hydroxide was injected at a concentration of approximately 40 ppm to maintain a pH of 7.0 standard units. Hydrazine is injected for oxygen control at a concentration of 0.15 ppm.

Reactor Secondary Coolant Loop. The reactor secondary coolant loop was supplied by demineralized water with chemicals added for water QC. Morpholine was injected at a concentration of approximately 4 ppm to maintain a pH of 8.6 to 9.2 standard units. Hydrazine was injected for oxygen control at a concentration of 1 ppm or less.

A2.2.1.4 Reactor Primary Coolant Loop Decontamination. The reactor primary coolant loop was decontaminated every 2 to 4 years. The decontamination solution consisted of 79,500 L (21,000 gal) TURCO 4512-A™ (70% phosphoric acid) and 136 to 181 kg (300 to 400 lb) of diethylthiourea. This solution was diluted to an 8 wt% phosphoric acid solution as it entered the reactor coolant loop.

After the pH of the rinsate was verified between 6.0 and 9.0 standard units, the final rinse solution containing approximately 378,500 L (100,000 gal) of demineralized water was discharged. The calculated phosphoric acid released per decontamination was 5.7 L (1.5 gal), and the calculated amount of diethylthiourea was 2.3 g (0.0051 lb).

A2.2.1.5 Building Drains. The radioactive drain system collected radioactive water from throughout the 109-N and 105-N Buildings. Pump leakage, system bleed off from the reactor primary and periphery cooling systems, laboratories, decontamination activities, and other routine activities were drained to 1301-N and 1325-N via this system.

Three of the waste streams exhibited characteristics of a dangerous waste at the point of generation. These were leaks and spills from the auxiliary power battery lockers, hydrazine mixing spills, and laboratory wastes. Each of these wastes contained contaminants that are designated dangerous wastes under WAC 173-303-090. However, sampling of the 1301-N and 1325-N influent (Table A-1) did not identify characteristics of a dangerous waste at the point of discharge into 1301-N and 1325-N.

Wastes from Chemical Analyses. Chemical analyses were performed in laboratories to determine hydrazine, ammonia, chloride, and fluoride concentrations in reactor coolant. Waste characterization indicated that approximately 9,800 L/yr (2,600 gal/yr) contained constituents designated as dangerous wastes under WAC 173-303-090.

Auxiliary Power Battery Lockers. Spills and leaks from the auxiliary power battery lockers contributed 300 to 450 L/yr (80 to 120 gal/yr) of waste from nickel-cadmium and lead-acetate batteries. It is estimated that approximately 40% of the spilled material was from nickel-cadmium batteries and 60% from lead-acetate batteries.

Hydrazine Mixing and Injection Area Floor Drains. Hydrazine spills from mixing and injection activities entered the radioactive drain system. Spills were very small in volume and, in the case of the mixed solution, were extremely dilute. Approximately 160 kg (350 lb) of hydrazine was spilled yearly in this manner.

A2.2.2 Liquid Waste Discharge Chronology

A chronology of liquid waste discharges to 1301-N and 1325-N is provided in Table A-2.

Table A-2. Chronology of Liquid Waste Discharges.

Year	Liquid Waste Discharge to 1301-N LWDF (L/day)	Liquid Waste Discharge to 1325-N LWDF (L/day)
1964	9,462,500*	0
1965	9,462,500*	0
1966	9,462,500*	0
1967	9,462,500*	0
1968	9,462,500*	0
1969	9,462,500*	0
1970	9,462,500*	0
1971	9,462,500*	0
1972	9,462,500*	0
1973	8,702,000	0
1974	9,500,000	0
1975	9,500,000	0
1976	9,900,000	0
1977	14,500,000	0
1978	12,500,000	0
1979	13,500,000	0
1980	12,500,000	0
1981	10,500,000	0
1982	10,500,000	0
1983	6,942,000	1,960,000
1984	8,100,000	1,900,000
1985	7,200,000	2,800,000
1986	0	7,250,000
1987	0	2,100,000
1988	0	1,660,000
1989	0	1,660,000
1990	0	1,660,000
1991+	0	0

1WHC-SD-ER-TA-001, Rev. 0 (WHC 1991).
*There are no reliable data available for average flow rates and effluent discharge rates for 1301-N. Estimates based on discharge volumes from 1973 to 1976 were used for 1964 through 1972. Data for 1973 through 1989 were taken from the yearly effluent release reports.
LWDF = liquid waste disposal facility

A3.0 GROUNDWATER MONITORING

A3.1 AQUIFER IDENTIFICATION

The unconfined aquifer in the 100-N Area is located primarily in the upper part of the Ringold Formation (sands and gravels) and is approximately 12 to 15 m (40 to 50 ft) thick. The base of the aquifer is believed to be a laterally continuous clay-rich unit containing a series of paleosols. Lithologies in this unit range from clay and silt to sand. Most of the wells in the 100-N Area did not penetrate through the clay layer; therefore, the thickness of the clay-rich unit is unknown at most locations.

The water table is approximately 21 to 23 m (69 to 75 ft) below land surface near 1301-N and approximately 23 m (75 ft) below land surface near 1325-N. Water levels have returned to these "pre-Hanford" levels after years of groundwater mounding caused by artificial recharge from the units and other effluent disposal in the 100-N Area.

A representative range of transmissivity estimates for the unconfined aquifer in the 100-N Area is 93 to 560 m^2/day (1,000 to 6,030 ft^2/day) throughout most of that area. Wells in the northwest portion seem to show a higher transmissivity (up to 1,900 m^2/day [20,500 ft^2/day]). These values correspond to horizontal hydraulic conductivity of 6 to 37 m/day (20 to 121 ft/day), and 120 m/day (394 ft/day) in the northwest portion. Specific yield is estimated at 0.1 to 0.3.

Hartman and Lindsey (1993) describe the hydrogeology of the 100-N Area in more detail.

A3.2 INTERIM STATUS GROUNDWATER MONITORING

Groundwater monitoring began at 1301-N and 1325-N in December 1987. The original monitoring networks were modified over the years as water levels declined and new wells were installed to replace dry wells.

After the first year of groundwater monitoring at 1301-N, specific conductance in one downgradient well was found to be elevated above background (i.e., upgradient) levels. A groundwater quality assessment program was initiated (Gilmore and Jensen 1989). The assessment program found no evidence that dangerous waste or dangerous waste constituents from 1301-N had entered the groundwater (Hartman 1992). Rather, the elevated specific conductance was caused by sulfate/sodium contaminated groundwater coming from the nearby 1324-N/NA site. In 1992, the groundwater monitoring program at 1301-N reverted to an indicator parameter monitoring program, as described in 40 CFR 265.93(d)(6). An additional upgradient well was added to the network to reflect the influence of 1324-N/NA. New critical mean values were established for indicator parameters, and the site remains in indicator evaluation status.

Some contamination has been detected in the groundwater under or near the 1301-N and 1325-N units. Two dangerous waste constituents, nitrate and chromium, were found to be at levels above the MCL (Hartman and Dresel, 1997). Nitrate levels above the MCL of 44 mg/L were observed in well 199-N-3 and 199-N-32 in 1996. Well 199-N-3 monitors the 1301-N unit and well 199-N-32 monitors the 1325-N unit. Nitrate values from nearby wells monitoring the same interval are not above the MCL. Chromium concentrations above the MCL of 0.1 mg/L have been observed in wells 199-N-33 and well 199-N-80 in 1996. Well 199-N-33 monitors the 1325-N unit. The 1996 data from well 199-N-33 is considered anomalous. Well 199-N-80 monitors the bottom zone of the unconfined aquifer and is located downgradient from 1301-N. Wells monitoring the upper part of the unconfined aquifer for 1301-N do not have values of chromium above the MCLs. Although contamination has been detected as described, the interim status groundwater monitoring configuration did not identify these constituents as releases attributable to operation of, or residual contamination in, the 1301-N and 1325-N units through statistical analysis of upgradient versus downgradient wells.

The 1325-N unit has been monitored under an indicator evaluation program throughout its history of *Resource Conservation and Recovery Act of 1976* (RCRA) monitoring. Wells were added or deleted from the network to reflect changing conditions.

Groundwater is monitored under several programs in addition to the RCRA in the 100-N Area. The most significant programs in terms of numbers of wells and analytes are those of the RCRA, sitewide surveillance, and CERCLA. Sampling and analysis for RCRA, CERCLA, and sitewide surveillance monitoring have been coordinated for several years to avoid duplication. However, this coordination did not include the planning stages of the monitoring programs.

In an attempt to reduce redundancy further and make monitoring more efficient, representatives of the various contractors involved in 100-N groundwater monitoring held a series of workshops to consolidate and streamline monitoring. Monitoring networks were redesigned to disseminate information for all programs as efficiently as possible, and constituent lists were trimmed to the constituents of concern. Sampling frequency also decreased in some cases. Sampling trips and analytical costs are divided among data users. Borghese et al. (1996) describe the well and constituent lists for the combined program. That document does not include requirements for sampling and analysis protocols, QC, or statistical evaluations. Hartman (1996a) presents a revised groundwater monitoring plan for the RCRA program, and this is summarized in the following section.

A3.2.1 Well Location and Design

The monitoring network for 1301-N includes two upgradient wells and three downgradient wells (Figure A-2, Table A-3). All of the wells monitor the unconfined aquifer. As-built diagrams are included in Hartman (1996a). One of the downgradient wells, 199-N-105A, is an extraction well for the CERCLA pump-and-treat system. This well is screened across the entire thickness of the uppermost aquifer (7.3 m [24 ft]) instead of just the top 3.0 to 4.6 m (10 to 15 ft) of the aquifer

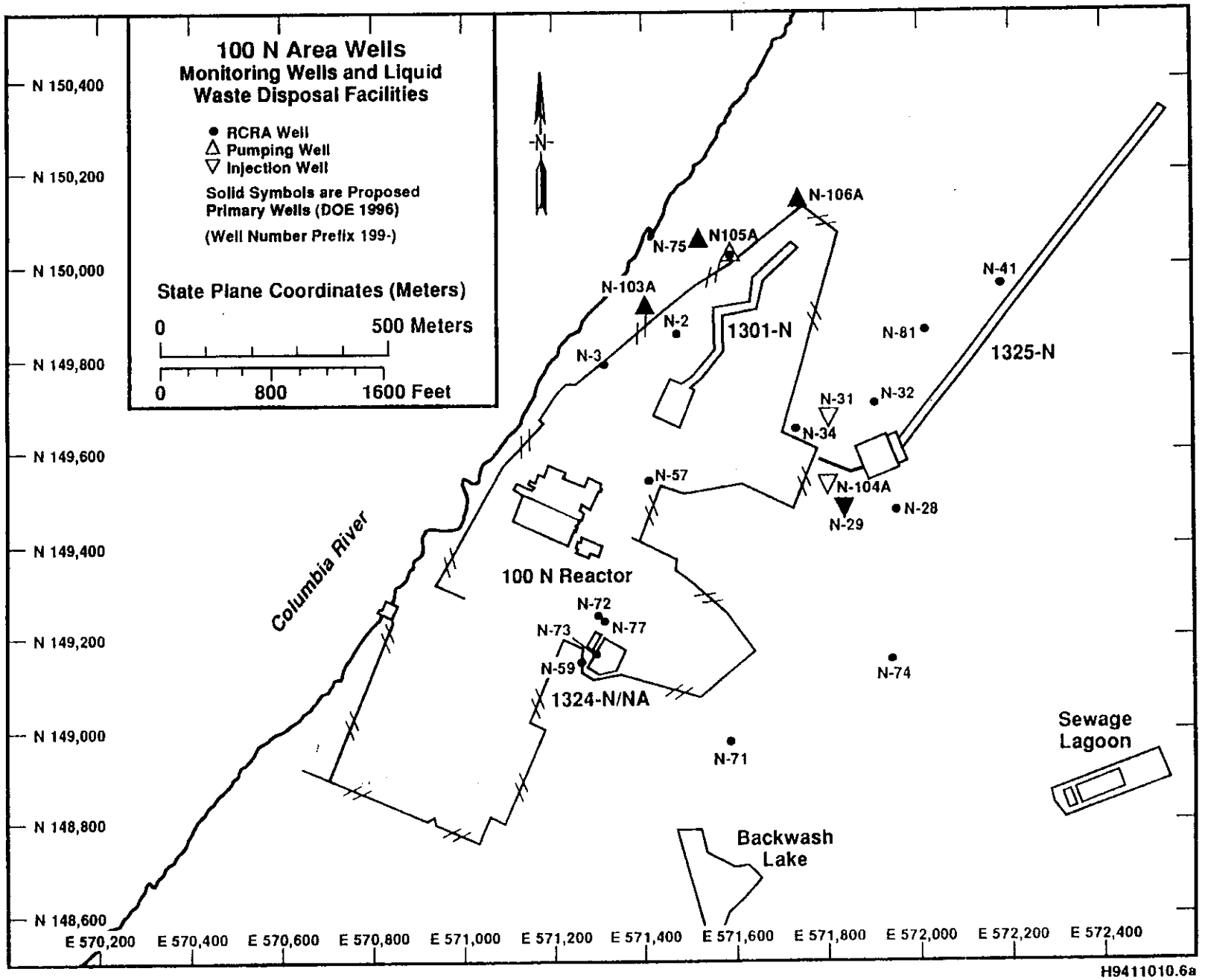


Figure A-2. Proposed RCRA Groundwater Monitoring Network for the 1301-N and 1325-N Units.

Table A-3. Proposed RCRA Groundwater Monitoring Networks for the 1301-N and 1325-N Liquid Waste Disposal Facilities.

Well Number	Proposed Network	Drill Date	Elev. T.O.C.[a] (m)	Casing/Screen Materials	Screened or perf'd depth[b] (m)	Depth to Water[c] (m)
199-N-2	1301-N	1964	140.129	Carbon steel/ perf'd casing; no annular seal	10.7 - 28.0	21.010 (6/96)
199-N-3	1301-N	1964	140.015	Carbon steel/ perf'd casing; no annular seal	10.4 - 27.7	20.793 (6/96)
199-N-28	1325-N	1983[d]	141.647	Carbon steel/ stainless steel w/ packer; surface seal	14.32 - 25.3	23.311 (9/94)
199-N-32	1325-N	1983	140.990	Carbon steel/ stainless steel w/ packer; surface seal	13.4 - 24.1	22.357 (3/96)
199-N-34	1301-N	1983	140.247	Carbon steel/ stainless steel w/ packer; surface seal	10.4 - 23.5	21.732 (3/96)
199-N-41	1325-N	1984	139.626	Carbon steel/ stainless steel w/ packer; surface seal	16.2 - 22.3	21.193 (3/96)
199-N-57	1301-N	1987	139.671	Stainless steel/ stainless steel; full annular seal	17.7 - 22.3	20.708 (3/96)
199-N-74	1325-N	1991	139.482	Stainless steel/ stainless steel; full annular seal	18.0 - 24.4	20.537 (6/96)
199-N-81	1325-N	1993	142.067	Stainless steel/ stainless steel	21.3 - 27.4	22.552 (3/96)
199-N-105A	1301-N	1995	140.655	Stainless steel/ stainless steel; full annular seal	21.0 - 28.7	21.220 (7/95)

[a] Surveyed to North American Vertical Datum of 1988.
[b] Approximate depth below land surface; converted from feet.
[c] Depth below top of casing; converted from feet.
[d] Well 199-N-28 to be used for supplemental information; no statistical evaluations.

like the other wells. Because it is an extraction well, 199-N-105A will pull in water from beneath a large area of the 1301-N Trench, making it a useful monitoring well.

The construction of some of the 1301-N wells does not meet WAC requirements (see Table A-3). Wells 199-N-2 and 199-N-3 have perforated, carbon steel casing and no annular seals. However, these wells appear to yield representative data, and installing new wells is not warranted. Ecology has accepted the data from these and other wells since RCRA monitoring began at the 100-N Area in 1987.

The monitoring network for 1325-N will include one upgradient and three downgradient wells (see Figure A-2 and Table A-3). Treated water from the CERCLA pump-and-treat system is injected into well 199-N-29 near the 1325-N. Well 199-N-28 is used by the RCRA program to monitor potential effects of injected water; it is not being used in statistical evaluations.

A3.2.2 Sampling and Analysis Plan

The *Groundwater Monitoring Plan for the 1301-N, 1325-N, and 1324-N/NA Sites* (Hartman 1996b) describes the sampling and analysis plan for RCRA monitoring. Groundwater is sampled for the constituents listed in Table A-4. Indicator parameters are analyzed semiannually; additional parameters are analyzed annually.

Table A-4. Constituent List for 1301-N and 1325-N.

Analyzed Semiannually	Analyzed Annually
Contamination Indicator Parameters (Quadruplicate samples): Specific conductance (field) pH (field) Total Organic Carbon Total Organic Halogen Turbidity (field)	ICP Metals (filtered) Anions Alkalinity

ICP = Inductively Coupled Plasma

Groundwater sampling procedures, sample collection documentation, and chain-of-custody requirements are described in *Environmental Investigation and Site Characterization Manual (EI)* (WHC-CM-7-7), the *Environmental Activities Procedural Manual* (WHC-CM-7-8), and in the *Quality Assurance Project Plan for Groundwater Monitoring Activities Managed by Westinghouse Hanford Company* (WHC 1995). Work by other contractors is conducted to their equivalent approved standard operating procedures. Procedures for field measurements (pH, conductivity, turbidity) are specified in WHC-CM-7-8 and in the user's manuals for the meters used. Analytical methods are selected from those provided in *Test Methods for Evaluating Solid*

Wastes, Laboratory and Field Manuals for Physical/Chemical Methods (EPA 1990) as specified by WHC (1995) or its most recent revision.

A3.2.3 Quality Assurance and Quality Control

Quality assurance (QA) requirements are defined in the *Westinghouse Hanford Company Quality Assurance Manual* (WHC-CM-4-2) and Article 31 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1996). Additional requirements for QA and QC are included in the *Quality Assurance Project Plan for Groundwater Monitoring Activities Managed by Westinghouse Hanford Company* (WHC 1995) or its most recent revision.

A3.3 RESULTS OF GROUNDWATER MONITORING

A3.3.1 Potentiometric Levels

At various times in the history of waste disposal at the 100-N Area, groundwater mounds formed beneath 1301-N and 1325-N. Changes in water levels are illustrated in Figure A-3. Water levels have returned to "pre-Hanford" levels in the 100-N Area but are still affected by changes in river stage and, recently, by the operation of pumping and injection wells.

Water levels are measured in all wells before sampling. Many of the wells in the 100-N Area are also measured as part of the site-wide semiannual water level program (Serkowski et al. 1995). The Environmental Restoration Contractor has equipped about 20 wells with pressure transducers and data loggers. Any of the data described above can be used to construct water table maps to aid in determining groundwater flow directions.

During average or low river stage, natural groundwater flow is toward the northwest beneath 1301-N. When river stage is high, the gradient is reversed, and there is a potential for water to flow out of the river into the aquifer. Groundwater flow beneath 1325-N is toward the north regardless of river stage.

A groundwater pump-and-treat system has been in operation in the 100-N Area since August 1995. DOE-RL (1996b) reports the results of an evaluation of the first phase of the system's operation. Data from a network of transducers were used to construct water table maps and estimate capture zones.

Pumping of wells between 1301-N and the Columbia River has created a groundwater depression. Groundwater flows toward the pumping wells from the river and from beneath 1301-N. Treated water is injected into a well near 1325-N.

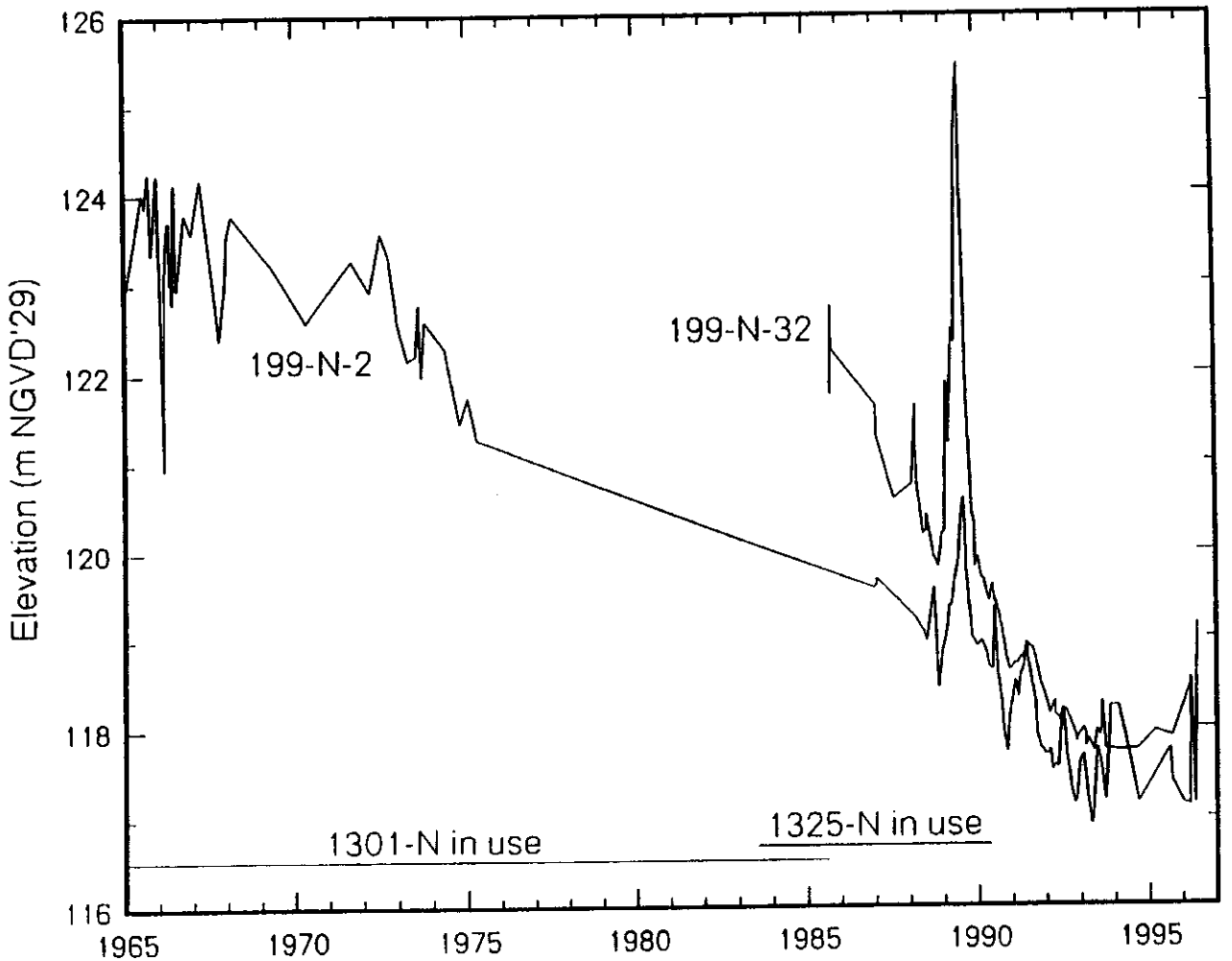


Figure A-3. Water Level Changes in Groundwater Below 1301-N and 1325-N.

Vertical groundwater gradients are not well defined in the 100-N Area. There is no significant difference in head between wells completed at the top and bottom of the unconfined aquifer. There does appear to be an upward gradient immediately adjacent to the river. Water levels in deeper wells were consistently higher than shallow wells or the river, indicating an upward gradient (Gilmore et al. 1991).

A3.3.2 Groundwater Quality

Groundwater quality in the unconfined aquifer beneath the 100-N Area has been affected by 1301-N, 1325-N, and the 1324-NA Percolation Pond. In addition, various leaks and spills may have affected soil or groundwater chemistry (DOE-RL 1991). Data from RCRA sampling and analysis are reported electronically in the Hanford Environmental Information System database. Interpretation of the data are included in annual reports (Hartman 1996a).

The indicator parameters at the 1301-N and 1325-N units are specific conductance, pH, total organic carbon (TOC), and total organic halogens (TOX) (40 CFR 265.92[b][3]). Groundwater is also analyzed for other constituents that were discharged to the 1301-N and 1325-N units during their use. These analytes include nitrate, chromium, phosphate, lead, and cadmium. Samples have also been analyzed for mercury and volatile organics in the past. Chromium, lead, and cadmium (in filtered samples), phosphate, or volatile organics have not been detected in 1301-N or 1325-N groundwater in significant concentrations. Nitrate increased in some wells near 1301-N and 1325-N during 1995, exceeding the drinking water standard in wells 199-N-2 and 199-N-3. One well southwest (upgradient) of 1301-N also had nitrate above the standard. Concentrations decreased in wells 199-N-2 and 199-N-3 in early 1996, but increased in excess of the drinking water standard in well 199-N-32. The source of nitrate is unknown.

While the 1301-N and 1325-N units were in use, they introduced radioactive constituents, primarily tritium and strontium-90, to the groundwater. These are not considered dangerous waste constituents under interim status RCRA regulations, but were monitored by RCRA in the past because they are the primary contaminants originating from the units.

A3.4 GROUNDWATER MONITORING DURING CLOSURE

A3.4.1 Monitoring Program

Groundwater monitoring will be done in accordance with the existing groundwater monitoring program (Borghese, et.al 1996).

A3.4.2 Inspection, Maintenance, and Replacement of Wells

Each time a well is sampled, the well head and associated structures are inspected. Problems with the pump or with the sample (e.g., excessive turbidity) are also noted. Repairs are made according to approved contractor procedures. Subsurface inspection and maintenance is performed on a 3- to 5-year schedule, or as needed to repair problems identified during sampling.

If a monitoring well becomes unsuitable for use, the monitoring program will be reevaluated to determine if a new or existing well should be substituted.

A4.0 CLOSURE ACTIVITIES

The physical activities required to close 1301-N and 1325-N in accordance with WAC 173-303-610 and the Permit will be integrated with the ROD for this TSD CMS. The ROD and the remedial design for the selected alternative will specify further the closure activities that will be required for CERCLA remedial action. Closure activities necessary to comply with dangerous waste regulations and the Permit will need to be consistent with CERCLA activities. CERCLA activities will be required to include elements necessary for closure of a dangerous waste unit. The Closure Plan presents the physical remedial activities and the sampling and analysis required to comply with WAC 173-303-610 and the Permit for each of the remedial alternatives presented in this TSD CMS and as defined in Section A1.2.

The closure activities are discussed in this section to highlight the site-specific elements of removal or characterization as clean of structures and piping for the 1301-N and 1325-N units. The other closure activities are not well defined for these sites at present but will be developed during the remedial design phase. Additional details about the alternatives can be found in Section 5.2 of the TSD CMS.

A4.1 REMOVAL OF STRUCTURES

The structures in 1301-N and 1325-N include concrete structures and earthen basins and trenches. The 1301-N structures are discussed in Section 2.4.1 of the TSD CMS. Figure 2-5 shows the earthen crib structure, and Figure 2-6 shows the concrete weir box. Figures 2-8 and 2-9 illustrate the trench. Figures 2-10 through 2-13 show the trench cover support beams and cover panel configuration.

Structures in 1325-N are discussed in Section 2.4.3 of the TSD CMS Report. Figures 2-17 and 2-18 show the crib, concrete cover, and effluent distribution system. Figures 2-19 and 2-20 show the trench and tie-in structure.

A4.1.1 Earthen Structures

The contaminated soil in the earthen structures will be excavated by conventional earthmoving techniques. Removal technologies are described in Section 5.1.3 of the TSD CMS Report. Differing amounts of contaminated soils will be generated depending upon the remedial alternative selected for 1301-N and 1325-N. Alternatives that include soil removal are described in Sections 5.2.1.5 through 5.2.1.8 of the TSD CMS Report for a residential exposure scenario and in Sections 5.2.2.5 through 5.2.2.8 for a modified CRCIA ranger/industrial exposure scenario. After loading into containers, contaminated soils will be treated if necessary and/or disposed in an approved disposal facility on the Hanford Site. Particular attention will be given to the protection of workers and the environment from exposure to airborne contaminants during excavation and container loading. Dust mitigating measures, such as water sprays and chemical fixatives, may be employed to control fugitive dust emissions. The as low as reasonably achievable review will consider the use of shielding and/or remote handling techniques to reduce worker exposures from direct ionizing radiation.

The 1301-N unit demolition waste volumes are discussed in the TSD CMS Sections 4.5.1.1 and 4.5.1.2 for the earthen crib structure and Sections 4.5.2.1 and 4.5.2.2 for the trench. The 1325-N unit demolition volumes are presented in the TSD CMS Sections 4.5.3.1 and 4.5.3.2 for the crib, and in 4.5.4.1 and 4.5.4.2 for the trench. Waste volume tabulations are provided in Appendix D of the TSD CMS.

A4.1.2 Concrete Structures

Alternatives that include removal of concrete structures are described in the TSD CMS Report, Sections 5.2.1.3 through 5.2.1.8, for a residential exposure scenario, and in Sections 5.2.2.3 through 5.2.2.8 for a modified CRCIA ranger/industrial exposure scenario. The concrete weir box in the 1301-N Crib will be removed as contaminated waste. Demolition of the structure may be necessary or advantageous prior to removal. Dust controls will be employed to control fugitive emissions during any demolition. The demolition waste volume of the weir box is discussed in Section 4.5.1.3 of this TSD CMS.

The concrete cover support beams and cover panels over the 1301-N Trench and 1325-N Crib and trench will be removed as intact components, if possible. Demolition activities, if required, will be minimized to maintain control of airborne releases and to simplify soil excavation in the trench. As with the earthen structure removal, particular attention will be given to the control of fugitive dusts and worker exposures to direct ionizing radiation. The demolition waste volume of the cover system is discussed in Section 4.5.2.3 of this TSD CMS for 1301-N, and in Section 4.5.4.3 for 1325-N. Waste volume tabulations are provided in Appendix D of this TSD CMS.

Demolition debris and solid wastes in the cribs and trenches potentially include demolished concrete, wooden poles, and netting. These materials will be removed during crib and trench excavation operations and disposed with the contaminated soils.

A4.2 PIPING REMOVAL OR CHARACTERIZATION AS CLEAN

The remediation of 1301-N and 1325-N includes the excavation and removal of the contaminated piping systems that have not been characterized and determined to be clean (i.e., contain no dangerous waste constituents above residential MTCA B concentrations) between N Reactor and the cribs. Alternatives that include removal of piping are described in the TSD CMS Report, Sections 5.2.1.3 through 5.2.1.8, for a residential exposure scenario, and in Sections 5.2.2.3 through 5.2.2.8 for a modified CRCIA ranger/industrial exposure scenario. Two figures are used to illustrate the potential extent of piping removal. Figure 2-14 shows the pipelines to be removed between the 1722-N Building and 1301-N and between 1310-N and 1301-N. Figure 2-21 shows the piping between the 1301-N Crib and the 1325-N Crib. Pipe lengths and map references are provided in Appendix D of the TSD CMS.

The buried pipelines will be unearthed by conventional excavation equipment. The exposed piping may be segmented for removal manually or by remote methods, depending on contact radiation exposures. Contamination controls will focus on the drainage of residual fluids in the piping prior to, and during, segmentation and on the control of airborne contamination during cutting and pipe handling operations. After the piping has been removed, the pipe bedding soil will be surveyed for residual contamination, excavated, and disposed as necessary.

A4.3 SAMPLING AND ANALYSIS ACTIVITIES

A4.3.1 Past Soil Characterization Data

Data used to characterize the vadose zone soils were obtained from six boreholes drilled and sampled to support the 1301-N and 1325-N limited field investigation (LFI) (DOE-RL 1996c). Figure 2-32 of the TSD CMS shows the locations of these boreholes. Two of the boreholes are adjacent to 1301-N (199-N-107A and 199-N-108A), one is next to 1325-N (199-N-109A), and three are located northwest of 1301-N (199-N-75, 199-N-76, and 199-N-80) between that facility and the river. Samples were obtained from near the surface to a depth of up to 30.2 m (99 ft). All of these data are presented in the LFI.

In addition to the boreholes, sediment samples were collected from the 116-N-1 Crib. Data from these samples were not used in this evaluation because of insufficient QC associated with the sample collection process. Other soil samples have been collected from this vicinity, but most have only been analyzed for radionuclides.

Data from the characterization samples are summarized in Appendix A of the 1301-N and 1325-N LFI. These data indicate that chromium is the only metal of concern in vadose zone soils at 1301-N below 3.0/4.6 m (10/15 ft). Chromium exceeded background concentrations in data associated with 1301-N. Mercury is the only other metal that is included in the contaminants of concern (COCs), but no data from the boreholes at 1301-N and 1325-N are available to evaluate the presence or absence of this analyte in vadose zone soils. Therefore, it is retained as a COC in surface soils (0 to 3.0/4.6 m [10/15 ft]). However, as indicated in Appendix G of this TSD CMS,

mercury will not reach groundwater in 1,000 years and therefore is not considered to be a constituent of concern for groundwater protection below 3.0/4.6 m (10/15 ft). Evaluation of nitrate concentrations in the soil is similarly limited because of a paucity of data, so that substance has been retained as a COC. Nitrate is a mobile constituent, and a nitrate plume exists in the groundwater. Therefore, nitrate is considered a COC for both surface and subsurface soils.

Data from the three boreholes located outside of these facilities indicate that no metals are above background values. One sample from the 150- to 180-cm (5- to 6-ft) interval in borehole 199-N-76 was analyzed for mercury, and its value is well below typical background concentrations. These data indicate that metals deposited in the TSDs did not migrate laterally in the vadose zone any substantial distance.

The organic analyte methanol is included in the COCs . It is considered a COC because of its inclusion in the Part A permit. The LFI sampling was not analyzed for the presence of methanol, and methanol was not listed as detected in any other sampling efforts. Acetone, however, was detected in three samples collected from boreholes outside of the facilities, at concentrations up to 51 ppb. Organic analytes were not analyzed in samples collected within and adjacent to the TSD units; however, field screening using an organic vapor monitor did not detect any organic compounds. Acetone is a common laboratory contaminant, and most of the data reported by the laboratory are either at detection limit or are associated with a blank that contained detectable amounts of acetone. These circumstances cast doubt on the presence of detectable quantities of acetone in the wells outside the bounds of the TSD unit.

A4.3.2 Characterization Activities to Determine Closure Option

To determine the appropriate closure option for 1301-N and 1325-N in accordance with Condition II.K. of the Permit, sampling and analysis will be required to verify whether a modified closure option has been achieved. As presented in Section A4.3.1 and in Table 4-17 of this TSD CMS, dangerous waste constituents are retained as constituents of concern in both surface soils and subsurface soils. All alternatives (other than the No-Action Alternative) will result in the removal of dangerous waste constituents above 3.0 m (10 ft) bgs for the modified CRCIA ranger/industrial exposure scenario and 4.6 m (15 ft) bgs for the rural-residential scenario. This will result in removal of all soils that could be contaminated at levels that present a direct exposure hazard as defined in MTCA. Verification sampling to determine MTCA direct soil exposure standard compliance will therefore not be required unless some areas around the units are not excavated and removed to the 3.0m and 4.6m level. Verification sampling will be performed on contaminants that may be present below 3.0 m or 4.6 m for the purposes of determining compliance with groundwater protection standards.

As part of the closure activities for these units, a data quality objectives (DQO) process will be initiated to define extent and type of sampling and analysis during and after excavation. This effort will define sampling issues which may include analytes of interest, sample location, number of samples, number and frequency of field QC samples (i.e., trip blanks, equipment blanks, splits, and duplicates), sampling methodology, analytical methods, laboratory protocols,

laboratory validation, data error tolerances, and data evaluation methods. This DQO effort will culminate in an Ecology-approved sampling and analysis plan.

Alternative-specific sampling and analysis activities are as follows:

RRES-6 and MCRIS-6 - The Remove/Treat if Required/Dispose/Backfill (Removal) alternatives will require sampling and analysis at the end of excavation to determine that, at a minimum, a modified closure option has been attained. Dangerous waste constituents must be below MTCA Method C direct soil exposure and groundwater protection standards in order to preclude landfill closure and placement of a cover. Dangerous waste constituents must be below MTCA B direct soil exposure and groundwater protection standards in order to achieve remediation under RRES-6.

MCRIS-7 - The Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Backfill/Capping alternative will result in the placement of a WAC 173-303-compliant cover should dangerous waste constituents be left in place above MTCA Method C levels. Concentrations of dangerous waste constituents remaining under the units would be irrelevant to the need for placement of a landfill cover; however, to determine whether other landfill postclosure requirements should be imposed at one or both units, concentrations of constituent would need to be defined. Sampling would be required after excavation and/or prior to backfilling and placement of the cap for this alternative.

MCRIS-8 - Sampling and analysis would be required for the Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Vitrify (Vitrification) alternative to define the extent of contamination of the dangerous waste constituents needing treatment. Sampling after vitrification may be required in order to determine the effectiveness of the treatment for dangerous waste constituents.

In addition to the sampling described above, sampling may be performed during excavation to help define extent of contamination, to guide field activities, and for waste characterization to determine ex situ treatment and disposal requirements.

A4.3.3 Piping Characterization

Should a determination be made that piping associated with the 1301-N and 1325-N units may be able to meet clean closure standards and be left in place, such a determination will be submitted to Ecology for their concurrence. This determination may be based on process knowledge, sampling, or both.

A4.4 WASTE MANAGEMENT

Closure of the 1301-N and 1325-N units in accordance with the remedial alternatives identified will generate low-level radioactive or mixed waste in the form of contaminated soils and debris. Disposal of these wastes will be performed at the Environmental Restoration Disposal Facility or the W-025 Trench, both located on the 200 Area Plateau of the Hanford Site, in compliance with

WAC 173-303 for any dangerous or mixed waste that will be generated. If generated wastes do not meet the acceptance criteria for these units, such as compliance with land disposal restrictions (40 CFR 268), a disposal plan will be developed to determine appropriate treatment or disposal options for these wastes. Waste generated as part of this remediation activity will be managed and disposed of in such a way as to ensure protection of human health and the environment.

Waste generation, management, and disposal will be conducted in accordance with operational procedures and with all State, Federal, and DOE Orders and regulations dealing with waste, including agreements with the public and stakeholders.

A4.5 MODIFIED CLOSURE INSTITUTIONAL CONTROL REQUIREMENTS

Should a modified closure option be determined for 1301-N and/or 1325-N, institutional controls in accordance with Permit Condition II.K.3.a and WAC 173-340-440 shall be adhered to. Institutional controls consist of physical measures and administrative and legal mechanisms. Possible methods of controlling access to contaminated sites include placement of signs, entry control such as locked fencing, artificial or natural barriers, and active surveillance. Measures to be used depend on specific site conditions and degree of hazard associated with contamination left at the end of remediation activities. Because of this, specific institutional controls cannot be detailed until after selection of an alternative and incorporation of design elements during the remedial design phase.

A notice in deed and survey plat will be submitted to the Benton County Auditor as described in Section A4.11.

A4.6 FINAL COVER REQUIREMENTS FOR LANDFILL CLOSURE

Should dangerous waste contaminants be left within the soil column above MTCA Method C levels, a landfill cover would need to be designed and constructed over the unit(s). Specific design aspects associated with a landfill cover would require development after the ROD and during the remedial design phase associated with 1301-N and 1325-N.

A4.7 PERSONNEL TRAINING

Training will be provided to site personnel in accordance with the 1301-N and 1325-N training plan contained in Attachment A-4. This training will be effective until the postclosure period. At that point, the personnel training information contained in Section A5.4 will supplement training of personnel for postclosure care activities.

A4.8 CLOSURE CONTACT

The DOE-RL will be the official contact for 1301-N and 1325-N during the postclosure period at the following address:

Director, Environmental Assurance, Permits, and Policy Division*
U.S. Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

*or its equivalent should there be a future reorganization at DOE-RL

A4.9 CLOSURE SCHEDULE

The closure schedule for 1301-N (116-N-1) and 1325-N (116-N-3) is presented in Figure A-4. Closure activities (actual cleanup) for 116-N-3 will begin in July 2000 and will continue for an approximate duration of 15 months. At the completion of 116-N-3, closure activities at 116-N-1 will begin. The approximate duration of completion for both TSD units is 3 years. The corrective action schedule of compliance for UPR-100-N-31 will be the same as the closure schedule.

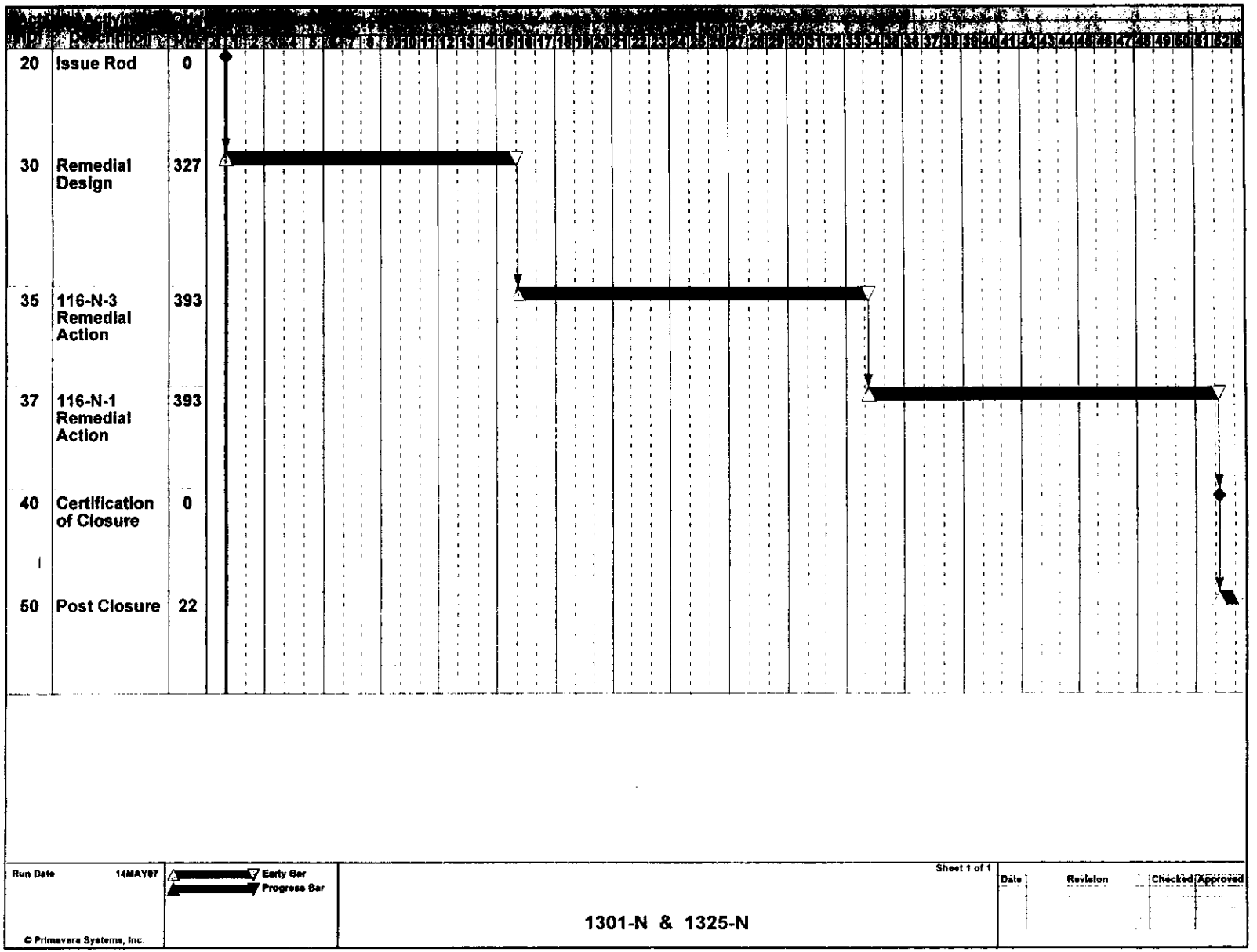
A4.10 AMENDMENT OF CLOSURE PLAN

The 1301-N and 1325-N closure plan will be amended whenever changes in closure activities or postclosure requirements occur and prior to certification of closure and postclosure, respectively, that would constitute a Class 1, 2, or 3 modification to the Permit (WAC 173-303-830).

A4.11 CERTIFICATION OF CLOSURE

In accordance with WAC 173-303-610(6), within 60 days of closure of 1301-N and 1325-N, RL will submit to Ecology a certification of closure signed by both RL and an independent registered professional engineer. The certification will specify that the units have been closed in accordance with specifications contained within the approved closure plan, as amended, and as contained in the Permit.

Figure A-4. Closure Schedule for 1301-N and 1325-N.



A4.12 SURVEY PLAT AND NOTICE IN DEED

A survey plat will be submitted by RL to the Benton County Planning Department no later than 60 days after certification of closure of each unit in accordance with WAC 173-303-610(10). Also, a notice in deed will be submitted by RL to the Auditor of the Benton County no later than 60 days after certification of closure of each unit in accordance with WAC 173-303-610(10). After submitting this notice, a certification signed by the Permittees will be submitted to Ecology stating that notification has been recorded along with a copy of the notice in deed. The notice in deed will specify the type, location, and quantity of dangerous wastes remaining after closure actions have been completed.

A5.0 POSTCLOSURE PLAN

Postclosure requirements will be applicable to 1301-N and 1325-N. Because it is uncertain whether postclosure requirements would involve modified closure requirements or landfill requirements, actions necessary to comply with both closure options are presented.

A5.1 MODIFIED POSTCLOSURE INSTITUTIONAL CONTROLS AND PERIODIC ASSESSMENTS

Institutional controls under a modified closure option will consist of continued restrictions to access and use of groundwater and may consist of access controls to surface soils or deeper soils such as a fence. Institutional controls will be defined after remedial alternative selection. Inspections and maintenance of institutional controls and monitoring will be requirements of postclosure under a modified closure option.

A5.1.1 Periodic Assessments

Periodic assessments shall include a compliance monitoring plan in accordance with Permit Condition II.K.3.b. and WAC 173-340-410. The compliance monitoring plan will address the assessment requirements, which include protection and confirmation monitoring. This will include at least one assessment activity that is to take place after a period of five years from the completion of closure. The assessment activity will demonstrate whether the soils and groundwater have been maintained at or below the allowed concentrations for a modified closure as defined in Permit Condition II.K.3. The compliance plan will identify the nature and date of the assessment activities and will include a timetable for performance of these activities. This information will be contained in the CERCLA Operation and Maintenance Plan and its supporting documents.

Should the required assessment activities identify contamination above the allowable limits (i.e., landfill closure levels specified in Permit Condition II.K.4.), the unit must be further

remediated or the postclosure plan must be modified to include activities to be undertaken at the unit to meet landfill closure and postclosure requirements. Should the required assessment activities demonstrate that contamination has diminished or remained the same, the Permittees may request that Ecology reduce or eliminate the assessment activities and/or institutional controls.

As allowed by WAC 173-340-410, such monitoring may be combined with other plans, and it is the intention that protection and confirmation sampling of groundwater be achieved through implementation of the dangerous waste final status groundwater monitoring plan to be written prior to, and implemented upon, the effective date of the Permit modification adding 1301-N and 1325-N to the Permit (anticipated to occur in 1999).

In addition to groundwater monitoring, compliance monitoring for institutional controls will include routine visual inspections and evaluations. Visual inspections shall consist of examinations of soil cover surfaces for signs of deterioration and improper usage of the surface area (e.g., buildings, impervious surfaces such as concrete or asphalt). An evaluation of existing data from the groundwater monitoring system should also be performed, as well as any other activities that would help assess the integrity of the cover.

A5.1.2 Inspections

Inspections of institutional controls and groundwater monitoring systems under a modified closure option will be required. Groundwater monitoring postclosure inspection requirements will be identical to those under a landfill closure option and are contained in Section A5.2. Because the exact nature of institutional controls that may be utilized at 1301-N and 1325-N depend upon the remedial alternative chosen, site conditions, further characterization efforts, and the success of remedial actions taken, a list of potential inspection items is contained in Table A-5. Frequency of inspection of these potential items is also contained in this table. These inspections may be implemented in checklist form. Such a checklist could specify entering checklist performance and results in the appropriate inspection logbook.

A5.1.2.1 Inspection Logbook. Inspectors will be trained in accordance with the postclosure personnel training plan contained in Section A5.4. The inspector will record any damage to the area and/or maintenance needs as well as the weather conditions at the time of inspection. Separate logbook entries will be signed and dated. Performance of any related inspection checklists will be documented in the logbook. Maintenance actions will be started and should be completed within 90 days. Logbook entries will document the correction of the problem or the status of corrective actions. Entries should also uniquely identify, where possible, work documents that actually performed the activities.

A5.1.2.2 Security Control Devices. The 1301-N and 1325-N units are currently surrounded by a fence with locked gate access. If fences are removed to accommodate remedial activities, they will be replaced with an appropriate physical barrier, if required, in accordance with institutional controls defined after remedial alternative selection.

Table A-5. Minimum Inspection Schedule for 1301-N and 1325-N.

Item(s)	Inspection Frequency		
	Monthly	Quarterly	Annually
Security control devices			X
Erosion damage	X (until vegetative cover is established)	X (thereafter)	
Cover settlement and displacement		X	
Condition of vegetative cover	X (first 2-3 years)	X (thereafter)	
Well condition and purge water collection system		X	
Benchmark integrity			X

A5.1.2.3 Erosion Damage and General Integrity. Should surface ground covers or other earthen barriers be utilized as part of the modified closure institutional controls for 1301-N and 1325-N, inspection of these systems for erosion control and general integrity will be performed. Inspection frequency will be quarterly and will be performed by physically walking over the site to visually check for wind and water erosion, subsidence, displacement, and general site integrity. Any site damage noted during inspections will be recorded in the field logbook and reported to the appropriate maintenance authority.

A5.2 LANDFILL POSTCLOSURE REQUIREMENTS

Should a landfill cover be required, an inspection and maintenance plan will be developed during remedial design for the 1301-N and 1325-N cover systems.

A5.3 GROUNDWATER MONITORING POSTCLOSURE REQUIREMENTS

A5.3.1 PostClosure Groundwater Monitoring

During the postclosure period, monitoring of groundwater will continue according to the existing groundwater monitoring program (Borghese et.al 1996). The detection monitoring program in accordance with WAC 173-303-645(9) is scheduled for implementation when the 1301-N and 1325-N units are incorporated in the Permit.

A5.3.2 Inspection, Maintenance, and Replacement of Wells

Each time a well is sampled, the well head and associated structures are inspected. Problems with the pump or with the sample (e.g., excessive turbidity) are also noted. Repairs are made

according to approved contractor procedures. Subsurface inspection and maintenance is performed on a 3- to 5-year schedule, or as needed to repair problems identified during sampling.

If a monitoring well becomes unsuitable for use, the monitoring program will be reevaluated to determine if a new or existing well should be substituted.

A5.4 PERSONNEL TRAINING DURING POSTCLOSURE

This section describes the training of personnel required to complete postclosure care requirements contained in this closure plan and the Permit. It is intended to supplement the training plan currently in place and identified in Attachment A-4. A brief description of how training will be designed to meet job tasks is presented below.

A5.4.1 Surveillance Personnel

The following outline provides potential information on classroom or on-the-job training that surveillance personnel will complete before conducting independent site surveillance at 1301-N and 1325-N during a postclosure period. Only those that are applicable to the selected closure option will be used:

- Site surface inspections (water and wind erosion, settlement and displacement, vegetative cover)
- Security inspections
- Location, integrity, and inspection of benchmarks, if appropriate
- Location, integrity, and inspection of groundwater wells
- Erosion damage
- Cover settlement and displacement
- Vegetative cover condition.

A5.4.2 Groundwater Sampling and Analysis Task Leader and Sampling Personnel

After closure of 1301-N and 1325-N, 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 , packaging, and shipping groundwater samples to field and offsite laboratories
- Sampling and monitoring equipment operation and maintenance
- Providing sample chain of custody to the laboratory.

The training of the sampling and analysis task leader and sampling personnel will receive either classroom instruction or on-the-job training. Sampling and analysis personnel will be trained to perform these functions in accordance with the *Hanford Analytical Services Quality Assurance Requirements Documents* (DOE-RL 1996d). A person successfully completing the required training courses 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.

A5.4.3 Additional Training Descriptions for Landfill Closure

Training descriptions for additional tasks associated with a landfill closure are as follows:

- Site Cover Inspections - This on-the-job training program is established to ensure that the surveillance personnel know what to inspect after the closure of 1301-N and 1325-N. It will include how to inspect for obvious signs of erosion, proper drainage, settlement, and sedimentation. In addition, personnel will be informed as to what constitutes proper vegetation coverage.

Additional on-the-job or classroom training under a landfill closure option includes the following:

- Site Security Inspections - Personnel will be instructed on how to inspect for obvious signs of a security breach. Signs may include cut fencing, unlocked gates, or cut chains.

- Location, Integrity, and Inspection of Benchmarks - Personnel will be shown the location of benchmarks and report any obvious signs of destruction or deterioration.

A5.5 SECURITY

A5.5.1 24-Hour Surveillance System

The 1301-N and 1325-N units are located within the 100 Area of the Hanford Site. The 100 Area will remain an area controlled by RL for the foreseeable future due to the decommissioning and

deactivation of facilities associated with and including the 100-N Reactor. These areas will be under 24-hour surveillance by Hanford Patrol Protective Force personnel.

A5.5.2 Barrier, Means to Control Entry, and Warning Signs

Roadways to the unit and site access will remain administratively restricted to use by authorized personnel only. Posted federal warning signs restrict access to the 100-N Area from the Columbia River. Further institutional and administrative measures controlling TSD unit site access may be initiated for the site commensurate with the future use of the property.

A5.6 POSTCLOSURE CONTACT

The RL will be the official contact for the 1301-N and/or 1325-N units during the postclosure period at the following address:

Director, Environmental Assurance, Permits, and Policy Division*
U.S. Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

A5.7 CERTIFICATION OF POSTCLOSURE

No later than 60 days after completion of the postclosure care period, RL will submit to Ecology a certification of completion of postclosure care. This certification, stating that postclosure care for the unit was performed in accordance with the approved closure plan, will be signed by RL and an independent registered professional engineer. The certification will be submitted by registered mail or an equivalent delivery service. Documentation supporting the independent registered professional engineer's certification will be supplied upon request of the regulatory authority.

A6.0 REFERENCES

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Gilmore, T. J. and E. J. Jensen, 1989, *Groundwater Quality Assessment Program for the 1301-N Liquid Waste Disposal Facility*, WHC-SD-EN-AP-004, Westinghouse Hanford Company, Richland, Washington.

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Hartman, M.J., and P.E. Dresel, eds, 1997, *Hanford Site Groundwater Monitoring for Fiscal Year 1996*, PNNL-11470, Pacific Northwest National Laboratory, Richland, Washington.

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WHC, 1991, *Numerical Stimulation of Strontium-90 Transport for the 100-N Area Liquid Waste Disposal Facilities*, WHC-SD-ER-TA-001, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995, *Quality Assurance Project Plan for Groundwater Monitoring Activities Managed by Westinghouse Hanford Company*, WHC-SD-EN-QAPP-001, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-2, *Westinghouse Hanford Company Quality Assurance Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-7-7, *Environmental Investigation and Site Characterization Manual*, Westinghouse Hanford Company, Richland, Washington.

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ATTACHMENT A-1

PART A, FORM 3, FOR THE 1301-N LIQUID WASTE DISPOSAL FACILITY

042778

ATTACHMENT 1
7 Pages

REVISION 7 OF FORM 3 DANGEROUS WASTE PERMIT APPLICATION FOR THE 1301-N LIQUID WASTE DISPOSAL FACILITY

1301-N Liquid Waste Disposal Facility
Rev. 7.
042778 Page 1 of 7

Please print or type in the unshaded areas only
(fill-in areas are spaced for elite type, i.e., 12 character/inch).

FORM 3

DANGEROUS WASTE PERMIT APPLICATION

1. EPA/STATE I.D. NUMBER: W A 7 8 9 0 0 0 8 9 6 7

FOR OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED *(mo., day, & yr.)*	COMMENTS

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA/STATE I.D. Number, or if this is a revised application, enter your facility's EPA/STATE I.D. Number in Section I above.

A. FIRST APPLICATION *(place an "X" below and provide the appropriate data)*

[X] 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

MO. 0 3 | DAY 2 2 | YR. 4 3 * FOR EXISTING FACILITIES, PROVIDE THE DATE *(mo., day, & yr.)* OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(see the boxes to the left)*
*The date construction of the Hanford Facility commenced.

[ ] 2. NEW FACILITY *(Complete item below)*

MO. | DAY | YR. FOR NEW FACILITIES, PROVIDE THE DATE *(mo., day, & yr)* OPERATION BEGAN OR IS EXPECTED TO BEGIN

B. REVISED APPLICATION *(place an "X" below and complete Section I above)*

[X] 1. FACILITY HAS AN INTERIM STATUS PERMIT

[X] 2. FACILITY HAS A FINAL PERMIT

III. PROCESSES - CODES AND CAPACITIES

A. PROCESS CODE - Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process *(including its design capacity)* in the space provided on the *(Section III-C)*.

B. PROCESS DESIGN CAPACITY - For each code entered in column A enter the capacity of the process.

1. AMOUNT - Enter the amount.

2. UNIT OF MEASURE - For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER (barrel, drum, etc)	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D80	GALLONS OR LITERS
LANDFILL	D81	ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER
LAND APPLICATION	D82	ACRES OR HECTARES
OCEAN DISPOSAL	D83	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D84	GALLONS OR LITERS

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR; GALLONS PER HOUR OR LITERS PER HOUR
OTHER (Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Section III-C.)	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G
LITERS	L
CUBIC YARDS	Y
CUBIC METERS	C
GALLONS PER DAY	U

UNIT OF MEASURE	UNIT OF MEASURE CODE
LITERS PER DAY	V
TONS PER HOUR	D
METRIC TONS PER HOUR	W
GALLONS PER HOUR	E
LITERS PER HOUR	H

UNIT OF MEASURE	UNIT OF MEASURE CODE
ACRE-FEET	A
HECTARE-METER	F
ACRES	B
HECTARES	Q

EXAMPLE FOR COMPLETING SECTION III *(shown in line numbers X-1 and X-2 below): A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400 gallons.* The facility also has an incinerator that can burn up to 20 gallons per hour.

LINE NUMBER	A. PROCESS CODE *(from list above)*	B. PROCESS DESIGN CAPACITY 1. AMOUNT *(specify)*	2. UNIT OF MEASURE *(enter code)*	FOR OFFICIAL USE ONLY	LINE NUMBER	A. PROCESS CODE *(from list above)*	B. PROCESS DESIGN CAPACITY 1. AMOUNT *(specify)*	2. UNIT OF MEASURE *(enter code)*	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G		5				
X-2	T 0 3	20	E		6				
1	D 8 1	4,320,000	U		7				
2					8				
3					9				
4					10				

Continued from the front.

III. PROCESSES (continued)

C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESS (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY.

D81

The 1301-N Liquid Waste Disposal Facility (LWDF) was used from 1963 to September 1985. The LWDF received mixed process and cooling waste water from N Reactor. The LWDF also received dangerous waste generated from laboratories, and may have received waste from spills within the N Reactor Building, which were discharged through the mixed waste drain system. The dangerous waste discharges consisted of less than 0.002% of the total volume of the waste discharged to the LWDF. The 1301-N LWDF was a percolation unit designed for the disposal of liquid waste through the soil column. The process design capacity for the LWDF was 16,352,900 liters (4,320,000 gallons) a day. The process design capacity reflects the maximum volume of water discharged on a daily basis rather than the physical capacity of the unit. The influent pipes up to the face of the 105-N building facility are considered to be included within the treatment, storage, and disposal unit boundary.

IV. DESCRIPTION OF DANGEROUS WASTES

A. DANGEROUS WASTE NUMBER - Enter the four digit number from Chapter 173-303 WAC for each listed dangerous waste you will handle. If you handle dangerous wastes which are not listed in Chapter 173-303 WAC, enter the four digit number(s) that describes the characteristics and/or the toxic contaminants of these dangerous wastes.

B. ESTIMATED ANNUAL QUANTITY - For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non-listed waste(s) that will be handled which possess that characteristic or contaminant.

C. UNIT OF MEASURE - For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. PROCESSES

1. PROCESS CODES:

For listed dangerous waste: For each listed dangerous waste entered in column A select the code(s) from the list of process codes contained in Section III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non-listed dangerous wastes: For each characteristic or toxic contaminant entered in Column A, select the code(s) from the list of process codes contained in Section III to indicate all the processes that will be used to store, treat, and/or dispose of all the non-listed dangerous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: DANGEROUS WASTES DESCRIBED BY MORE THAN ONE DANGEROUS WASTE NUMBER - Dangerous wastes that can be described by more than one Waste Number shall be described on the form as follows:

1. Select one of the Dangerous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other Dangerous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other Dangerous Waste Number that can be used to describe the dangerous waste.

EXAMPLE FOR COMPLETING SECTION IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* - A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non-listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE NO.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
X-1	K054	900	P	T03 D80	
X-2	D002	400	P	T03 D80	
X-3	D001	100	P	T03 D80	
X-4	D002			T03 D80	included with above

CONTINUE ON PAGE 3

1301-N Liquid Waste Disposal Facility
Rev. 7.
Page 3 of 7

Continued from page 2.
NOTE: Photocopy this page before completing if you have more than 26 wastes to list.

I.D. NUMBER (entered from page 1) WA7890008967

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

LINE NO.	A. DANGEROUS WASTE NO. (enter codes)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter codes)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
1	F003	6,200	P	D81	Percolation
2	D002	20,600	P	D81	Percolation
3	D006	100	P	D81	Percolation
4	D007	10,000	P	D81	Percolation
5	D008	150	P	D81	Percolation
6	D009	6,200	P	D81	Percolation
7	WC02	4,000	P	D81	Percolation
8	WT02	15,000	P	D81	Included with above
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					

ECL30 - 271 - ECY 030-31 Form 3

PAGE 3 ____ OF 6
(enter "A", "B", "C", etc. behind the "3" to identify photo copied pages)

CONTINUE ON REVER

Continued from the front.

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM SECTION D(1) ON PAGE 3.

The 1301-N LWDF was used for the disposal of liquid waste from N Reactor. The waste consisted of waste from nonspecific sources and listed waste (F003), toxicity characteristic waste (D006, D007, D008, and D009), characteristic waste (D002), state-only carcinogenic waste (WC02), and state-only toxic waste (WT02).

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail)*.

VI. PHOTOGRAPHS

All existing facilities must include photographs *(aerial or ground-level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail)*.

VII. FACILITY GEOGRAPHIC LOCATION This information is provided on the attached drawings and photos.

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*

VIII. FACILITY OWNER

[X] A. If the facility owner is also the facility operator as listed in Section VII on Form 1, "General Information", place an "X" in the box to the left and skip to Section D below.

B. If the facility owner is not the facility operator as listed in Section VII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER	2. PHONE NO. *(area code & no.)*

3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
John D. Wagoner, Manager U.S. Department of Energy Richland Operations Office	John D. Wagoner	2/25/97

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
SEE ATTACHMENT		

 CONTINUE ON PAGE 5

WA7890008967

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

John D. Wagoner

Owner/Operator
John D. Wagoner, Manager
U.S. Department of Energy
Richland Operations Office

2/25/97
Date

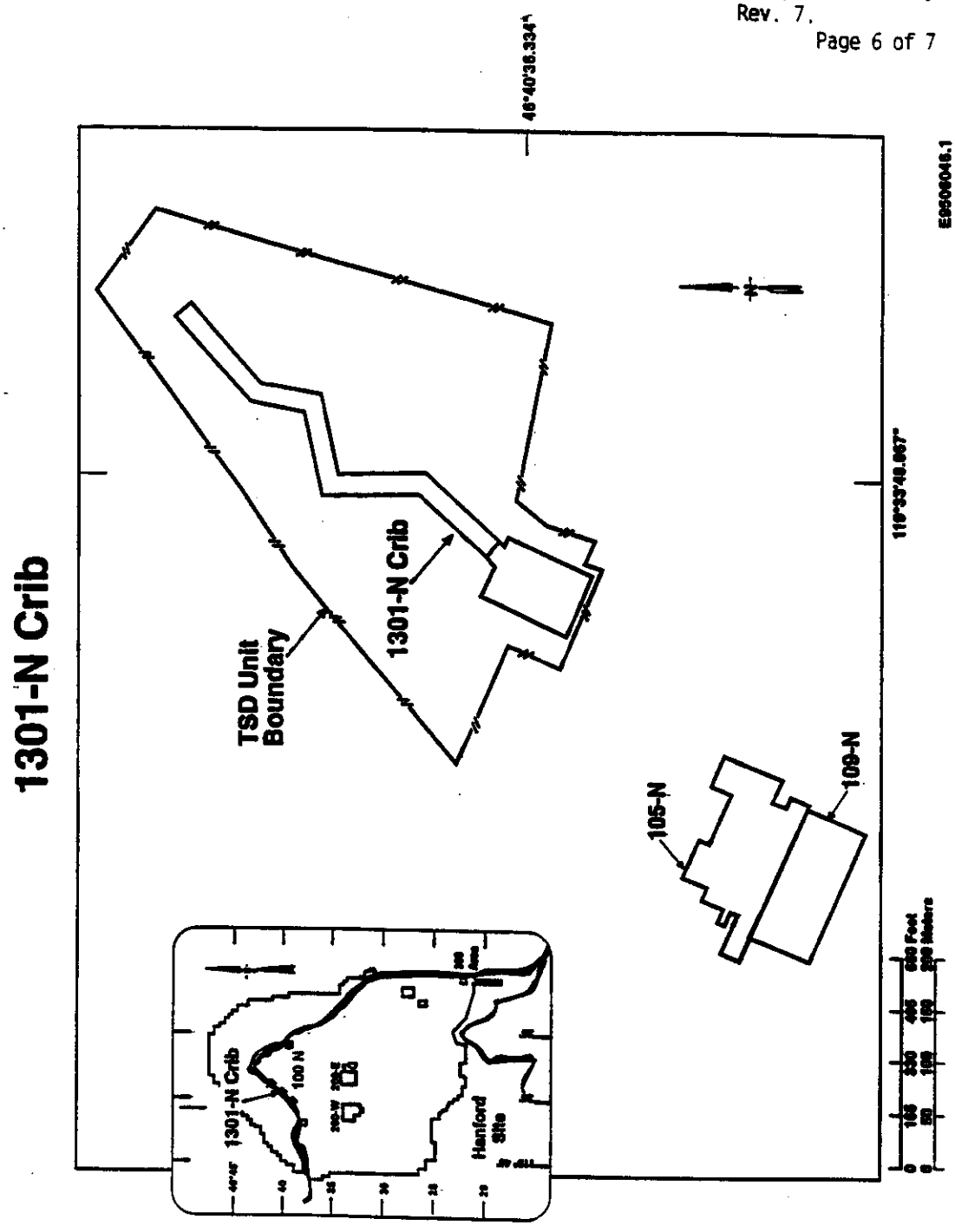
R M L

Co-operator
R. Michael Little, President
Bechtel Hanford, Inc.

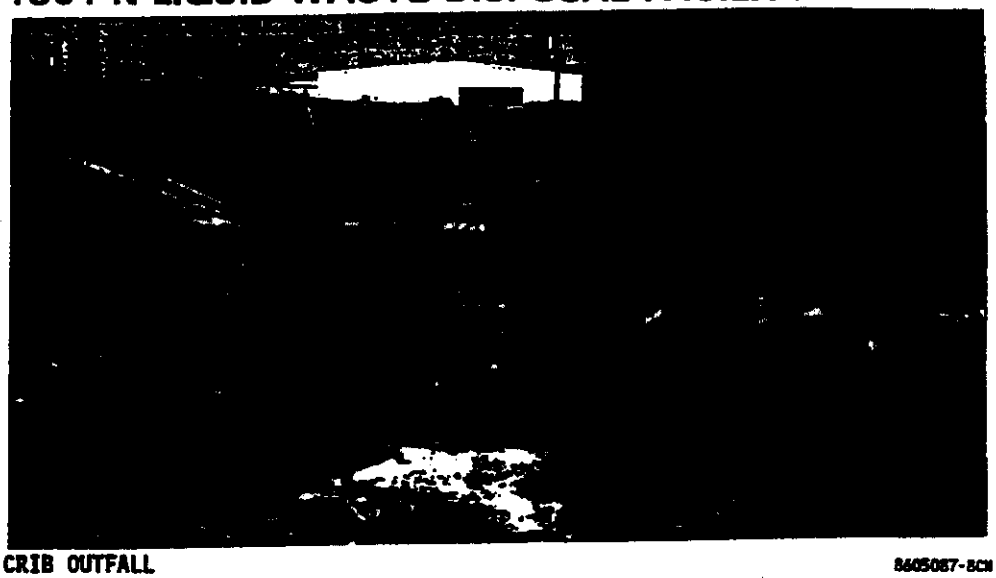
2/7/97
Date

WA7890008967

1301-N Liquid Waste Disposal Facility
Rev. 7.
Page 6 of 7



1301-N LIQUID WASTE DISPOSAL FACILITY



CRIB OUTFALL

8605087-8CN

TRENCH CONCRETE COVER

46°40'36.334"
119°33'48.867"

8605087-15CN
(PHOTOS TAKEN 1986)

ATTACHMENT A-2

PART A, FORM 3 FOR THE 1325-N LIQUID WASTE DISPOSAL FACILITY

ATTACHMENT 2
7 Pages

REVISION 7 OF FORM 3 DANGEROUS WASTE PERMIT APPLICATION
1325-N LIQUID WASTE DISPOSAL FACILITY

Please print or type in the unshaded areas only
(fill-in areas are spaced for elite type, i.e., 12 character/inch).

FORM 3

DANGEROUS WASTE PERMIT APPLICATION

1. EPA/STATE I.D. NUMBER: W A 7 8 9 0 0 0 8 9 6 7

FOR OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED (mo., day, & yr.)	COMMENTS

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA/STATE I.D. Number, or if this is a revised application, enter your facility's EPA/STATE I.D. Number in Section I above.

A. FIRST APPLICATION *(place an "X" below and provide the appropriate dates)*

[X] 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

MO.	DAY	YR.
0 3	2 2	4 3

*FOR EXISTING FACILITIES, PROVIDE THE DATE *(mo., day, & yr.)* OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(use the boxes to the left)*
*The date construction of the Hanford Facility commenced.

[ ] 2. NEW FACILITY *(Complete item below)*

MO.	DAY	YR.

FOR NEW FACILITIES, PROVIDE THE DATE *(mo., day, & yr.)* OPERATION BEGAN OR IS EXPECTED TO BEGIN

B. REVISED APPLICATION *(place an "X" below and complete Section I above)*

[X] 1. FACILITY HAS AN INTERIM STATUS PERMIT

[X] 2. FACILITY HAS A FINAL PERMIT

III. PROCESSES - CODES AND CAPACITIES

A. PROCESS CODE - Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process *(including its design capacity)* in the space provided on the *(Section III-C)*.

B. PROCESS DESIGN CAPACITY - For each code entered in column A enter the capacity of the process.

1. AMOUNT - Enter the amount.

2. UNIT OF MEASURE - For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER (barrel, drum, etc)	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D80	GALLONS OR LITERS
LANDFILL	D81	ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER
LAND APPLICATION	D82	*ACRES OR HECTARES*
OCEAN DISPOSAL	D83	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D84	GALLONS OR LITERS

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR: GALLONS PER HOUR OR LITERS PER HOUR
OTHER (Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided: Section III-C.)	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G
LITERS	L
CUBIC YARDS	Y
CUBIC METERS	C
GALLONS PER DAY	U

UNIT OF MEASURE	UNIT OF MEASURE CODE
LITERS PER DAY	V
TONS PER HOUR	D
METRIC TONS PER HOUR	W
GALLONS PER HOUR	E
LITERS PER HOUR	H

UNIT OF MEASURE	UNIT OF MEASURE CODE
ACRE-FEET	A
HECTARE-METER	F
ACRES	B
HECTARES	Q

EXAMPLE FOR COMPLETING SECTION III *(shown in line numbers X-1 and X-2 below): A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400 gallons.* The facility also has an incinerator that can burn up to 20 gallons per hour.

LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT (specify)	B. PROCESS DESIGN CAPACITY 2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY	LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT (specify)	B. PROCESS DESIGN CAPACITY 2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G		5				
X-2	T 0 3	20	E		6				
1	0 8 1	4,320,000	U		7				
2					8				
3					9				
4					10				

CONTINUE ON REVERSE

Continued from the front.

III. PROCESSES (continued)

C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESS (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACI

D81

The 1325-N Liquid Waste Disposal Facility (LWDF) was used from 1985 to April 1991. The LWDF received nonregulated mixed process and cooling waters from N Reactor. The LWDF also received dangerous waste generated from laboratories and may have received waste from spills from within the N Reactor Building, which was discharged through the mixed waste drain system. The dangerous waste discharges consisted of less than 0.002% of the total volume of waste discharged to the LWDF. The LWDF was a percolation unit designed for the disposal of liquid waste through the soil column. The process design capacity for the 1325-N LWDF was 16,353,000 liters (4,320,000 gallons) per day. The process design capacity reflects the maximum volume of water discharged daily rather than the physical capacity of the LWDF. The influent pipes between the 1325-N and the 1301-N LWDFs are considered to be included within the treatment, storage, and disposal unit boundary.

IV. DESCRIPTION OF DANGEROUS WASTES

A. DANGEROUS WASTE NUMBER - Enter the four digit number from Chapter 173-303 WAC for each listed dangerous waste you will handle. If you handle dangerous wastes which are not listed in Chapter 173-303 WAC, enter the four digit number(s) that describes the characteristics and/or the toxic contaminants of those dangerous wastes.

B. ESTIMATED ANNUAL QUANTITY - For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non-listed waste(s) that will be handled which possess that characteristic or contaminant.

C. UNIT OF MEASURE - For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

-If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account t appropriate density or specific gravity of the waste.

D. PROCESSES

1. PROCESS CODES:

For listed dangerous waste: For each listed dangerous waste entered in column A select the code(s) from the list of process codes contained in Section III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non-listed dangerous wastes: For each characteristic or toxic contaminant entered in Column A, select the code(s) from the list of process codes contained Section III to indicate all the processes that will be used to store, treat, and/or dispose of all the non-listed dangerous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: DANGEROUS WASTES DESCRIBED BY MORE THAN ONE DANGEROUS WASTE NUMBER - Dangerous wastes that can be described by more than one Waste Number shall be described on the form as follows:

1. Select one of the Dangerous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other Dangerous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other Dangerous Waste Number that can be used to describe the dangerous waste.

EXAMPLE FOR COMPLETING SECTION IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* - A facility will treat and dispose of an estimated 900 pounds per y of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non-listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per y of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE NO.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
X-1	K 0 5 4	900	P	T 0 3 D 8 0	
X-2	D 0 0 2	400	P	T 0 3 D 8 0	
X-3	D 0 0 1	100	P	T 0 3 D 8 0	
X-4	D 0 0 2			T 0 3 D 8 0	*included with above*

Continued from page 2.
NOTE: Photocopy this page before completing if you have more than 26 wastes to list.

I.D. NUMBER (entered from page 1)

W	A	7	8	9	0	0	0	8	9	6	7

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

LINE NO.	A. DANGEROUS WASTE NO. (enter codes)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
1	F003	6,200	P	D81	Percolation
2	D002	20,600	P	D81	Percolation
3	D006	100	P	D81	Percolation
4	D008	150	P	D81	Percolation
5	D009	6,200	P	D81	Percolation
6	WC02	4,000	P	D81	Percolation
7	WT02	15,000	P	D81	Included with above
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					

ECL30 - 271 - ECY 030-31 Form 3

PAGE 3 ____ OF 6
(enter "A", "B", "C", etc. behind the "3" to identify photo copied pages)

CONTINUE ON REVERSE

Continued from the front.

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM SECTION D(1) ON PAGE 3.

The 1325-N LWDF was used for the disposal of liquid waste from N Reactor. The waste consisted of waste from nonspecific sources and listed waste (F003), toxicity characteristic waste (D006, D008, and D009), characteristic waste (D002), state-only carcinogenic waste (WC02), and state-only toxic waste (WT02).

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail)*.

VI. PHOTOGRAPHS

All existing facilities must include photographs *(aerial or ground-level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail)*.

VII. FACILITY GEOGRAPHIC LOCATION This information is provided on the attached drawings and photos.

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*

VIII. FACILITY OWNER

[X] A. If the facility owner is also the facility operator as listed in Section VII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER	2. PHONE NO. *(area code & no.)*

3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
John D. Wagoner, Manager U.S. Department of Energy Richland Operations Office	John D. Wagoner	2/25/97

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
SEE ATTACHMENT		

ECL30 - 271 - ECY 030-31 Form 3 PAGE 4 OF 5 CONTINUE ON PAGE 5

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Owner/Operator
John D. Wagoner, Manager
U.S. Department of Energy
Richland Operations Office

Date: 2/25/97

Co-operator
R. Michael Little, President
Bechtel Hanford, Inc.

Date: 2/7/97

WA7890008967

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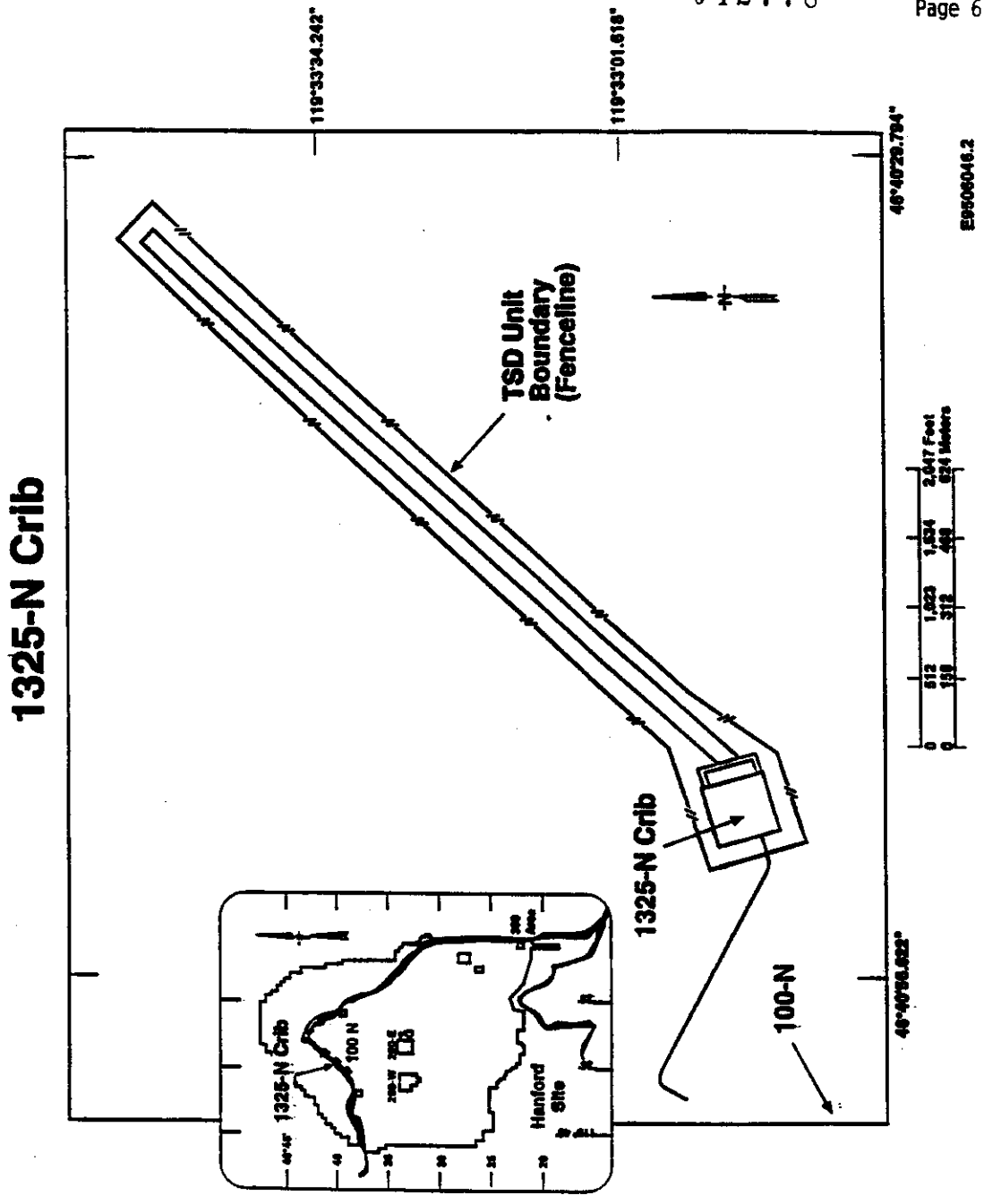

1325-N CRIB

46°40'56.622"
46°40'29.794"
119°33'01.618"
119°33'34.242"

8605087-6CN
(PHOTO TAKEN 1986)

ATTACHMENT A-3

DRAFT STATE ENVIRONMENTAL POLICY ACT CHECKLIST FOR 1301-N AND 1325-N

STATE ENVIRONMENTAL POLICY ACT

ENVIRONMENTAL CHECKLIST

FOR

THE HANFORD SITE

1301-N/1325-N LIQUID WASTE DISPOSAL FACILITY CLOSURE/POST CLOSURE PLAN

REVISION 0

**WASHINGTON ADMINISTRATIVE CODE
ENVIRONMENTAL CHECKLIST FORMS
(WAC 197-11-960)**

STATE ENVIRONMENTAL POLICY ACT
ENVIRONMENTAL CHECKLIST FOR THE HANFORD SITE
1301-N/1325-N LIQUID WASTE DISPOSAL FACILITY
CLOSURE/POST CLOSURE PLAN

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TO BE COMPLETED BY APPLICANT | EVALUATION FOR AGENCY USE ONLY

A. BACKGROUND

1. Name of proposed project, if applicable:

The name of this proposed project is 1301-N/1325-N Liquid Effluent Disposal Facilities Closure.

2. Name of applicants:

U.S. Department of Energy, Richland Operations Office (DOE-RL)

3. Address and phone number of applicants and contact persons:

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

Contact:

James E. Rasmussen, Program Manager
Office of Environmental Assurance,
Permits, and Policy
(509) 376-5441

David E. Olson, Project Manager
100-N Groundwater Project
(509) 376-7142

4. Date checklist prepared:

This SEPA Checklist was prepared concurrently with closure/postclosure plans.

5. Agency requesting the checklist:

Washington State Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600

6. Proposed timing or schedule: (including phasing, if applicable):

This SEPA Checklist is being submitted concurrently with closure/postclosure plans. Actual closure/postclosure will not occur until post 1999.

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7. **Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.**

   No

8. **List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.**

   This SEPA Environmental Checklist is being submitted to Ecology concurrently with closure/post closure plans.

   The Corrective Measure Study (CMS) will include the NEPA values; the closure/post closure plans will be addendums to the CMS. Cultural Resources reviews and Ecological Surveys will be completed for all sites.

   General information concerning the Hanford Facility environment can be found in the *Hanford Site National Environmental Policy Act (NEPA) Characterization,* PNL-6415, Revision 5, December 1992. This document is updated annually by Pacific Northwest Laboratory, and provides current information concerning climate and meteorology; ecology; history and archeology; socioeconomics; land use and noise levels; and geology and hydrology. These baseline data for the Hanford Site and its past activities are useful for evaluating proposed activities and their potential environmental impacts.

9. **Do you know whether applications are pending for government approvals of other proposals directly affecting the property covered by your proposal? if yes, explain.**

   No applications to government agencies are known to be pending for this proposed action.

10. **List any government approvals or permits that will be needed for your proposal, if known.**

    The proposed activities will be conducted under *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). Actions conducted under CERCLA are exempt from obtaining federal, state and local permits (CERCLA, Section 121[e][I]. However, the substantive provisions of requirements that are ARARs must be met for the proposed action. ARARs are standards, requirements, criteria on limitations promulgated under federal or state environmental laws. Appendix C of the CMS provides a list of the ARARs.

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11. Give a brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page.

Unit descriptions are provided in the response to question B.8.c.

All concrete structures and pipelines will be removed. Removal of the concrete panels for 1301-N trench and 1325-N crib will require a concrete saw to cut the grout used to interlock and seal the panels. Once the panels are free, the panels and beams will be removed with a minimal amount of breakage.

Once all the concrete and piping is removed, remediation can be completed. The first step in all remedial alternatives is to remove the clean overburden. This material will be set aside and used as backfill later. Three remedial alternatives are being considered:

(1) **Removal Alternative**: If the selected remedial alternative is to remove (excavate), treat if required, and then dispose of the contaminated soils in an approved disposal facility, contaminated soils would be excavated until the unit is clean according to the established Corrective Action Levels. Any contaminated soils requiring treatment to meet landfill acceptance criteria would be segregated and treated. All contaminated soils would then be shipped to an approved disposal facility. The unit will be backfilled with the clean overburden material and supplemented with clean borrow material from a near by borrow pit. The site will then be contoured to blend with the surrounding terrain and in a manner that will reduce surface runon/runoff in order to prevent soil erosion.

(2) **Capping Alternative:** If the alternative selected is capping, an RCRA approved cover will be built over the unit. First, the contaminants in soil to 3 m (10 ft) below ground surface will be removed from the units. They will then be backfilled with the clean overburden and supplemented with fill from a nearby borrow pit. This will provide a level consistent surface for the cover. Next, the cover will be constructed according to the required design specifications. Finally, the cover will be revegetated and a maintenance and monitoring program implemented.

(3) **Vitrification Alternative**: If in situ treatment (vitrification) is the selected remedial alternative, the contaminated soils to 3 m (10 ft) below ground surface will be removed. The contaminated soils below 3 m (10 ft) will be solidified using in situ vitrification. After the solidification process is complete the excavation will be backfilled with the clean overburden material and supplemented with clean fill

material from a near by borrow pit. The site will then be contoured to blend with the surrounding terrain and in a manner that will reduce surface runon/runoff in order to prevent soil erosion. A monitoring program, if required will be implemented.

12. **Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.**

    The 1301-N and 1325-N units are located in the 100-N Area of the Hanford Site. The 1301-N unit is located approximately 180 meters northeast of the 100-N Reactor, and the 1325-N Unit is located approximately 550 northeast of the 100-N Reactor. The 1301-N unit is located within 14N 26E Section 28 of the Coyote Rapids, Washington, Quadrangle Map, Willamette Principle Meridian. The 1325-N unit is located within 14N, 26E Section 28 of the Coyote Rapids Washington, Quadrangle Map, Willamette Principle Meridian.

B. ENVIRONMENTAL ELEMENTS

1. Earth

a. **General description of the site (circle one): Flat, rolling, hilly, steep slopes, mountainous, other_____.**

Generally flat with small rolling hills which do not usually exceed 3.0 - 4.6 m (10-15 ft).

b. **What is the steepest slope on the site (approximate percent slope)?**

The approximate slope of the land at the proposed project is less than 2 percent with slopes up to 100 percent on the sides of the small rolling hills.

c. **What general types of soils are found on the site? (for example, clay, sandy gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.**

The soil types in the 100 Area and around the proposed project consist mainly of

eolian and fluvial sands and gravel. More detailed information concerning specific 100 Area soil classifications can be found in the *Hanford Site National Environmental Policy Act (NEPA) Characterization,* PNL-6415, Revision 5, December 1992. Farming is not permitted on the Hanford Site.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

No.

e. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.

For all remedial alternatives, the units will be backfilled to surrounding grade with the clean overburden soils removed during remediation and supplemented with fill material from a nearby Hanford Site borrow pit. This fill material would be comprised of the same basaltic sandy gravel in which the units are constructed. It is anticipated the fill material would have the same general composition and particle size distribution as the overburden and the soils surrounding the units as a result of having the same depositional environment. The fill would be used to restore the terrain to its approximate original configuration and to reduce runon/runoff and prevent soil erosion. It is estimated that 165,000 cubic yards of fill material will be required for removal of 10 ft of surface soils in order to meet a recreational exposure scenario and 175,000 cubic yards of fill material for removal of 15 ft of surface soils in order to meet a residential exposure scenario.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

The surface, once backfilling is completed, will be contoured and revegetated to reduce runon/runoff which will help prevent soil erosion.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

None

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h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

The finished grade and the areas disturbed during activities would be stabilized on completion of this effort, while dust would be controlled by standard construction techniques (e.g., water sprays, crusting agents).

2. Air

a. What types of emissions to the air would result from the proposal (i.e., dust, automobile, odors, industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities, if known.

All three alternatives may create minor amounts of exhaust and dust (some of which might be contaminated) by vehicles and construction personnel during this project. Potential radiological and nonradiological emissions could occur during the in situ vitrification alternative. Heavy equipment and trucks transporting material from the facility will generate dust and gaseous (exhaust) emissions. If the selected remedy is removal, vehicular traffic would cease on completion. If vitrification or capping is implemented, automobile exhaust will be generated as a result of monitoring and maintenance activities. There is a potential for dust emissions from the removal of the concrete panels. Removal will require either cutting or breaking the panels which could result in dust generation.

b. Are there any off-site sources of emissions or odors that may affect your proposal? If so, generally describe.

No.

c. Proposed measures to reduce or control emissions or other impacts to the air, if any?

In order to reduce the amount of dust generated during closure activities, dust suppressants (e.g., water, crusting agents) will be used as necessary. If vitrification is the alternative selected, the best available controls technology will be used. Near-field air emissions monitors will be used for all three alternatives.

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3. **Water**

a. **Surface**

1) **Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.**

At the closest point, the 1301-N and 1325-N units are approximately 180 m (590 ft) from the Columbia River, the nearest natural watercourse.

2) **Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.**

No.

3) **Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.**

None.

4) **Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.**

No.

5) **Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.**

The proposed activities are not within the 100- or 500-year floodplains as described in the *Hanford Site National Environmental Policy Act (NEPA) Characterization,* PNL-6415, Revision 5, December 1992.

6) **Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.**

No.

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b. Ground

1) Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known.

No groundwater would be withdrawn in support of this project, and water would not be discharged to the aquifer. In the vicinity of the proposed action, the depth to groundwater is approximately 19.8 meters (65 ft).

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals...; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

Does not apply.

c. Water Run-off (including storm water)

1) Describe the source of run-off (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

The Hanford Site has a semi-arid climate averaging 15 - 18 cm (6 to 7 in.) of annual precipitation. Any precipitation that occurs at the site seeps into the soil on or near the site. Consequently, none would enter any surface waters.

2) Could waste materials enter ground or surface waters? If so, generally describe.

Contaminants from these waste sites are currently in the groundwater beneath the sites. Remediation of the site will result in no further migration of contaminants to the groundwater. Contaminants already in vadose zone soils below the maximum water table may continue to be released to the groundwater and eventually the Columbia River.

d. Proposed measures to reduce or control surface, ground, and run-off water

TO BE COMPLETED BY APPLICANT | EVALUATION FOR AGENCY USE ONLY

impacts, if any:

Post-closure leaching of contaminated subsoils by surface water will be prevented by: removal of contaminated soils; the installation of a barrier (the final cover) designed to preclude the migration of surface water to underlying contaminated soils; or in situ vitrification of any contaminated soils remaining.

4. Plants

a. Check or circle the types of vegetation found on the site.

_ **deciduous tree: alder, maple, aspen, other**
_ **evergreen tree: fir, cedar, pine, other**
_ **shrubs**
X **grass**
_ **pasture**
_ **crop or grain**
_ **wet soil plants: cattail, buttercup, bulrush, skunk cabbage, other**
_ **water plants: water lily, eelgrass, milfoil, other**
X **other types of vegetation** (Sagebrush)

b. What kind and amount of vegetation will be removed or altered?

Sites are cobble and clear of vegetation. The nearby areas are dominated by cheatgrass, which may be disturbed with closure activities. All areas denuded of vegetation as a result of this project will be revegetated appropriately.

c. List threatened or endangered species known to be on or near the site.

There are no threatened or endangered plants known to be on or adjacent to the site, however, an updated biological survey in the general vicinity of the proposed project would be conducted before construction.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

The surface will be regraded to reduce runon/runoff which will help prevent control erosion then revegeated with perennial grass species well suited to the local climate.

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5. **Animals**

   a. **Indicate (by underlining) any birds and animals which have been observed on or near the site or are known to be on or near the site:**

   birds: hawk, heron, eagle, songbirds, other:.....
   mammals: deer, bear, elk, beaver, other:.....
   fish: bass, salmon, trout, herring, shellfish, other:.....

   Raptors (burrowing owls, ferruginous, redtail, and Swainson's hawks) are seen occasionally in the 100 Area. Small passerines (sparrows, starlings, finches) also may be present in the general vicinity. Mule deer, rabbits, badgers, and coyotes occasionally are seen in the general area.

   b. **List any threatened or endangered species known to be on or near the site.**

   Two federal listed threatened or endangered species have been identified on the 560 square mile (1,450 square kilometer) Hanford Site along the Columbia River; the bald eagle and peregrine falcon. In addition, the state listed white pelican, sandhill crane, and ferruginous hawk also occur on or migrate through the Hanford Site. However, since this proposed action does not disturb any natural habitat and there are no known nesting or roosting locations near the project site, none of these species will be impacted by the proposed activities.

   c. **Is the site part of a migration route? If so, explain.**

   The Hanford Site is a part of the broad migratory waterfowl Pacific Flyway.

   d. **Proposed measures to preserve or enhance wildlife, if any:**

   The project specific Environmental Survey will indicate any necessary measures. However, because of the lack of habitat, few adverse impacts requiring preservation measures are anticipated. Revegetation after closure will enhance habitat for the future.

6. **Energy and Natural Resources**

   a. **What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.**

Postclosure monitoring activities will require the use of petroleum products to power motor vehicles.

b. **Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.**

No.

c. **What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:**

None.

7. **Environmental Health**

a. **Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.**

All three alternatives may create minor amounts of exhaust and dust (some of which might be contaminated) by vehicles and construction activities during this project. Potential radiological and nonradiological emissions could occur during the vitrification alternative. Heavy equipment and trucks transporting material from the facility will generate dust and gaseous (exhaust) emissions.

1) **Describe special emergency services that might be required.**

Hanford Site security, fire response, and ambulance services are on call at all times in the event of an onsite emergency. Hanford Site emergency services personnel are specially trained to manage a variety of circumstances involving chemical and/or radioactive constituents and situations.

2) **Proposed measures to reduce or control environmental health hazards, if any:**

Stringent administrative controls and engineered barriers would be employed to minimize the probability of even a minor incident and/or accident.

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b. Noise

1) What type of noise exists in the area which may affect your project (for example: traffic, equipment, operation, other)?

All three alternatives would create a minor amount of traffic and equipment noise in the vicinity, although it is not expected to affect personnel that would be working at the proposed sites.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

All three alternatives would create some amount of noise from grading and excavation equipment and would cease upon completion.

3) Proposed measures to reduce or control noise impacts, if any:

If Occupational Safety and Health Administration noise standards are exceeded, appropriate measures to protect workers would be employed.

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties?

The proposed activities are part of the U.S. Government-owned Hanford Site, which is used for the management of waste associated with the cleanup from past and/or present production of special nuclear materials, and for energy research. Past activities at 100-N Area include a nuclear reactor and a commercial power generating station which have been shut down since 1987. Current activities include remediation of waste sites and groundwater as well as decommissioning and demolition of buildings.

b. Has the site been used for agriculture? If so, describe.

No portion of the 100 Area on the Hanford Site has been used for agricultural purposes since 1943.

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c. Describe any structures on the site.

The 1301-N and 1325-N Liquid Waste Disposal Facilities are each comprised of two structures: a rectangular crib and a long trench coming off the crib. The 1301-N crib is approximately 88 m by 38 m (290 ft by 125 ft) and averages 3.7 (12 ft) deep. The crib is filled with at least three different layers of boulders and rocks to a thickness varying between 2.1 m to 3.4 m (7 ft to 11 ft). A weir box measuring 16 m long by 3.7 m wide by 3 m deep (52 ft by 12 ft by 10 ft) sits in the southern portion of the crib. The weir box is constructed of 0.3 m (12 in) thick reinforced concrete and is open on top. Several pipelines, including a 0.9 m (36 in) diameter line, come into the weir box and two 0.9 m (36 in) diameter pipelines come out of the weir box which go to 1325-N. Some pipelines are buried while others are on the surface.

The north end of the crib exits into the trench portion of the unit. The trench is a zigzag structure measuring 490 m (1,600 ft) long by 3 m (10 ft) wide on the bottom by 3.7 m (12 ft) deep. The trench has 1.5 to 1.0 (run to rise) sloped sides with a top width of approximately 14 m (46 ft). The trench is covered with precast concrete panels supported on concrete beams running across the trench.

The 1325-N crib measures 76 m by 73 m (250 ft by 240 ft) and is 1.8 m (6 ft) deep. The crib is covered with precast concrete panels supported by precast concrete beams resting on foundations positioned at regular intervals throughout the interior of the crib. Under the crib cover, between the beams and foundations is the effluent distribution system. This is a system of concrete troughs that distributed the effluent equally throughout the crib. The effluent is delivered to the crib through a 0.9 m (36 in.) diameter pipeline which comes from the 1301-N weir box.

The 1325-N trench runs to the northeast away from the crib and is connected to the crib by two concrete conduits, one from the north corner of the crib and one from the east corner. The conduits join together in a common weir box which exits into the trench. The trench is 914 m (3000 ft) long by 7.6 m (25 ft) wide on the bottom. The sides slope up at 1.5 to 1.0 (run to rise). The trench is covered with precast concrete panels 2.7 m (9 ft) above the bottom of the trench. The panels are 16.8 m (55 ft) long and extend across the trench and rest on concrete foundations running the full length of the trench.

A total of approximately 1280 m (4,200 ft) of pipelines are associated with the 1301-N and 1325-N units. Both 1301-N and 1325-N are surrounded by 2.4 m (8 ft) chain link fences.

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d. Will any structures be demolished? If so, what?

All concrete structures and pipelines will be removed and disposed in an approved disposal facility. The fence will be removed and disposed of also.

e. What is the current zoning classification of the site?

The Hanford Site is zoned as an Unclassified Use (U) district by Benton County.

f. What is the current comprehensive plan designation of the site?

The 1985 Benton County Comprehensive Land Use Plan designates the Hanford Site as the "Hanford Reservation". Under this designation, land on the Hanford Site may be used for "activities nuclear in nature". Non-nuclear activities are authorized "if and when DOE approval for such activities is obtained". Future land use has not been determined. Land use alternatives are presented in the *Draft Hanford Remedial Action EIS,* which was issued for public review in 1996, and a second draft of the EIS will be issued for public review in 1998.

g. If applicable, what is the current shoreline master program designation of the site?

Does not apply.

h. Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.

No.

i. Approximately how many people would reside or work in the completed project?

No additional staff would be added as a result of the proposed activities.

j. Approximately how many people would the completed project displace?

Minimal

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k. Proposed measures to avoid or reduce displacement impacts, if any:

Does not apply.

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

The proposed project would remediate existing contamination and be compatible with future land use alternatives under consideration.

9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

None.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

None.

c. Proposed measures to reduce or control housing impacts, if any:

Does not apply.

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

Does not apply.

b. What views in the immediate vicinity would be altered or obstructed?

If the alternative selected is capping, installation of an earthen cover will be required. The cover, as designed, will have a maximum height of approximately 5 m (16.4 ft). The chain link perimeter fence may attain a height of 3 m (10 ft) Other alternatives would not alter any views.

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c. **Proposed measures to reduce or control aesthetic impacts, if any:**

If the selected alternative is removal or vitrification, the site would be regraded to contour. The site would be revegetated for all remedial alternatives.

11. Light and Glare

a. **What type of light or glare will the proposal produce? What time of day would it mainly occur?**

None.

b. **Could light or glare from the finished project be a safety hazard or interfere with views?**

No.

c. **What existing off-site sources of light or glare may affect your proposal?**

None.

d. **Proposed measures to reduce or control light and glare impacts, if any:**

None.

12. Recreation

a. **What designated and informal recreational opportunities are in the immediate vicinity?**

Fishing and boating on the Columbia River.

b. **Would the proposed project displace any existing recreational uses? If so, describe.**

No.

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c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any?

None.

13. Historic and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

At this time, no places or objects on or next to the proposed site activities are listed on any registers.

b. Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

The 1301-N and 1325-N units are located in a culturally sensitive location. Archaeological sites are located across the river and upstream from the N Reactor. Also, the knobs and kettles around the 1301-N and 1325-N area were known to the Wanapum as *"Mooli Mooli"* (Little Stacked Hills). The area was known as a salmon fishing location. Finally, surveys by Hanford archaeologists have recorded rock cairns on some of the mounds, indicating use of the area by native peoples. Qualified Site personnel will conduct a cultural resources review prior to any excavation activities.

c. Proposed measures to reduce or control impacts, if any:

The 1301-N and 1325-N units are located in areas that are heavily disturbed as a result of construction of these and other features in the area such as roads and wells. Project activities will be restricted to disturbed areas, thereby eliminating risks to cultural resources. Any need to locate project activities in undisturbed locations will be subjected to the cultural resource review process to ensure that no resources are disturbed. Cultural resource contacts from the local Indian Tribes will be informed about the project and provided an opportunity to get involved. Workers in all areas will be directed to watch for cultural material during all work activities.

14. Transportation

a. Identify public streets and highways serving the site, and describe proposed

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access to the existing street system. Show on site plans, if any.

The 100 Area is not served by public streets or highways.

b. **Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?**

The proposed activities are not accessible to the public and is not served by public transit.

c. **How many parking spaces would the completed project have? How many would the project eliminate?**

None.

d. **Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).**

No.

e. **Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.**

No.

f. **How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.**

None.

g. **Proposed measures to reduce or control transportation impacts, if any:**

None.

15. Public Services

a. **Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.**

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No.

b. Proposed measures to reduce or control direct impacts on public services, if any:

None.

16. Utilities

a. Circle utilities currently available at the site: electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other:

The only utility currently available at the site is fresh water.

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

A portable air supply for pneumatically operated equipment and a portable electrical generator will be necessary for closure operations. Water trucks may be available onsite to periodically spray the area, reducing airborne particles generated during construction activities. After closure, the only utility necessary for operation will be portable electrical generators for powering groundwater monitoring well pumps during inspection and sampling.

General construction activities are outlined in the answer to checklist question A.ll.

C. SIGNATURES

The above answers are true and complete to the best of my knowledge. We understand that the lead agency is relying on them to make its decision.

James E. Rasmussen, Program Manager | Date
Office of Environmental Assurance,
Permits, and Policy
U.S. Department of Energy
Richland Operations Office

ATTACHMENT A-4

1301-N AND 1325-N LIQUID WASTE DISPOSAL FACILITY TRAINING PLAN

1301-N AND 1325-N LIQUID WASTE DISPOSAL FACILITY TRAINING PLAN

This is the dangerous waste training plan for the 1301-N LWDF (1301-N) and the 1325-N LWDF (1325-N). It is intended to meet the requirements of WAC 173-303-330 and the Hanford Dangerous Waste Permit.

Training unrelated to compliance with WAC 173-303-330 is not addressed in this training plan. WAC 173-303-330(1)(d)(ii, v, vi) requires that personnel be familiarized, where applicable, with waste feed cut-off systems, response to ground-water contamination incidents, and shutdown of operations. These are not applicable to 1301-N and 1325-N and are, therefore, not covered in this training plan.

Training Matrix

Facility Personnel: The following matrix indicates the training that facility personnel must receive each calendar year relative to their position in order to perform work at the 1301-N and 1325-N. After a course has been taken once, a refresher course only is necessary for subsequent years. Training must be successfully completed by personnel within six months after employment at or assignment to 1301-N and 1325-N, or to a new position at 1301-N and 1325-N. Within the six month period, employees must be supervised until they complete training required for their position.

Nonfacility personnel: If nonfacility personnel will be anywhere near dangerous waste management activities, then they must receive site-specific training relative to the 1301-N and 1325-N to visit or be escorted by trained personnel.

Course requirements by job type are contained in the following matrix:

COURSE	WASTE HANDLERS	GENERAL WORKERS	SUPERVISORS	EMERGENCY COORDINATORS
Hazardous Waste Operations	YES	NO	YES	YES
NESO/HGET	YES	YES	YES	YES
Site-specific	YES	YES	YES	YES
Building Warden/ BED	NO	NO	NO	YES

Course Descriptions

Hazardous Waste Operations 24-Hour or 40-Hour Refresher: Provides training relative to dangerous waste management, hazard identification, and protective clothing.

Hanford Employee Safety Orientation Refresher (Hanford General Employee Training [HGET]: Provides training relative to contingency plan implementation, effective response to emergencies, communications and alarm systems, and response to fire or explosion.

Site Specific (Attachment A4-1 to Attachment A-4): Provides unit-specific training relative to dangerous waste management hazards, contingency plan implementation, effective response to emergencies, communications and alarm systems, response to fire or explosion, emergency equipment, and procedures for using, inspecting, repairing, and replacing emergency and monitoring equipment.

Building Warden Training or Building Emergency Director Training Refresher for either course: Provides training relative to emergency coordinator responsibilities.

Training Director

Personnel directing training under this plan shall be knowledgeable in dangerous waste management procedures.

Records Retention

This training plan includes employee training records. The employee training records are maintained electronically and are available on HLAN soft reporting. This training plan shall be kept at the Hanford Facility and be readily retrievable. A hard copy of any site-specific training that is not recorded in soft reporting must be kept on file and be readily retrievable.

Revision

This training plan shall be revised whenever:

- Training courses change names or numbers
- Employees change positions
- New employees are assigned to 1301-N and 1325-N
- Training requirements in WAC 173-303-330 or the Hanford Dangerous Waste Permit are revised.

Dangerous Waste Management Position Descriptions

This training plan applies only to employees who perform work at 1301-N and 1325-N or are 1301-N and 1325-N Coordinators. If employees fit into more than one position, they shall be placed in the position that requires the higher level of training.

Job Title: Waste Handler

Duties: Perform inspections, treat wastes, perform treatability tests, take samples, package and ship waste, respond to emergencies
Required Skills: Basic communication skills and ability to follow instructions
Required Education: None
Other Required Qualifications: None.

Job Title: General Workers

Duties: Perform inspections, respond to emergencies, provide maintenance services, operate equipment, set up equipment
Required Skills: Basic communication skills and ability to follow instructions
Required Education: None
Other Required Qualifications: None.

Job Title: Supervisors

Duties: Supervise waste handlers and general workers, assure personnel training, perform inspections, respond to emergencies
Required Skills: Management
Required Education: 4 year college degree or equivalent knowledge and experience
Other Required Qualifications: None.

Job Title: Emergency Coordinators

Duties: Respond to emergencies per WAC 173-303-360
Required Skills: Management
Required Education: 4 year college degree or equivalent knowledge and experience
Other Required Qualifications: None.

ATTACHMENT A4-1

SITE-SPECIFIC TRAINING PLAN
1301-N AND 1325-N LIQUID WASTE DISPOSAL FACILITY

Objectives

Site-specific training will provide the facility worker with the facility specific knowledge relative to dangerous waste management hazards, contingency plan implementation, effective response to emergencies, communications and alarm systems, response to fire or explosion, emergency equipment, and procedures for using, inspecting, repairing, and replacing emergency and monitoring equipment.

Description

The 1301-N LWDF (1301-N) and the 1325-N LWDF (1325-N) received nonregulated mixed process and cooling waters from N-Reactor. 1301-N and 1325-N also received dangerous waste generated from laboratory tests, spills, and leaks within the N-Reactor Building, which was discharged through the mixed waste drain system. This dangerous waste consisted of less that 0.002 percent of the total volume of waste discharged to 1301-N and 1325-N.

The 1301-N and 1325-N units were designed for the disposal of liquid waste through the soil column. The 1301-N unit has not received waste since September, 1985. The 1325-N unit has not received waste since April, 1991. The process design capacity for each unit was 4,320,000 gallons (16,353,000 liters) per day. The design capacity reflects the maximum volume of water discharged daily rather than the physical capacity of 1301-N and 1325-N.

Present routine activities for the 1301-N and 1325-N are scheduled inspections as required in the 1301-N and 1325-N LWDF Inspection Plan. All other activities have ceased since this unit is no longer receiving hazardous wastes.

Dangerous Waste Management Hazards

The 1301-N and 1325-N units no longer receive waste water. Since no waste water is being discharged, no immediate dangerous waste hazards are present. The units are secured by fencing and locked gates.

Implementation of the Site Specific Contingency Plan

The site-specific contingency plan is located at the facility. Each worker must be familiar with the site-specific contingency plan and its requirements. The site-specific contingency plan will be implemented by the Facility Emergency Coordinator. The contingency plan will be implemented whenever there is an immediate threat to human health or the environment.

Response to Emergencies

All emergencies (e.g., fires, explosions, personnel injury, etc.) shall be reported to the Facility Emergency Coordinator. The Facility Emergency Coordinator will respond to all emergencies as outlined in the Facility-Specific Contingency Plan and the Hanford Site Contingency Plan.

Communications

There are no fixed communication systems at 1301-N and 1325-N. Communication equipment may be obtained by the 105-N Shift Manager when deemed necessary.

Alarms

Normal Hanford Site-Wide Audible emergency signals will be observed. No facility-specific alarms are necessary for 1301-N and 1325-N.

Monitoring

Required monitoring is outlined in the Facility Specific Inspection Plan. Groundwater monitoring is completed by the Hanford Site Groundwater Monitoring Program.

Inspections

It is required that 1301-N and 1325-N be inspected at least once each calendar quarter of the year. The inspections must be done in accordance with the Facility-Specific Inspection Plan.

Environmental Hazards

The 1301-N unit is located approximately 60 feet above and 800 feet east of the shore of the Columbia River. The 1325-N unit is located adjacent to the outside perimeter fence at the South/East corner of the N-Reactor Facility. Environmental hazards consist of snakes, spiders, varmints, tripping hazards, extreme heat in the summer and extreme cold in the winter.

Radiological Hazards

The 1301-N and 1325-N units are radiological controlled areas. A Radiation Work Permit is required to enter the facility.

Documents to be Reviewed

Each facility worker must review and be cognizant of the following site-specific documents:

1301-N and 1325-N Site-Specific Contingency Plan
1301-N and 1325-N Site-Specific Inspection Plan
1301-N and 1325-N Training Plan.

APPENDIX B

1324-N SURFACE IMPOUNDMENT AND 1324-NA PERCOLATION POND CLOSURE PLAN

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ABBREVIATIONS AND ACRONYMS

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CMS	corrective measures study
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ICP	inductively coupled plasma
LWDF	liquid waste disposal facility
MTCA	*Model Toxics Control Act*
OU	operable unit
Permit	Hanford Facility Dangerous Waste Permit
QA	quality assurance
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1980*
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
SEPA	State Environmental Policy Act
TOX	total organic halogen
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*

B1.0 INTRODUCTION

Appendix B presents the closure plan for the 1324-N Surface Impoundment (1324-N), also known by the designation 120-N-2, and for the 1324-NA Percolation Pond (1324-NA), also known by the designation 120-N-1. The 1324-N and 1324-NA terminology will be used throughout this appendix because the LWDFs are identified as such in their interim status Part A Permit Applications. These nonradioactive dangerous waste units operated as treatment and disposal units under the authority of the *Washington Administrative Code* (WAC) 173-303. Closure of these units will commence pursuant to WAC 173-303-610 and the Hanford Facility Dangerous Waste Permit (Permit). Modification of the Permit to include this closure plan is anticipated to occur in calendar year 1998.

Soil data obtained during previous sampling efforts do not identify dangerous waste constituents above *Model Toxics Control Act* (MTCA) Method B residential standards. Thus the soil column meets clean closure standards pursuant to Permit condition II.K.1. However, groundwater contaminated by sulfate will require closure of these units under a modified closure option in accordance with Permit condition II.K.3.

B1.1 REGULATORY BACKGROUND

The 1324-N and 1324-NA units are operated by U.S. Department of Energy (DOE), Richland Operations Office (RL) and co-operated by Bechtel Hanford, Inc. Although the U.S. Government holds legal title to this facility, the RL, for purposes of regulation under WAC 173-303, is considered the legal owner of the facility under existing U.S. Environmental Protection Agency (EPA) interpretive regulations (51 Federal Register 7722).

The Part A, Form 3, dangerous waste permit application documentation for these units was originally submitted to the Washington State Department of Ecology (Ecology) and the EPA in August 1986.

The Part A for the 1324-NA Percolation Pond defined this unit, during operation, as a treatment (through soil column neutralization) and disposal unit for acid and caustic waste. The 1324-N Surface Impoundment, a lined unit, was defined solely as a neutralization treatment unit during its operation. Three revisions of Part A have been submitted since that time. The latest revisions (Revision 3) of these Part A's are attached to this appendix (Attachments B-1 and B-2). Also, a State Environmental Policy Act (SEPA) checklist, pursuant to WAC 197-11-960, will be approved prior to incorporation of this closure plan into the Permit. A draft SEPA checklist is attached to this appendix (Attachment B-3).

The Hanford Site Dangerous Waste Permit contains a schedule for incorporation of closure plans into the Permit. The closure plan for 1324-N and 1324-NA are scheduled for incorporation in 1998.

B1.2 CLOSURE PLAN AND CORRECTIVE MEASURES STUDY INTEGRATION

Closure of the 1324-N and 1324-NA units (collectively referred to as 1324-N and 1324-NA, but including the South Settling Pond and associated soils, structures, and piping) will occur under the authority of WAC 173-303. These units are also defined under the 100-NR-1 Operable Unit (OU) and are part of this Treatment, Storage, and Disposal Corrective Measures Study (TSD CMS).

The TSD CMS concludes that no contaminants of concern associated with operation of these units remain in the soil above MTCA Method B residential levels (Section 2.5.5). Information presented in this closure plan support this determination and are presented in Section B4.3. However, a sulfate plume attributable to operation of these units exists with concentrations above the secondary drinking water standard as described in the 100-NR-1 and 100-NR-2 CMS (DOE-RL 1996a) . The presence of this sulfate plume will require closure of 1324-N and 1324-NA under a modified closure option. Integrated TSD and OU closure actions will be necessary to return the area "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]) and to remediate the groundwater. Actions to accomplish this may include characterization to determine that piping and/or structures are clean, removing structures and piping associated with the units, backfilling, regrading and revegetating the area, and implementing groundwater remedial technologies for cleanup of the sulfate plume. Section B4.0 provides details of the closure activities and includes characterization data, cleanup standards, and actions to be taken to accomplish the closure activities.

Actions taken to remediate these TSDs will comply with the provisions of both CERCLA and RCRA. The CERCLA public involvement, including public notice and opportunity to comment, has been enhanced to concurrently satisfy the RCRA closure process. The remedy selected under CERCLA will be incorporated into the Hanford Facility RCRA Permit as the RCRA closure action after issuance of the public notice and comment process.

It is anticipated that the CERCLA ROD will be issued subsequent to the RCRA permit modification. Should the CERCLA ROD contain provisions inconsistent with the approved RCRA modifications, the Hanford Facility RCRA Permit will be again modified to reconcile these differences during the next permit modification cycle.

B1.3 CLOSURE PERFORMANCE STANDARDS

The closure performance standards of WAC 173-303-610(2) require that the owner/operator of a TSD unit close the unit in a manner that (1) minimizes the need for further maintenance; (2) controls, minimizes, or eliminates postclosure escape of dangerous waste to the extent necessary to protect human health and the environment; and (3) returns the land to the appearance and use of surrounding land areas.

B1.3.1 Minimize the Need for Further Maintenance

The 1324-N and 1324-NA units will achieve clean closure of the soil column; therefore, further maintenance will not be needed for surface activities after certification of closure. The existing groundwater monitoring program (Borghese, et. al, 1996) will be continued upon the effective date of the Permit modification adding these units. This system will be operated to minimize maintenance activities.

B1.3.2 Control Dangerous Waste Escape to Protect Human Health and the Environment

Because no dangerous waste or constituents above levels that are considered protective of human health and the environment exist in the soil column at these units prior to closure activities, this closure performance standard is not applicable to this media. Groundwater is administratively restricted from access as a drinking water source by RL and will continue to be restricted until decisions regarding remediation of the sulfate plume are made in a final ROD for the 100-NR-2 OU.

B1.3.3 Return Land to Appearance and Use of Surrounding Area

The appearance and use of 1324-N and 1324-NA after closure will be consistent with the future use of the 100-N Area. Structures and piping that do not meet clean closure standards will be removed. Earthen basins will be backfilled, regraded, and revegetated in a manner consistent with the prior site condition.

B2.0 UNIT DESCRIPTION

This section provides a general description of the 1324-NA Percolation Pond and 1324-N Surface Impoundment. This description is intended to provide an overview of these units.

B2.1 GENERAL DESCRIPTION OF UNITS

1324-N, 1324-NA, the South Settling Pond (100-N-58), and soils contained within the current fence line surrounding these units are subject to this WAC 173-303 closure action. Pipelines associated with dangerous waste discharges from generating units to the ponds/surface impoundment are within this closure scope as well.

A chronology of events associated with these units is contained in Table 2-6 of this TSD CMS. A brief description of the units that are the subject of this closure plan is presented below.

From August 1977 until spring 1983, the 1324-N Settling Pond system consisted of the North and South Settling Ponds and the 1324-NA Percolation Pond. These ponds received both the

corrosive regeneration wastes from the 163-N Demineralization Plant and the nondangerous filter backwash wastestream. Plugging of the settling ponds may have caused some flooding on the northern side of the units as described in Section 2.4.4 of this TSD CMS.

Because all ponds received corrosive dangerous wastes after the effective date of regulation for TSD units (November 19, 1980), they are all subject to closure under dangerous waste regulations. The settling ponds, however, have never been described in a Part A Permit Application that would define them as interim status TSD units.

The 1324-NA is a large, unlined, inactive pond that was used to treat corrosive wastes. The pond was placed in service in August 1977 and was used to treat corrosive regeneration wastes from the 163-N Demineralization Plant and to dispose of nondangerous filter backwash water from the 183-N Filtered Water Plant. The corrosive wastes were treated in the Percolation Pond by the alternate addition of acidic cation column regeneration wastes and alkaline anion column regeneration wastes and were concomitantly disposed of through percolation throughout the soil column.

1324-N is an inactive basin that was used as a neutralization pond for the corrosive wastes generated from the 163-N Demineralization Plant. The addition of sulfuric acid and sodium hydroxide in series into this unit resulted in a neutralized nondangerous wastewater. This wastewater was then routed to 1324-N. The 1324-N basin had a double liner as well as leak detection and leachate collection system. This site appears as an unlined basin next to the 1324-NA site today.

For a general discussion on the unit background and a more in-depth description of 1324-N, 1324-NA, the South Settling Pond, and associated piping, refer to Section 2.4.4 of the TSD CMS.

B2.1.1 Topographical Maps

The topographical map for 1324-N and 1324-NA is provided in Figure 2-30 of the TSD CMS report.

B2.1.2 Floodplain

The U.S. Army Corp of Engineers (Jamison 1982) has calculated the probable maximum flood based on the upper limit of precipitation falling on a drainage area and other hydrologic factors such as antecedent moisture conditions, snowmelt, and tributary conditions that could lead to a maximum runoff. The probable maximum flood for the Columbia River below Priest Rapids Dam has been calculated to be 41 million L/s (1.4 million ft^3/s). The 1324-N and 1324-NA units are located above the 100-year floodplain.

B2.1.3 Traffic

The majority of traffic inside the Hanford Site boundaries consists of light-duty vehicles used to transport employees to work areas. The 1324-N and 1324-NA units are located within the Hanford Controlled Access Area where roadways cannot be accessed by the general public These units are isolated from the nearest public highway, State Highway 24, by approximately 6 km (4 mi). Vehicle traffic around the units is restricted and is minimal. Access to the units is prevented by a locked, 2.4-m (8-ft) chain link fence topped with barbed wire.

B2.1.4 General Hydrogeologic Conditions

Section 2.4 of the TSD CMS provides information on the geology and hydrogeology underlying 1324-N and 1324-NA.

B2.1.5 Physical Dimensions of the Waste Units

The 1324-NA Percolation Pond is a rectangular basin, 3.7 m (12 ft) deep, with outer dimensions of 95 m by 61 m (310 ft by 200 ft).

1324-N is a basin with outer dimensions of approximately 43 m by 23 m (140 ft by 75 ft) at grade, sloping to 24 m by 4.6 m (80 ft by 15 ft) at approximately 4.6 m (15 ft) below grade.

B2.1.6 Design Capacity

Both 1324-N and 1324-NA units were designed with a 24-hour period discharge capacity of 1,050 L/min (277 gal/min).

B2.1.7 Ancillary Equipment

The 1324-N and 1324-NA units are passive liquid waste handling/disposal units, which do not rely on active systems for operations support. The units consist of transfer piping, structures, and soil.

B2.1.8 Containment Systems

The 1324-NA unit does not include containment systems. Diking exists between units. The 1324-N unit contains a double lining of 45-mil Hypalon™ and leak detection systems to contain disposed liquids and prevent percolation into the underlying soils.

B2.1.9 Structures and Piping Requiring Removal or Characterization as Clean

Structures requiring removal include a sampling building, valve pits, leak detection systems, and the liners. Associated piping is described in Section 2.4.4 of the TSD CMS.

B2.1.10 Security

The entire Hanford Site is a controlled-access area. The Hanford Site maintains around-the-clock surveillance to restrict unauthorized access for the protection of the public and of government property, classified information, and special nuclear materials. The Hanford Patrol maintains a continuous presence of protective force personnel to provide Hanford Site security.

Within the Hanford Site are operational areas, including 100-N, to which access is restricted. There is a staffed checkpoint at the Wye Barricade (Figure 1-1 of this TSD CMS) through which access to the 100-N Area is allowed only to authorized personnel. Authorized personnel are those individuals with a DOE-issued security identification badge indicating the appropriate authorization. Such personnel are subject to a search of items carried into or out of controlled areas. Unknowing entry by individuals to the 100-N Area is administratively prevented by posting on access roads that allow authorized access only. To preclude unknowing access into the 1324-N and 1324-NA units and to minimize the possibility of entry by animals or by unauthorized individuals, the unit is surrounded by a fence that has locked gate access. Also, posted at the unit are placards that read "Danger - Unauthorized Personnel Keep Out."

B2.2 WASTE CHARACTERISTICS

B2.2.1 Liquid Waste Discharges

The hazardous wastes treated in 1324-NA were produced by the regeneration of ion exchange columns in the 163-N Demineralizer Plant. The wastes consisted of acid and caustic regeneration fluids and process and cooling water flushes. The pH of the demineralized water plant wastes varied from less than 1.0 to as high as 14 standard units. These discharges qualified as corrosive dangerous wastes defined in WAC 173-303-090(a)(i) when pH was less than 2.0, or greater than/equal to 12.5. The regeneration solutions would have contained a variety of metal constituents as a result of concentration on the ion exchange media. These metals were not detected at levels that would regulate them as characteristic waste (WAC 173-303-090).

Tables B-1 and B-2 contain the results of chemical analyses performed on the cation and anion regeneration wastes respectively. The analyses indicate that the discharges were corrosive dangerous wastes, but did not qualify as dangerous wastes under any of the other criteria. Table B-3 contains analyses of the 183-N Filtered Water Plant backwash effluent, the nondangerous wastewater also discharged to 1324-N and 1324-NA.

B2.2.2 Liquid Waste Discharge Chronology

A chronology of liquid waste discharges to the 1324-N/NA units is provided in Table B-4.

B3.0 GROUNDWATER MONITORING

B3.1 AQUIFER IDENTIFICATION

The unconfined aquifer in the 100-N Area is located primarily in the upper part of the Ringold Formation (sands and gravels) and is approximately 12 to 15 m (40 to 50 ft) thick. The base of the aquifer is believed to be a laterally continuous clay-rich unit containing a series of paleosols. Lithologies in this unit range from clay and silt to sand. Most of the wells in the 100-N Area were completed at the water table; therefore, the thickness of the clay-rich unit is not known at all locations.

The water table is approximately 22 m (72 ft) below land surface near the 1324-N and 1324-NA units. Water levels have returned to "pre-Hanford" levels after years of groundwater mounding caused by artificial recharge from the 1324-NA and other effluent disposal in the 100-N Area.

Table B-1. 163-N Demineralization Plant Regeneration Effluent Waste Analysis Cation Regeneration Cycle. (Page 1 of 2)

Parameter (MDL)	Sample			
	1	2	3	Average
pH (standard units)	0.894	0.936	0.922	0.917
Conductivity (micromhos)	37000	40100	35000	37367
Mercury (.001 ppm)	ND	ND	ND	ND
Ethylene glycol (10 ppm)	ND	ND	ND	ND
Enhanced thiourea (.2 ppm)	ND	ND	ND	ND
TOC (1 ppm)	0.0013	0.0019	0.0018	0.0016
Cyanide (.01 ppm)	ND	ND	ND	ND
Barium (.006 ppm)	0.03	0.023	0.020	0.024
Cadmium (.002 ppm)	0.003	0.002	0.003	0.003
Chromium (.01 ppm)	ND	ND	ND	ND
Lead (.03 ppm)	ND	ND	ND	ND
Silver (.01 ppm)	ND	ND	ND	ND
Sodium (.1 ppm)	12.2	16.5	9.6	12.8
Nickel (.01 ppm)	ND	ND	ND	ND
Copper (.01 ppm)	ND	ND	ND	ND
Vanadium (.005 ppm)	0.025	0.027	0.020	0.024
Antimony (.1 ppm)	ND	ND	ND	ND
Aluminum (.15 ppm)	0.725	0.842	0.655	0.741
Manganese (.005 ppm)	0.027	0.035	0.027	0.030
Potassium (.1 ppm)	12.2	15.5	14.8	14.2
Iron (.05 ppm)	1.1	1.2	1.0	1.1
Beryllium (.005 ppm)	ND	ND	ND	ND
Osmium (.3 ppm)	ND	ND	ND	ND
Strontium (.3 ppm)	1.3	1.4	1.2	1.3
Zinc (.005 ppm)	0.016	0.024	0.067	0.036
Calcium (.05 ppm)	282.6	347.4	324.9	318.3

Table B-1. 163-N Demineralization Plant Regeneration Effluent Waste Analysis Cation Regeneration Cycle. (Page 2 of 2)

Parameter (MDL)	Sample			
	1	2	3	Average
Nitrate (.5 ppm)	1.0	0.5	0.8	0.8
Sulphate (.5 ppm)	2310	4271	2952	3201
Fluoride (.5 ppm)	ND	ND	ND	ND
Chloride (.5 ppm)	2.0	1.8	1.9	1.9
Phosphate (1 ppm)	ND	ND	ND	ND
Phosphorus Pesticides (.005 ppm)	ND	ND	ND	ND
Chlorinated Pesticides (.001 ppm)	ND	ND	ND	ND
Enhanced ABN List	ND	ND	ND	ND
Citrus Red (1 ppm)	ND	ND	ND	ND
Arsenic (.005 ppm)	ND	ND	ND	ND
Ammonium Ion (.05 ppm)	ND	ND	ND	ND
Coliform (3 MPN)	ND	ND	ND	ND
Selenium (.005 ppm)	ND	ND	ND	ND
Thallium (.01 ppm)	ND	ND	ND	ND
Enhanced VOA (10 ppm)	26	28	26	27

ND = Not Detected
MDL = Minimum Detection Limit
Data obtained from samples taken August 1985.
DOE-RL (1994)

Table B-2. 163-N Demineralization Plant Regeneration Effluent Waste Analysis Anion Regeneration Cycle. (Page 1 of 2)

Parameter (MDL)	Sample			
	1	2	3	Average
pH (standard units)	13.72	13.74	13.77	13.74
Conductivity (micromhos)	62000	60000	70000	64000
Mercury (.001 ppm)	0.0001	0.0001	0.0001	0.0001
Ethylene glycol (10 ppm)	ND	ND	ND	ND
Enhanced thiourea (.2 ppm)	ND	ND	ND	ND
TOC (1 ppm)	462	499	456	472
Cyanide (.01 ppm)	0.01	0.015	ND	0.013
Barium (.006 ppm)	ND	ND	ND	ND
Cadmium (.002 ppm)	ND	ND	ND	ND
Chromium (.01 ppm)	ND	ND	ND	ND
Lead (.03 ppm)	ND	ND	ND	ND
Silver (.01 ppm)	ND	ND	ND	ND
Sodium (.1 ppm)	26910	28200	26330	27150
Nickel (.01 ppm)	ND	ND	ND	ND
Copper (.01 ppm)	ND	ND	ND	ND
Vanadium (.005 ppm)	ND	ND	ND	ND
Antimony (.1 ppm)	ND	ND	ND	ND
Aluminum (.15 ppm)	ND	ND	ND	ND
Manganese (.005 ppm)	ND	ND	ND	ND
Magnesium (5 ppm)	ND	ND	ND	ND
Potassium (.1 ppm)	26.5	27.2	26.3	26.7
Iron (.05 ppm)	ND	ND	ND	ND
Beryllium (.005 ppm)	ND	ND	ND	ND
Osmium (.3 ppm)	ND	ND	ND	ND
Strontium (.3 ppm)	ND	ND	ND	ND
Zinc (.005 ppm)	ND	ND	ND	ND

Table B-2. 163-N Demineralization Plant Regeneration Effluent Waste Analysis Anion Regeneration Cycle. (Page 2 of 2)

Parameter (MDL)	Sample			
	1	2	3	Average
Calcium (.05 ppm)	ND	ND	ND	ND
Nitrate (.5 ppm)	1.0	1.4	0.9	1.1
Sulphate (.5 ppm)	30.9	30.6	30.6	30.7
Fluoride (.5 ppm)	ND	ND	ND	ND
Chloride (.5 ppm)	2.5	2.3	2.3	2.4
Phosphate (1 ppm)	ND	ND	ND	ND
Phosphorus Pesticides (.005 ppm)	ND	ND	ND	ND
Chlorinated Pesticides (.001 ppm)	ND	ND	ND	ND
Enhanced ABN List	ND	ND	ND	ND
Citrus Red (1 ppm)	ND	ND	ND	ND
Arsenic (.005 ppm)	ND	ND	ND	ND
Ammonium Ion (.05 ppm)	2.3	2.7	2.8	2.6
Coliform (3 MPN)	---	0.023	0.009	0.016
Selenium (.005 ppm)	ND	ND	ND	ND
Thallium (.01 ppm)	ND	ND	ND	ND
Enhanced VOA (10 ppm)	26	28	26	27

ND = Not Detected
MDL = Minimum Detection Limit
Data obtained from samples taken August 1987.
DOE-RL (1994)

Table B-3. 183-N Filtered Water Plant Backwash Effluent Analysis. (Page 1 of 2)

Parameter (MDL)	Sample			
	1	2	3	Average
pH (standard units)	7.08	7.65	7.64	7.46
Conductivity (micromhos)	160	150	150	153
Mercury (.001 ppm)	ND	ND	ND	ND
Ethylene glycol (10 ppm)	ND	ND	ND	ND
Enhanced thiourea (.2 ppm)	ND	ND	ND	ND
TOC (1 ppm)	0.002	0.002	0.002	0.002
Cyanide (.01 ppm)	ND	ND	ND	ND
Barium (.006 ppm)	0.03	0.031	0.030	0.030
Cadmium (.002 ppm)	0.004	0.002	0.002	0.003
Chromium (.01 ppm)	ND	ND	ND	ND
Lead (.03 ppm)	ND	ND	ND	ND
Silver (.01 ppm)	ND	ND	ND	ND
Sodium (.1 ppm)	2.202	2.287	2.186	2.225
Nickel (.01 ppm)	ND	ND	ND	ND
Copper (.01 ppm)	ND	ND	ND	ND
Vanadium (.005 ppm)	ND	ND	ND	ND
Antimony (.1 ppm)	ND	ND	ND	ND
Aluminum (.15 ppm)	0.392	0.389	0.376	0.386
Manganese (.005 ppm)	0.020	0.015	0.014	0.016
Potassium (.1 ppm)	0.799	0.814	0.762	0.792
Iron (.05 ppm)	ND	ND	ND	ND
Beryllium (.005 ppm)	ND	ND	ND	ND
Osmium (.3 ppm)	ND	ND	ND	ND
Strontium (.3 ppm)	ND	ND	ND	ND
Zinc (.005 ppm)	ND	ND	ND	ND
Calcium (.05 ppm)	17.34	17.72	17.02	17.36
Nitrate (.5 ppm)	0.789	0.50	0.50	0.596

Table B-3. 183-N Filtered Water Plant Backwash Effluent Analysis. (Page 2 of 2)

Parameter (MDL)	Sample			
	1	2	3	Average
Sulphate (.5 ppm)	18.9	20.98	19.11	19.66
Fluoride (.5 ppm)	ND	ND	ND	ND
Chloride (.5 ppm)	2.846	2.671	2.901	2.806
Phosphate (1 ppm)	ND	ND	ND	ND
Phosphorus Pesticides (.005 ppm)	ND	ND	ND	ND
Chlorinated Pesticides (.001 ppm)	ND	ND	ND	ND
Enhanced ABN List	ND	ND	ND	ND
Citrus Red (1 ppm)	ND	ND	ND	ND
Arsenic (.005 ppm)	ND	ND	ND	ND
Ammonium Ion (.05 ppm)	ND	ND	ND	ND
Coliform (3 MPN)	0.24	2.4	2.4	1.68
Selenium (.005 ppm)	ND	ND	ND	ND
Thallium (.01 ppm)	ND	ND	ND	ND
Enhanced VOA (10 ppm)	---	0.24	0.25	0.25

ND = Not Detected
MDL = Minimum Detection Limit
Data obtained from samples taken August 1985.
DOE-RL (1994)

Table B-4. Chronology of Liquid Waste Discharges.

Year	Liquid Waste Discharge to 1324-N and 1324-NA (L/day)
1964	0
1965	0
1966	0
1967	0
1968	0
1969	0
1970	0
1971	0
1972	0
1973	0
1974	0
1975	0
1976	0
1977	1,703,250
1978	1,703,250
1979	1,703,250
1980	1,703,250
1981	1,703,250
1982	1,703,250
1983	1,703,250
1984	1,703,250
1985	1,703,250
1986	1,703,250
1987	1,703,250
1988	1,703,250
1989	1,703,250
1990	1,703,250
1991+	0

WHC (1991)

A representative range of transmissivity estimates for the unconfined aquifer in the 100-N Area is 93 to 560 m^2/day (1,000 to 6,030 ft^2/day) throughout most of the 100-N Area. Wells in the northwest seem to show a higher transmissivity (up to 1,900 m^2/day [20,500 ft^2/day]). These values correspond to horizontal hydraulic conductivity of 6 to 37 m/day (20 to 121 ft/day); 120 m/day (394 ft/day) in the northwest. Specific yield is estimated at 0.1 to 0.3.

Hartman and Lindsey (1993) describe the hydrogeology of the 100-N Area in more detail.

B3.2 INTERIM STATUS GROUNDWATER MONITORING

The 1324-N and the 1324-NA areas are monitored together because of their proximity to one another and their similar waste histories. Groundwater monitoring began at the 1324-N and 1324-NA units in December 1987. The original monitoring network was modified over the years as water levels declined and new wells were installed to replace dry wells.

After the first year of groundwater monitoring at the 1324-N/NA site, statistical evaluations were performed according to 40 *Code of Federal Regulations* (CFR) 265.93. Results indicated that specific conductance in all of the downgradient wells was significantly elevated above background (i.e., upgradient) levels. This was not unexpected because the effluent discharged to the units had high specific conductance. A groundwater quality assessment program was initiated (Gilmore 1989) in conjunction with the program for the nearby 1301-N Liquid Waste Disposal Facility (LWDF). The assessment program found no evidence that dangerous waste constituents had entered the groundwater (Hartman 1992). Sulfate and sodium were elevated, but these were not historically defined as dangerous waste constituents under the interim status program defined by 40 CFR 265.

The 1324-N and 1324-NA monitoring program did not immediately revert to an indicator evaluation program. Total organic halogen (TOX) had become elevated in two of the downgradient wells. The assessment program was revised to investigate the cause of the elevated TOX (Hartman 1993). The revised program indicated the presence of chloroform, probably from reaction of chlorine with organic material disposed in a French drain near the units (Hartman 1996c). The TOX and chloroform levels decreased, and the units reverted to indicator evaluation monitoring in early 1996 (Hartman 1996c).

Groundwater is monitored under several programs in addition to the *Resource Conservation and Recovery Act of 1976* (RCRA) in the 100-N Area. The most significant in terms of number of wells and analytes are the RCRA and CERCLA programs, and sitewide surveillance. Sampling and analysis for RCRA, CERCLA, and sitewide surveillance monitoring have been coordinated for several years to avoid duplication. However, this coordination did not include the planning stages of the monitoring programs.

In an attempt to reduce redundancy further and make monitoring more efficient, representatives of the various contractors involved in 100-N groundwater monitoring held a series of workshops to consolidate and streamline monitoring. Monitoring networks were redesigned to provide the

most information for all programs most efficiently, and constituent lists were trimmed to the constituents of concern. Sampling frequency also decreased in some cases. Sampling trips and analytical costs are divided among data users. Borghese et al. (1996) describe the well and constituent lists for the combined program. That document does not include requirements for sampling and analysis protocols, quality control (QC), or statistical evaluations. Hartman (1996b) presents a revised groundwater monitoring plan for the RCRA program as summarized in the following section.

B3.2.1 Well Location and Design

The monitoring network for the 1324-N/NA site includes one upgradient well and four downgradient wells (Figure B-1, Table B-5). Well 199-N-59 was installed when the local water table was higher than it is now. The well is now nearly dry and will only be sampled when the water table is seasonally high. All of the wells monitor the unconfined aquifer and are constructed to WAC 173-160 standards. As-built diagrams are included in Hartman (1996b).

B3.2.2 Sampling and Analysis Plan

The *Groundwater Monitoring Plan for the 1301-N, 1324-N/NA, and 1325-N Sites* (Hartman 1996b) describes the interim status sampling and analysis plan for RCRA monitoring. Groundwater is analyzed for the constituents listed in Table B-6. Indicator parameters are analyzed semiannually; additional parameters are analyzed annually.

Groundwater sampling procedures, sample collection documentation, and chain-of-custody requirements are described in *Environmental Investigation Instructions (EII)* (WHC-CM-7-7), The *Environmental Activities Procedural Manual* (WHC-CM-7-8), and in the *Quality Assurance Project Plan for Groundwater Monitoring Activities Managed by Westinghouse Hanford Company* (WHC 1995). Work by other contractors is conducted to their equivalent approved standard operating procedures. Procedures for field measurements (pH, conductivity, turbidity) are specified in WHC-CM-7-8 and in the user's manuals for the meters used. Analytical methods are selected from those provided in *Test Methods for Evaluating Solid Wastes* (EPA 1990) as specified by WHC (1995) or its most recent revision.

B3.2.3 Quality Assurance and Quality Control

Quality assurance (QA) requirements are defined in the *Westinghouse Hanford Company Quality Assurance Manual* (WHC-CM-4-2) or equivalent procedures, and Article 31 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994). Additional requirements for QA and QC are included in WHC (1995) or its most recent revision.

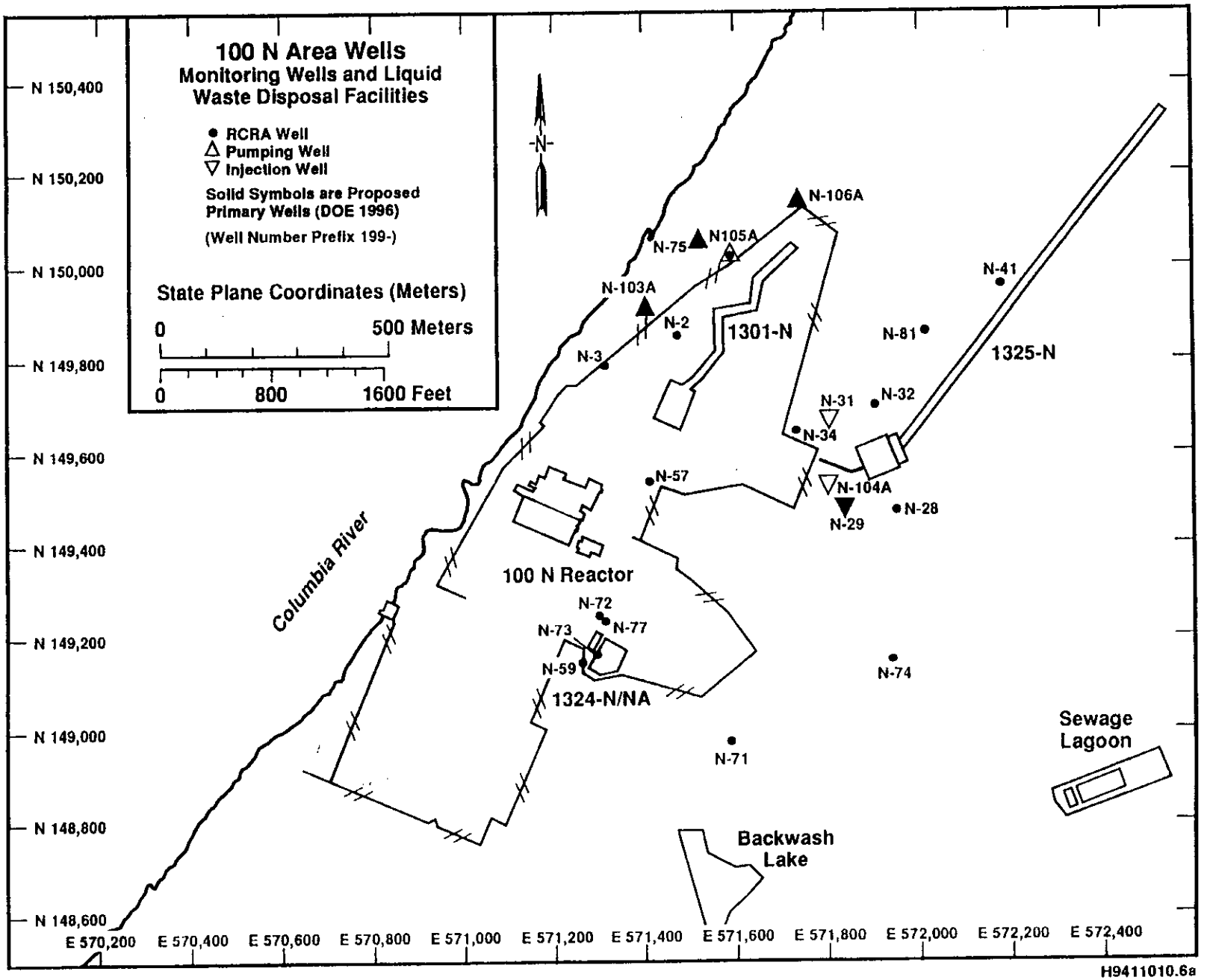


Figure B-1. Proposed RCRA Groundwater Monitoring Network for the 1324-N and 1324-NA Units.

Table B-5. Proposed RCRA Groundwater Monitoring Network for the 1324-N and 1324-NA Units.

Well number	Drill date	Elev. top of casing[a] (m)	Casing/screen materials	Screened or perforated depth[b] (m)	Depth to water[c] (m)
199-N-59	1987	141.25	Stainless steel/ stainless steel	17.4 - 21.9	22.616 (3/96)
199-N-71	1991	141.121	Stainless steel/ stainless steel	19.5 - 25.9	22.314 (3/96)
199-N-72	1991	139.889	Stainless steel/ stainless steel	18.6 - 25.0	21.080 (3/96)
199-N-73	1991	141.194	Stainless steel/ stainless steel	19.8 - 26.2	22.171 (6/96)
199-N-77	1992	141.06	Stainless steel/ stainless steel	25.6 - 29.0	22.231 (3/96)

[a] Surveyed to North American Vertical Datum of 1988.
[b] Approximate depth below land surface; converted from feet.
[c] Depth below top of casing; converted from feet.

Table B-6. Constituent List for 1324-N and 1324-NA Units.

Analyzed Semiannually	Analyzed Annually
Contamination Indicator Parameters (Quadruplicate samples): Specific conductance (field) pH (field) Total Organic Carbon Total Organic Halogen Turbidity (field)	ICP[a] Metals (filtered) Anions Alkalinity

[a] ICP = Inductively Coupled Plasma

B3.3 RESULTS OF GROUNDWATER MONITORING

B3.3.1 Potentiometric Levels

Water levels are measured in all wells before sampling. Many of the wells in the 100-N Area are also measured as part of the sitewide semiannual water level program (Serkowski et al. 1995). About 20 wells are equipped with pressure transducers and data loggers. Any of the data described above can be used to construct water table maps to aid in determining groundwater flow directions.

At various times in the history of waste disposal at the 100-N Area, groundwater mounds formed beneath the 1324-NA Percolation Pond and other effluent disposal sites. Changes in water levels are illustrated in Figure B-2. Water levels have returned to "pre-Hanford" levels in the 100-N Area but are still affected by changes in river stage. Groundwater flow beneath the 1324-N and 1324-NA units currently is toward the Columbia River.

Vertical groundwater gradients are not well defined in the 100-N Area. There is no significant difference in head between wells completed at the top and bottom of the unconfined aquifer near the 1324-N and 1324-NA units.

B3.3.2 Groundwater Quality

Groundwater quality in the unconfined aquifer beneath the 100-N Area has been affected by the 1301-N LWDF, the 1325-N LWDF, and the 1324-NA Percolation Pond. In addition, various leaks and spills may have affected soil or groundwater chemistry (DOE-RL 1991). Data from RCRA sampling and analysis are reported electronically in the Hanford Environmental Information System database. Interpretation of the data has been included in annual reports (Hartman 1996a).

Groundwater beneath the 1324-N/NA units is characterized by high specific conductance, primarily because of elevated sulfate and sodium. Specific conductance increased in wells 199-N-72, 199-N-73, and 199-N-77 in 1993 and 1994, but leveled off in 1995. Sulfate and sodium concentrations follow the same pattern as specific conductance. The pH in 1324-N and 1324-NA wells generally is between 8 and 8.2, with no significant difference between upgradient and downgradient wells.

The TOX was slightly elevated in some of the 1324-N/NA downgradient wells in 1992-93, but subsequently decreased to background levels (usually below detection limits). A revised assessment program investigated the elevated TOX, and results indicated that chloroform was the cause of the TOX. A French drain, used to dispose of nondangerous chlorinated water, is located near the 1324-NA pond and was probably the cause of the chloroform (i.e., chlorine interacting with organic material). Results of TOX assessment are presented by Hartman (1996c).

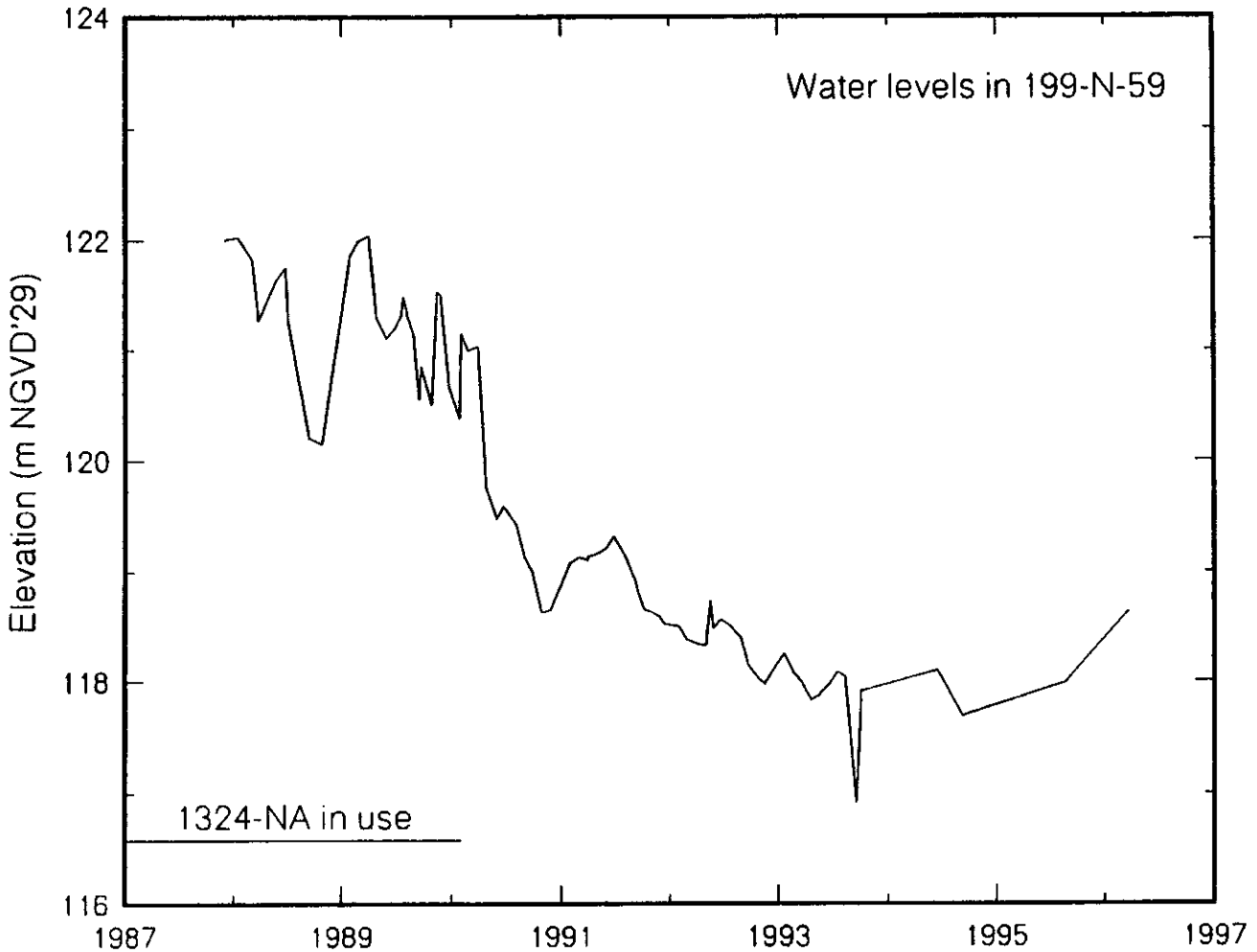


Figure B-2. Water Level Changes in Groundwater Below 1324-N and 1324-NA.

B3.4 GROUNDWATER MONITORING DURING CLOSURE

B3.4.1 Corrective Action Program

The presence of a sulfate plume attributable to past operations at 1324-N and 1324-NA will require that a corrective action program (WAC 173-303-645[11]) be implemented upon the effective date of the modification to the Permit adding these closure units. Groundwater monitoring will be done in accordance with the existing groundwater monitoring program (Borghese, et.al, 1996). A corrective action program to remove or treat the sulfate will be determined in a final ROD for the 100-NR-2 OU.

B3.4.2 Inspection, Maintenance, and Replacement of Wells

Each time a well is sampled, the well head and associated structures are inspected. Problems with the pump or with the sample (e.g., excessive turbidity) are also noted. Repairs are made according to approved contractor procedures. Subsurface inspection and maintenance is performed on a 3- to 5-year schedule, or as needed to repair problems identified during sampling.

If a monitoring well becomes unsuitable for use, the monitoring program will be reevaluated to determine if a new or existing well should be substituted.

B4.0 CLOSURE ACTIVITIES

The physical activities required to close 1324-N and 1324-NA in accordance with WAC 173-303-610 and the Permit will be integrated with the ROD for this TSD CMS and the 100-NR-1/100-NR-2 CMS. Closure activities necessary to comply with dangerous waste regulations and the Permit will need to be consistent with CERCLA activities. CERCLA activities will be required to include elements necessary for closure of a dangerous waste unit.

B4.1 REMOVAL OF STRUCTURES

There will be no remediation excavation in the 1324-N/NA earthen basins for closure, but the Hypalon™ liner and leak detection systems in the 1324-N Surface Impoundment will be removed, using conventional excavation equipment, and disposed as noncontaminated waste. In addition, the sampling shed and perimeter fence will be removed. The structures are discussed in the TSD CMS Section 2.4.4. Figure 2-29 shows the surface impoundment, sampling shed and perimeter fence.

The Hypalon™ liner, sampling shed and perimeter fence will be demolished and removed using conventional demolition/earthmoving equipment. The demolished components will be disposed of in an appropriate non-hazardous disposal facility or recycled as scrap, as appropriate.

B4.2 PIPING REMOVAL OR CHARACTERIZATION AS CLEAN

Should a determination be made that piping associated with the units may be able to meet clean closure standards and be left in place, the determination will then be submitted to Ecology for its concurrence. This determination may be based on process knowledge, sampling, or both. Specific sampling requirements will be developed after the ROD and during the remedial design phase of the remedial action. Where piping cannot be determined to be clean, the influent pipelines between the 163-N facility and the 1324-N/NA units will be excavated and removed for disposal as scrap metal destined for recycling. Should piping not be appropriate for recycling, it will be sampled to determine its regulatory status and treated and disposed of accordingly. This piping is shown in Figure 2-28 of the TSD CMS Report. Appendix D of this TSD CMS provides the reference maps and estimated pipe lengths.

If removal of the buried pipelines is required, they will be unearthed by conventional excavation equipment. The exposed piping will be segmented for removal manually or with the excavation equipment. Contamination controls will focus on the drainage of residual fluids in the piping prior to, and during, segmentation and on the control of airborne contamination during cutting and pipe handling operations. After the piping has been removed, the pipe bedding soil will be surveyed for residual contamination, excavated, and disposed as necessary.

B4.3 EVALUATION OF SOIL DATA

B4.3.1 Sampling and Analysis

Soil samples associated with the vadose zone at 1324-N and 1324-NA were collected from two boreholes and one test pit in late 1992 and early 1993. The test pit was excavated in the 1324-NA percolation pond, and samples were collected from the surface to 21.3 m (70 ft) in 1.5-m (5-ft) intervals. Samples from borehole 199-N-88 were collected from the surface to 21.9 m (72 ft), and samples from borehole 199-N-89 were collected from the surface to 23.2 m (76 ft). All the borehole samples were collected in approximately 1.5-m (5-ft) intervals, and composited over 0.15- to 0.76-m (0.5- to 2.5-ft) intervals. A total of 53 samples were collected from the 3 areas. Figure B-3 contains a map showing the sample locations.

Data for ICP metals, mercury, cyanide, pH, and anions are presented in Attachment B-4 of this appendix. Analyses for organic constituents were also performed, but none of these were present above detection limits; thus, they will not be discussed further. The following sections use these data to evaluate whether the activities that occurred at 1324-N and 1324-NA have impacted the vadose zone soils.

Samples collected from the test pit and borehole 199-N-88 provide data on vadose zone soil composition beneath 1324-NA and the South Settling Pond, respectively. If significant amounts of contamination were deposited in the vadose zone under these two ponds, the data presented here would likely show evidence of this contamination. Borehole 199-N-89 is located to the

northwest of 1324-N. Because of the boreholes location, using data from it to assess dangerous waste in the vadose zone is questionable.

B4.3.2 Assessment of Contamination

In order to evaluate if 1324-N and 1324-NA have released contamination into the vadose zone, the data described above were statistically summarized and compared to background levels for the Hanford Site. Background is allowed as a default cleanup level in most environmental regulations (e.g., WAC 173-303, 173-340), which recognize that background levels are rarely detrimental to human health or the environment and that remediating to levels below background concentrations is futile. The comparison with background values follows the methodology recommended by Ecology (Ecology 1992).

Table B-7 lists the upper 95% confidence limit on the mean of the data from the units, as well as other statistical values. The data were determined to follow a log normal distribution, so the statistics were calculated on that basis.

Table B-8 presents the evaluation of the data compared to background, using the three-part test recommended by Ecology. The data pass the first part of the test, which compares the background value at the 90th percentile to the 95% upper confidence level on the mean of the waste site data. Using this comparison, the data are below background for all analytes.

The second and third parts of the Ecology test evaluate frequency and magnitude of exceedences of the data above comparison criteria levels (background, in this case). The allowable frequency of exceedences for comparison to background is determined by using the binomial theorem to calculate the probability that a single sample is greater than background at a probability of 0.10. This calculation requires knowledge of the percentile chosen for background (0.90), the number of samples from the units (53), and the exceedence frequency (0.10). Using this criterion, a maximum of eight exceedences is allowed. Copper is the only analyte that has a significant number of exceedences (seven samples; see Table B-8), and it is below the maximum number permitted.

The third part of the Ecology test requires that the largest value from the waste site data be less than two times the cleanup level. As seen in Attachment B-4 of this appendix, none of the analytes exceed this criterion.

B4.3.3 Summary and Recommendations

The data presented here strongly indicate that the vadose zone under 1324-N, 1324-NA, and the South Settling Pond has concentrations of metals indistinguishable from background compositions. The data used to lead to this conclusion were obtained from samples located in areas expected to record adverse impacts from the units. An exception to this is the lack of data from samples that may have been influenced by an overflow of the North Settling Pond. There are some indications that this event may have occurred and that standing water was present in the

Figure B-3. Sample Locations for 1324-N and 1324-NA Soil Data.

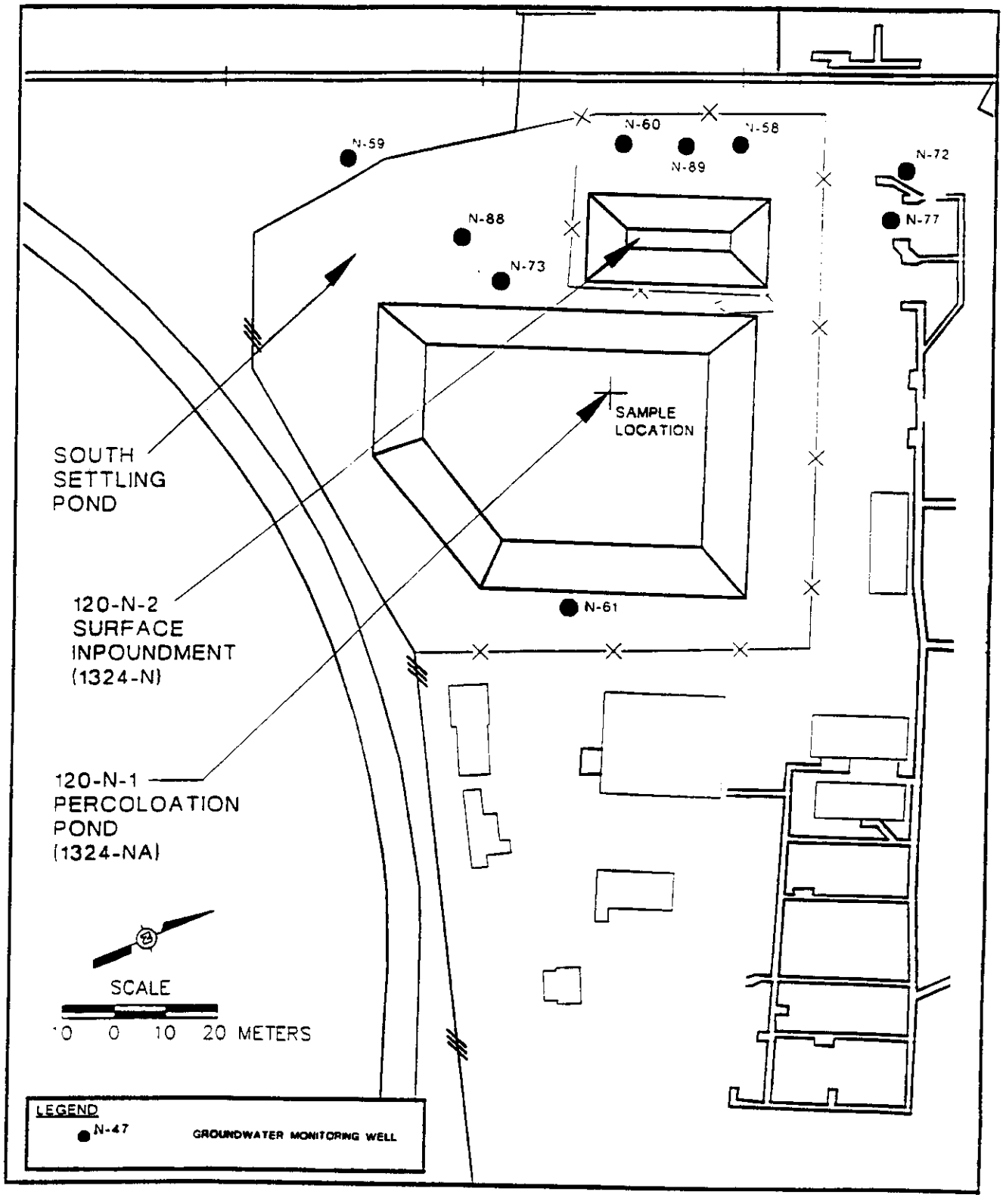


Table B-7. Statistical Summary of Data From 1324-N/1324-NA/South Settling Pond TSD.

	Geo. Mean	Min	Max	N	90th Percentile	95% UCL on Mean
Antimony[a]	3.04	1.70	6.35	53	5.14	3.66
Arsenic	1.05	0.37	3.5	53	2.03	1.37
Barium	48.43	16.80	93.7	53	72.61	54.99
Chromium	4.56	0.65	14.6	53	13.28	8.23
Cobalt	8.12	1.05	15.8	53	16.09	10.78
Copper	14.06	2.60	31.5	53	27.36	18.45
Fluoride	1.14	0.30	3.2	53	2.17	1.47
Lead	2.76	1.50	6.4	53	4.54	3.28
Manganese	213	73.80	702	53	341.81	250
Mercury	0.038	0.02	0.37	53	0.10	0.061
pH	8.10	5.6	9.8	53	9.76	8.42
Nickel	7.40	2.08	17.6	53	12.13	8.77
Selenium[a]	0.60	0.21	2.5	53	1.17	0.79
Sulfate	32.81	6.00	135	53	77.37	49.41
Vanadium	33.02	3.70	81.1	53	80.45	50.96
Zinc	34.74	6.80	94.4	53	67.80	45.66

[a] Background values for these analytes were below detection limit; highest detection limit reported by the laboratory is used.
UCL = Upper Confidence Limit

Table B-8. Comparison of TSD Soil Data to Background.

	Average	Upper 95 UCL on Mean	Background, 90th percentile	# of data > BG	% of data > BG	Max value/ background
Antimony	3.29	3.66	11.1	0	0.0	0.57
Arsenic	1.20	1.37	6.47	0	0.0	0.54
Barium	50.68	54.99	132	0	0.0	0.71
Chromium	6.00	8.23	18.5	0	0.0	0.79
Cobalt	9.07	10.78	15.7	1	1.9	1.01
Copper	15.70	18.45	22	7	13.2	1.43
Fluoride	1.28	1.47	2.81	3	5.7	1.14
Lead	2.99	3.28	10.2	0	0.0	0.63
Manganese	227	250	512	1	1.9	1.37
Mercury	0.05	0.06	0.33	1	1.9	1.12
Nickel	7.92	8.77	19.1	0	0.0	0.92
Selenium	0.70	0.79	5	0	0.0	0.50
Sulfate	40.69	49.41	237	0	0.0	0.57
Vanadium	39.40	50.96	85.1	0	0.0	0.95
Zinc	38.85	45.66	67.8	4	7.5	1.39

UCL = Upper Confidence Limit

northern portion of the units. To evaluate any impacts from an event of this kind, two samples will be collected from the northern part of the units and analyzed for metals, pH, and sulfate. The location of the samples will be determined and agreed upon by all parties involved in the closure decisions.

B4.4 WASTE MANAGEMENT

Closure of the 1324-N and 1324-NA units may generate small quantities of clean or contaminated nonradioactive debris. Disposal of these wastes will be dependent upon their level of contamination. It is doubtful that dangerous waste will be generated during cleanup of these units, however, should dangerous waste be generated, its management will occur in compliance with WAC 173-303. Waste generated as part of this closure activity will be managed and disposed of in such a way as to ensure protection of human health and the environment.

Waste generation, management, and disposal will be conducted in accordance with operational procedures and with all State, Federal, and DOE Orders and regulations dealing with waste, including agreements with the public and stakeholders.

B4.5 SITE RESTORATION

After the system structures and piping have been removed or they have been characterized as clean, the earthen basins will be backfilled, regraded, and revegetated in a manner consistent with the prior site condition.

B4.6 PERSONNEL TRAINING

No radioactive or dangerous waste constituent hazards are expected to be encountered during closure activities at 1324-N and 1324-NA, nor are dangerous wastes expected to be generated. However, should hazards be encountered or dangerous waste be generated that were not anticipated, training will be provided to site personnel in accordance with the site-specific training plan contained in Attachment B-4.

Training required during closure activities for personnel involved in the groundwater monitoring program are the same as those identified in Section 5.5 the Postclosure Plan.

B4.7 CLOSURE CONTACT

The DOE-RL will be the official contact during the postclosure period at the following address:

Director, Environmental Assurance, Permits, and Policy Division*
U.S. Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

*or its equivalent should there be a future reorganization at DOE-RL

B4.8 CLOSURE SCHEDULE

The closure schedule for 1324-N (120-N-2) and 1324-NA (120-N-1) is presented in Figure B-4. Closure activities (actual cleanup) for the 120-N-1 and 120-N-2 will begin in July 2001 and will continue for an approximate duration of 15 months. The corrective action schedule of compliance for 100-N-58 will be the same as the closure schedule.

B4.9 AMENDMENT OF CLOSURE PLAN

The 1324-N and 1324-NA closure plan will be amended whenever changes in closure activities or postclosure requirements occur and prior to certification of closure and postclosure, respectively, that would constitute a Class 1, 2, or 3 modification to the Permit (WAC 173-303-830).

B4.10 CERTIFICATION OF CLOSURE

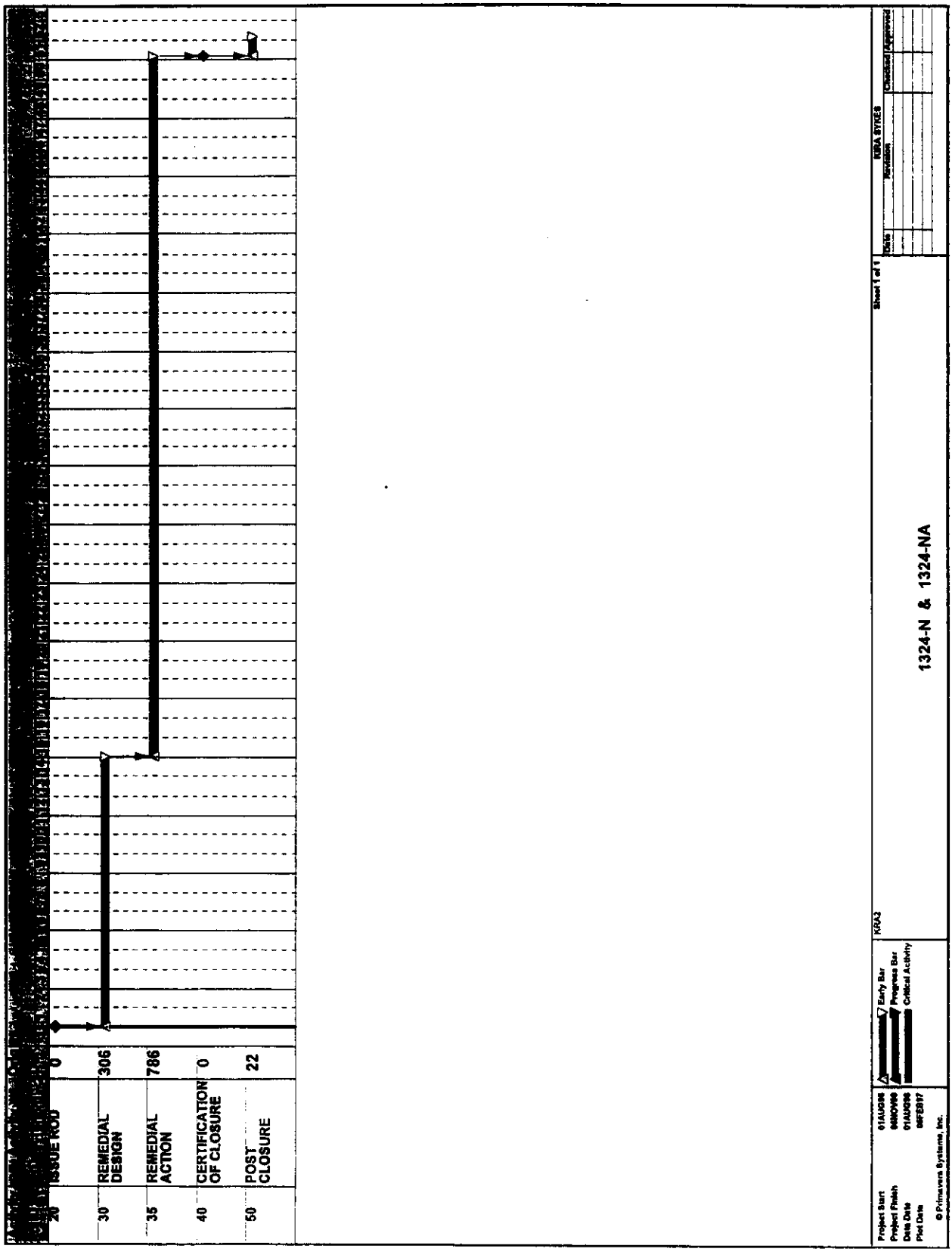
In accordance with WAC 173-303-610(6), within 60 days of closure of 1324-N and 1324-NA, RL will submit to Ecology a certification of closure signed by both RL and an independent registered professional engineer. The certification will specify that the units have been closed in accordance with specifications contained within the approved closure plan as contained in the Permit.

B4.11 SURVEY PLAT AND NOTICE IN DEED

A survey plat will be submitted by RL to the Benton County Planning Department no later than 60 days after certification of closure of each unit in accordance with WAC 173-303-610(10). Also, a notice in deed will be submitted by RL to the Auditor of the Benton County no later than 60 days after certification of closure of each unit in accordance with WAC 173-303-610(10). After submitting this notice, a certification signed by the Permittees will be submitted to Ecology stating that notification has been recorded along with a copy of the notice in deed. The notice in

deed will specify the type, location, and quantity of dangerous wastes remaining after closure actions have been completed.

Figure B-4. Closure Schedule for 1324-N and 1324-NA.



B5.0 POSTCLOSURE PLAN

Modified postclosure requirements will be applicable to 1324-N and 1324-NA. Permit condition II.K.3. allows a modified closure option for a unit if it can meet MTCA Method C cleanup levels. The soil column has been demonstrated to be able to meet clean closure standards under MTCA Method B. However, sulfate concentrations exceed MTCA Method C groundwater protection standards because MTCA Method B and Method C standards are identical when the basis is a federal drinking water standard, as is the case with sulfate.

Units where contamination exceeds MTCA Method C may be required to close as a landfill (Permit condition II.K. 4). However, as part of this postclosure plan, Attachment B-6 presents a demonstration that a landfill cover is not required over the 1324-N and 1324-NA units and therefore modified closure is the appropriate closure option for these units. The amount of clean soil meeting MTCA Method B cleanup standards that will remain at the closed 1324-N and 1324-NA units would prevent a downward driving force of precipitation that could contribute to further degradation of the groundwater. Attachment B-6 shows that precipitation would not reach groundwater for over 200 years. Because the soil column has been determined to be clean, and no downward driving force for further groundwater contamination exists, there would be no need for a landfill cover system at 1324-N and 1324-NA.

B5.1 INSTITUTIONAL CONTROLS

No soil contamination that would present a hazard from direct exposure remains at 1324-N and 1324-NA. Therefore, no measures are required to prohibit or limit access at the surface. For example, fences or barriers will not be required.

Institutional controls are required to be maintained in order to ensure that groundwater is not used as a drinking water source. Because DOE-RL will maintain control over this site for the foreseeable future, it is not anticipated that additional actions will be required to limit controls over groundwater usage. Should groundwater use restrictions be required after DOE-RL relinquishment of the area, appropriate institutional controls will be established.

B5.2 PERIODIC ASSESSMENTS

Periodic assessments are required by Permit Condition II.K.3.b. The first periodic assessment will take place after a period of five years from the completion of closure. As allowed by WAC 173-340-410, a compliance monitoring plan for protection and confirmation monitoring during the five year period may be combined with other plans. Protection and confirmation sampling of groundwater will be achieved through implementation of the dangerous waste groundwater monitoring plan.

B5.3 GROUNDWATER MONITORING POSTCLOSURE REQUIREMENTS

B5.3.1 Postclosure Groundwater Monitoring

During the postclosure period, monitoring of groundwater will continue under a corrective action program in accordance with WAC 173-303-645(11). A groundwater monitoring plan will be developed for 1324-N and 1324-NA and implemented prior to incorporation of this postclosure plan into the Permit.

B5.3.2 Inspection, Maintenance, and Replacement of Wells

Each time a well is sampled, the well head and associated structures are inspected. Problems with the pump or with the sample (e.g., excessive turbidity) are also noted. Repairs are made according to approved contractor procedures. Subsurface inspection and maintenance is performed on a 3- to 5-year schedule, or as needed to repair problems identified during sampling.

If a monitoring well becomes unsuitable for use, the monitoring program will be reevaluated to determine if a new or existing well should be substituted.

B5.4 CORRECTIVE ACTION PLAN

Because the groundwater monitoring data continues to show exceedences of sulfate concentrations above the secondary drinking water standard (250 mg/L) , corrective action to remove or treat the sulfate will be required. Corrective actions will be determined in a ROD for the 100-NR-2 OU. The sulfate plume is described in the 100-NR-1/100-NR-2 CMS (DOE-RL 1996a) in Section 3.3.3.2, "Nature and Extent of Contamination." Alternatives for its remediation are presented and analyzed in Sections 5 through 7. A Proposed Plan and ROD for the 100-NR-2 OU will determine any corrective actions required to remediate the sulfate plume.

B5.5 PERSONNEL TRAINING DURING POSTCLOSURE

This section describes the training of personnel required to complete postclosure care requirements contained in this closure plan and the Permit. It is intended to supplement the training plan currently in place and identified in Attachment B-4. A brief description of how training will be designed to meet job tasks is presented below.

B5.5.1 Surveillance Personnel

The following outline provides potential information on classroom or on-the-job training that surveillance personnel will complete before conducting independent site surveillance at 1324-N and 1324-NA during a postclosure period.

- Security inspections

- Location, integrity, and inspection of benchmarks, if appropriate
- Location, integrity, and inspection of groundwater wells
- Erosion damage
- Vegetative cover condition.

B5.5.2 Groundwater Sampling and Analysis Task Leader and Sampling Personnel

This section describes the training of the groundwater sampling and analysis task leader and sampling personnel required to complete postclosure care requirements as contained in this postclosure plan. A brief description of how training will be designed to meet job tasks is presented below.

The sampling and analysis task leader or delegate and samplers will be responsible for:

- Monitoring and reporting on groundwater well security and maintenance
- Collecting groundwater level data
- Collecting , packaging, and shipping groundwater samples to field and offsite laboratories
- Sampling and monitoring equipment operation and maintenance
- Providing sample chain of custody to the laboratory.

The training of the sampling and analysis task leader and sampling personnel will receive either classroom instruction or on-the-job training. Sampling and analysis personnel will be trained to perform these functions in accordance with the *Hanford Analytical Services Quality Assurance Requirements Documents* (DOE-RL 1996b). A person successfully completing the required training courses 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.

B5.6 SECURITY

B5.6.1 24-Hour Surveillance System

The 100 Area will remain an area controlled by the DOE-RL for the foreseeable future. These areas will be under 24-hour surveillance by Hanford Patrol protective force personnel.

B5.6.2 Barrier, Means to Control Entry, and Warning Signs

No direct exposure hazards remain at 1324-N and 1324-NA. However, roadways to the unit and site access will remain administratively restricted to use by authorized personnel only. Access to the 100-N Area from the Columbia River is restricted by posted federal warning signs.

B5.7 POSTCLOSURE CONTACT

The DOE-RL will be the official contact during the postclosure period at the following address:

Director, Environmental Assurance, Permits, and Policy Division*
U.S. Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

*or its equivalent should there be a future reorganization at DOE-RL

B5.8 CERTIFICATION OF POSTCLOSURE

No later than 60 days after completion of the postclosure care period, the DOE-RL will submit to Ecology a certification of completion of postclosure care. This certification, stating that postclosure care for the unit was performed in accordance with the approved closure plan, will be signed by DOE-RL and an independent registered professional engineer. The certification will be submitted by registered mail or an equivalent delivery service. Documentation supporting the independent registered professional engineer's certification will be supplied upon request of the regulatory authority.

B6.0 REFERENCES

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WHC-CM-7-7, *Environmental Investigation and Site Characterization Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-7-8, *Environmental Activities Procedural Manual*, Westinghouse Hanford Company, Richland, Washington.

ATTACHMENT B-1

PART A, FORM 3, DANGEROUS WASTE PERMIT APPLICATION FOR 1324-N

Please print or type in the unshaded areas only
(fill-in areas are spaced for elite type, i.e., 12 character/inch).

FORM 3

DANGEROUS WASTE PERMIT APPLICATION

I. EPA/STATE I.D. NUMBER: W A 7 8 9 0 0 0 8 9 6 7

FOR OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED *(mo., day, & yr.)*	COMMENTS

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA/STATE I.D. Number, or if this is a revised application, enter your facility's EPA/STATE I.D. Number in Section I above.

A. FIRST APPLICATION *(place an "X" below and provide the appropriate data)*

☐ 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

MO.	DAY	YR.
0 5	1 3	8 6

FOR EXISTING FACILITIES, PROVIDE THE DATE *(mo., day, & yr.)* OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(use the boxes to the left)*

☐ 2. NEW FACILITY *(Complete item below)*

MO.	DAY	YR.

FOR NEW FACILITIES, PROVIDE THE DATE *(mo., day, & yr)* OPERATION BEGAN OR IS EXPECTED TO BEGIN

B. REVISED APPLICATION *(place an "X" below and complete Section I above)*

☒ 1. FACILITY HAS AN INTERIM STATUS PERMIT

☐ 2. FACILITY HAS A FINAL PERMIT

III. PROCESSES - CODES AND CAPACITIES

A. PROCESS CODE - Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process *(including its design capacity)* in the space provided on the *(Section III-C)*.

B. PROCESS DESIGN CAPACITY - For each code entered in column A enter the capacity of the process.

1. AMOUNT - Enter the amount.

2. UNIT OF MEASURE - For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER (barrel, drum, etc)	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D80	GALLONS OR LITERS
LANDFILL	D81	ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER
LAND APPLICATION	D82	*ACRES OR HECTARES*
OCEAN DISPOSAL	D83	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D84	GALLONS OR LITERS

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR GALLONS PER HOUR OR LITERS PER HOUR
OTHER (Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Section III-C.)	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G
LITERS	L
CUBIC YARDS	Y
CUBIC METERS	C
GALLONS PER DAY	U

UNIT OF MEASURE	UNIT OF MEASURE CODE
LITERS PER DAY	V
TONS PER HOUR	D
METRIC TONS PER HOUR	W
GALLONS PER HOUR	E
LITERS PER HOUR	H

UNIT OF MEASURE	UNIT OF MEASURE CODE
ACRE-FEET	A
HECTARE-METER	F
ACRES	B
HECTARES	Q

EXAMPLE FOR COMPLETING SECTION III *(shown in line numbers X-1 and X-2 below): A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400 gallons.* The facility also has an incinerator that can burn up to 20 gallons per hour.

LINE NUMBER	A. PROCESS CODE *(from list above)*	B. PROCESS DESIGN CAPACITY 1. AMOUNT *(specify)*	2. UNIT OF MEASURE *(enter code)*	FOR OFFICIAL USE ONLY	LINE NUMBER	A. PROCESS CODE *(from list above)*	B. PROCESS DESIGN CAPACITY 1. AMOUNT *(specify)*	2. UNIT OF MEASURE *(enter code)*	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G		5				
X-2	T 0 3	20	E		6				
1	T 0 2	400,000	U		7				
2					8				
3					9				
4					10				

CONTINUE ON REVERSE

Continued from the front.

III. PROCESSES (continued)

C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESS (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY

T02

The 1324-N Surface Impoundment is a lined pond with a design capacity of 400,000 gallons (1,514,160 liters). The impoundment was used to treat waste from the regeneration of demineralizer columns. The waste exhibited the characteristics of corrosivity (D002). Successive additions to the pond of acidic and caustic waste served to neutralized the waste. The nonregulated neutralized waste was transferred to the 1324-N Percolation Pond. The 1324-N Surface Impoundment no longer receives waste and will be closed under interim status.

IV. DESCRIPTION OF DANGEROUS WASTES

A. DANGEROUS WASTE NUMBER - Enter the four digit number from Chapter 173-303 WAC for each listed dangerous waste you will handle. If you handle dangerous wastes which are not listed in Chapter 173-303 WAC, enter the four digit number(s) that describes the characteristics and/or the toxic contaminants of those dangerous wastes.

B. ESTIMATED ANNUAL QUANTITY - For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non-listed waste(s) that will be handled which possess that characteristic or contaminant.

C. UNIT OF MEASURE - For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE
POUNDS	P
TONS	T

METRIC UNIT OF MEASURE	CODE
KILOGRAMS	K
METRIC TONS	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. PROCESSES

1. PROCESS CODES:

For listed dangerous waste: For each listed dangerous waste entered in column A select the code(s) from the list of process codes contained in Section III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non-listed dangerous wastes: For each characteristic or toxic contaminant entered in Column A, select the code(s) from the list of process codes contained in Section III to indicate all the processes that will be used to store, treat, and/or dispose of all the non-listed dangerous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: DANGEROUS WASTES DESCRIBED BY MORE THAN ONE DANGEROUS WASTE NUMBER - Dangerous wastes that can be described by more than one Waste Number shall be described on the form as follows:

1. Select one of the Dangerous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other Dangerous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other Dangerous Waste Number that can be used to describe the dangerous waste.

EXAMPLE FOR COMPLETING SECTION IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* - A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non-listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE NO.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (If a code is not entered in D(1))
X-1	K 0 6 4	900	P	T 0 3 D 8 0	
X-2	D 0 0 2	400	P	T 0 3 D 8 0	
X-3	D 0 0 1	100	P	T 0 3 D 8 0	
X-4	D 0 0 2			T 0 3 D 8 0	*included with above*

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PAGE 2 OF 5

CONTINUE ON PAGE 3

Continued from page 2.
NOTE: Photocopy this page before completing if you have more than 26 wastes to list.

I.D. NUMBER *(entered from page 1)*

W	A	7	8	9	0	0	0	8	5	6	7

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

LINE NO.	A. DANGEROUS WASTE NO. *(enter code)*	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE *(enter code)*	D. PROCESSES 1. PROCESS CODES *(enter)*	D. PROCESSES 2. PROCESS DESCRIPTION *(if a code is not entered in D(1))*
1	D002	1,500,000,000	P	T02	Neutralization
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					

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(enter "A", "B", "C", etc. behind the "3" to identify photo copied pages)

Continued from the front.

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM SECTION D(1) ON PAGE 3.

The 1324-N Surface Impoundment was used to treat corrosive dangerous waste (D002) from the 163-N Demineralization Plant. The waste consisted of acidic and caustic backwashes from the regeneration of demineralizer columns. Approximately 1,500,000,000 pounds (680,388,600 kilograms) of waste were treated each year.

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail)*.

VI. PHOTOGRAPHS

All existing facilities must include photographs *(aerial or ground-level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail)*.

VII. FACILITY GEOGRAPHIC LOCATION This information is provided on the attached drawings and photos.

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*

VIII. FACILITY OWNER

[X] A. If the facility owner is also the facility operator as listed in Section VII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER	2. PHONE NO. *(area code & no.)*

3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
John D. Wagoner, Manager U.S. Department of Energy Richland Operations Office		

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
SEE ATTACHMENT		

 CONTINUE ON PAGE 5

X. OPERATOR CERTIFICATION

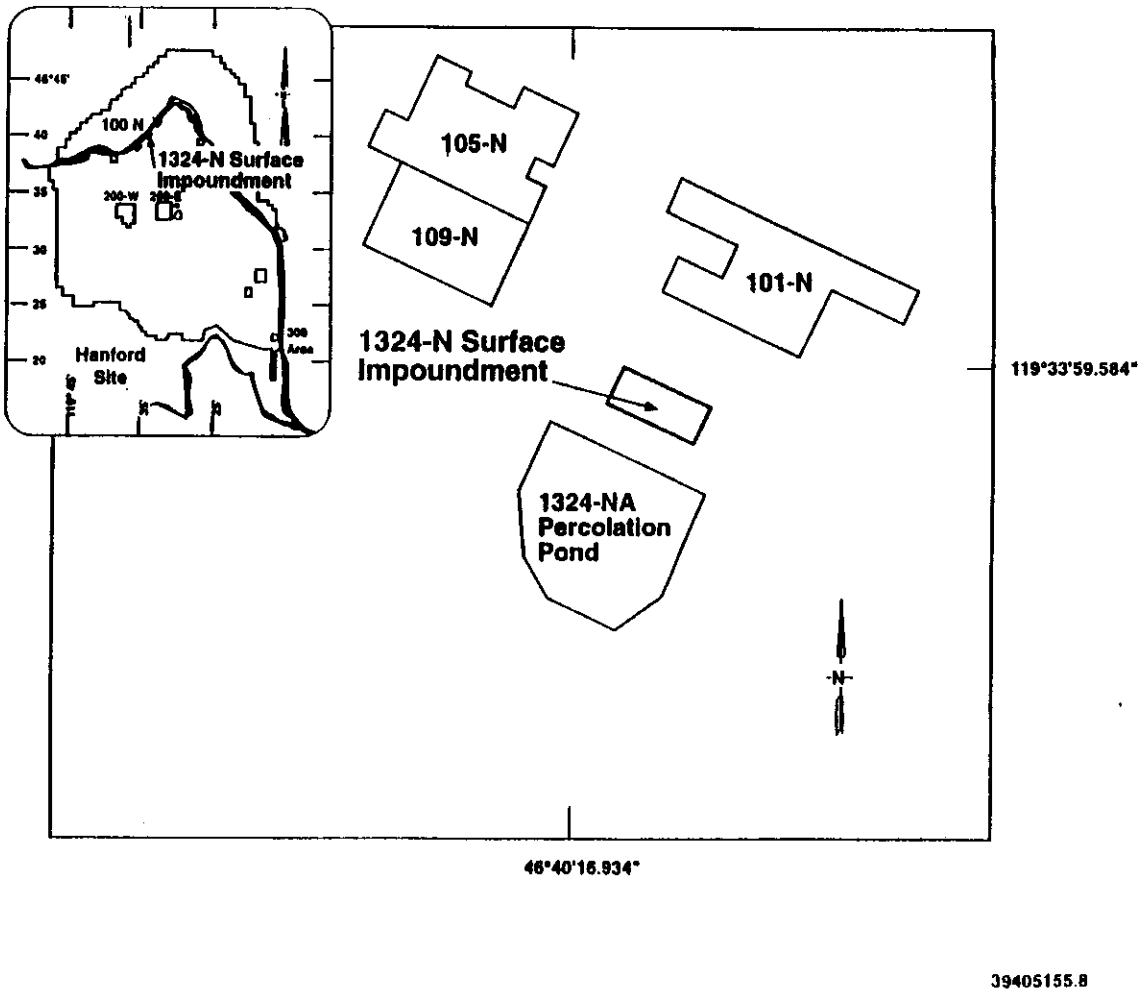
I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Owner/Operator
John D. Wagoner, Manager
U.S. Department of Energy
Richland Operations Office

Date

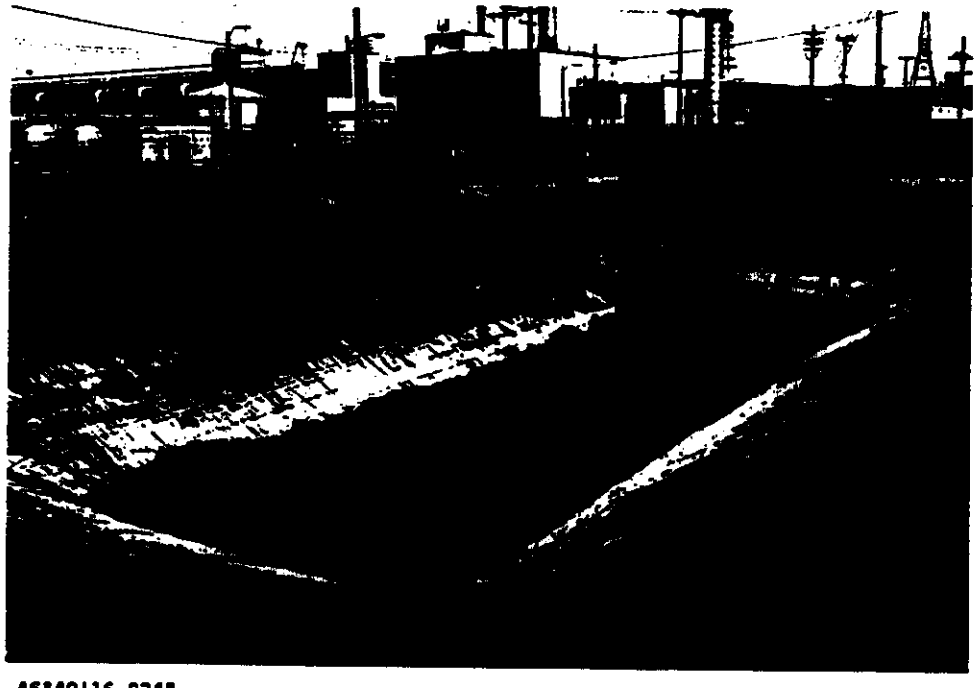
WA7890008967

1324-N Surface Impoundment



1324-N Surface Impoundment
Rev. 3, Page 3 of 7

1324-N SURFACE IMPOUNDMENT



46°40'16.934"
119°33'59.584"

94051304-12CN
(PHOTO TAKEN 1994)

ATTACHMENT B-2

PART A, FORM 3, DANGEROUS WASTE PERMIT APPLICATION FOR 1324-NA

Please print or type in the unshaded areas only
(fill-in areas are spaced for elite type, i.e., 12 character/inch).

FORM **3**

DANGEROUS WASTE PERMIT APPLICATION

1. EPA/STATE I.D. NUMBER: W A 7 8 9 0 0 0 8 9 5 7

FOR OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED (mo., day, & yr.)	COMMENTS

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA/STATE I.D. Number, or if this is a revised application, enter your facility's EPA/STATE I.D. Number in Section I above.

A. FIRST APPLICATION *(place an "X" below and provide the appropriate date)*

☐ 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

MO.	DAY	YR.
0 9	0 1	7 7

FOR EXISTING FACILITIES, PROVIDE THE DATE *(mo., day, & yr.)* OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(use the boxes to the left)*

☐ 2. NEW FACILITY *(Complete item below)*

MO.	DAY	YR.

FOR NEW FACILITIES, PROVIDE THE DATE *(mo., day, & yr)* OPERATION BEGAN OR IS EXPECTED TO BEGIN

B. REVISED APPLICATION *(place an "X" below and complete Section I above)*

☒ 1. FACILITY HAS AN INTERIM STATUS PERMIT

☐ 2. FACILITY HAS A FINAL PERMIT

III. PROCESSES - CODES AND CAPACITIES

A. PROCESS CODE - Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process *(including its design capacity)* in the space provided on the *(Section III-C)*.

B. PROCESS DESIGN CAPACITY - For each code entered in column A enter the capacity of the process.

1. AMOUNT - Enter the amount.
2. UNIT OF MEASURE - For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER (barrel, drum, etc)	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D80	GALLONS OR LITERS
LANDFILL	D81	ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER
LAND APPLICATION	D82	*ACRES OR HECTARES*
OCEAN DISPOSAL	D83	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D84	GALLONS OR LITERS

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR GALLONS PER HOUR OR LITERS PER HOUR
OTHER (Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided: Section III-C.)	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G
LITERS	L
CUBIC YARDS	Y
CUBIC METERS	C
GALLONS PER DAY	U

UNIT OF MEASURE	UNIT OF MEASURE CODE
LITERS PER DAY	V
TONS PER HOUR	D
METRIC TONS PER HOUR	W
GALLONS PER HOUR	E
LITERS PER HOUR	H

UNIT OF MEASURE	UNIT OF MEASURE CODE
ACRE-FEET	A
HECTARE-METER	F
ACRES	B
HECTARES	Q

EXAMPLE FOR COMPLETING SECTION III *(shown in line numbers X-1 and X-2 below): A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400 gallons.* The facility also has an incinerator that can burn up to 20 gallons per hour.

LINE NUMBER	A. PROCESS CODE *(from list above)*	B. PROCESS DESIGN CAPACITY 1. AMOUNT *(specify)*	B. 2. UNIT OF MEASURE *(enter code)*	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G	
X-2	T 0 3	20	E	
1	T 0 4	1,000,000	U	
2	D 8 4	1,000,000	G	
3				
4				

LINE NUMBER	A. PROCESS CODE *(from list above)*	B. PROCESS DESIGN CAPACITY 1. AMOUNT *(specify)*	B. 2. UNIT OF MEASURE *(enter code)*	FOR OFFICIAL USE ONLY
5				
6				
7				
8				
9				
10				

CONTINUE ON REVERSE

Continued from the front.

III. PROCESSES (continued)

C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESS (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY

T04, D84

The 1324-NA Percolation Pond received corrosive dangerous waste (D002) from the regeneration of demineralizer columns in the 163-N Demineralization Plant. Acidic and caustic waste was discharged to the pond in series, which served to neutralize the waste in the pond. Any acidic or caustic waste that reached the soil was neutralized further by the calcareous nature of the soil. Discharge of dangerous waste to this pond was discontinued in April 1986. The pond also received nonregulated neutralized waste from the 1324-N Surface Impoundment and nonregulated process and cooling water from the 163-N Plant. The process design capacity reflects the maximum volume of water discharged daily rather than the physical capacity of the unit. The 1324-NA Percolation Pond no longer receives waste and will be closed under interim status.

IV. DESCRIPTION OF DANGEROUS WASTES

A. DANGEROUS WASTE NUMBER - Enter the four digit number from Chapter 173-303 WAC for each listed dangerous waste you will handle. If you handle dangerous wastes which are not listed in Chapter 173-303 WAC, enter the four digit number(s) that describes the characteristics and/or the toxic contaminants of those dangerous wastes.

B. ESTIMATED ANNUAL QUANTITY - For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non-listed waste(s) that will be handled which possess that characteristic or contaminant.

C. UNIT OF MEASURE - For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. PROCESSES

1. PROCESS CODES:

For listed dangerous waste: For each listed dangerous waste entered in column A select the code(s) from the list of process codes contained in Section III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non-listed dangerous wastes: For each characteristic or toxic contaminant entered in Column A, select the code(s) from the list of process codes contained in Section III to indicate all the processes that will be used to store, treat, and/or dispose of all the non-listed dangerous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: DANGEROUS WASTES DESCRIBED BY MORE THAN ONE DANGEROUS WASTE NUMBER - Dangerous wastes that can be described by more than one Waste Number shall be described on the form as follows:

1. Select one of the Dangerous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other Dangerous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other Dangerous Waste Number that can be used to describe the dangerous waste.

EXAMPLE FOR COMPLETING SECTION IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* - A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non-listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE NO.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
X-1	K054	900	P	T03 D80	
X-2	D002	400	P	T03 D80	
X-3	D001	100	P	T03 D80	
X-4	D002			T03 D80	included with above

CONTINUE ON PAGE 3

Continued from page 2.
NOTE: Photocopy this page before completing if you have more than 26 wastes to list.

I.D. NUMBER (entered from page 1)

W	A	7	8	9	0	0	0	8	9	8	7

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

LINE NO.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)				D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
1	D002	1,500,000,000	P	T04	D84			Neutralization/Percolation
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								

ECL30 - 271 - ECY 030-31 Form 3

PAGE 3 ____ OF 6
(enter "A", "B", "C", etc. behind the "3" to identify photo copied pages)

CONTINUE ON REVERSE

Continued from the front.

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM SECTION D(1) ON PAGE 3.

The 1324-NA Percolation Pond received waste from the 163-N Demineralization Plant. The waste consisted of acid and caustic backwashes from the regeneration of demineralizer columns. Approximately 1,500,000,000 pounds (680,388,600 kilograms) of corrosive waste (D002) were managed each year.

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail)*.

VI. PHOTOGRAPHS

All existing facilities must include photographs *(aerial or ground-level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail)*.

VII. FACILITY GEOGRAPHIC LOCATION This information is provided on the attached drawings and photos.

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*

VIII. FACILITY OWNER

[X] A. If the facility owner is also the facility operator as listed in Section VII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER	2. PHONE NO. *(area code & no.)*

3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
John D. Wagoner, Manager U.S. Department of Energy Richland Operations Office		

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
SEE ATTACHMENT		

ECL30 - 271 - ECY 030-31 Form 3

PAGE 4 OF 5

CONTINUE ON PAGE 5

X. OPERATOR CERTIFICATION

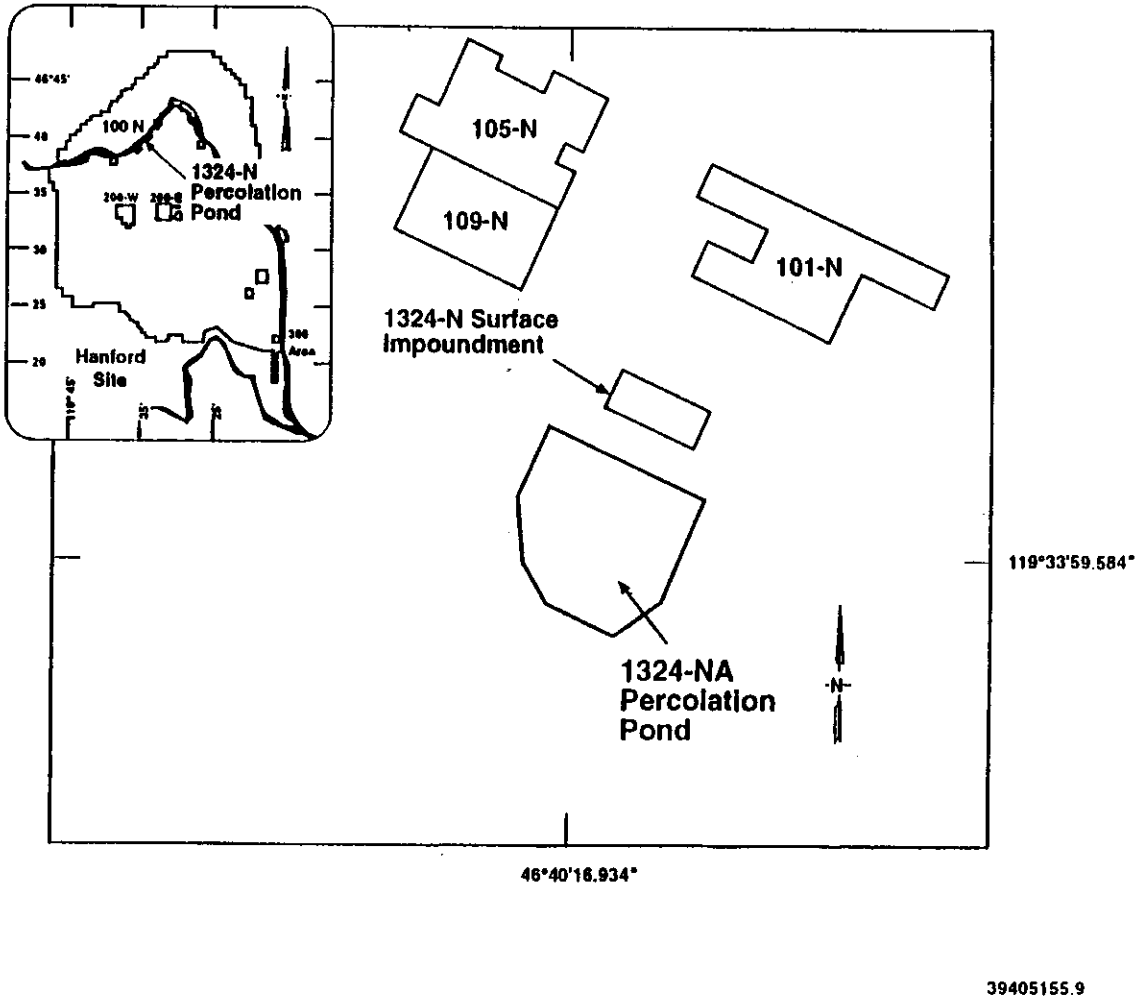
I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Owner/Operator
John D. Wagoner, Manager
U.S. Department of Energy
Richland Operations Office

Date

WA7890008967

1324-NA Percolation Pond



39405155.9

1324-NA Percolation Pond
Rev. 3,
Page 6 of 7

1324-NA PERCOLATION POND

46°40'16.934"
119°33'59.584"

94051304-3CN
(PHOTO TAKEN 1994)

ATTACHMENT B-3

DRAFT STATE ENVIRONMENTAL POLICY ACT CHECKLIST FOR 1324-N AND 1324-NA

STATE ENVIRONMENTAL POLICY ACT

ENVIRONMENTAL CHECKLIST

FOR

THE HANFORD SITE

**1324-N SURFACE IMPOUNDMENT AND
1324-NA PERCOLATION POND
CLOSURE/POST CLOSURE PLAN**

REVISION 0

WASHINGTON ADMINISTRATIVE CODE
ENVIRONMENTAL CHECKLIST FORMS
(WAC 197-11-960)

STATE ENVIRONMENTAL POLICY ACT
ENVIRONMENTAL CHECKLIST FOR THE HANFORD SITE
1324-N SURFACE IMPOUNDMENT AND
1324-NA PERCOLATION POND
CLOSURE/POSTCLOSURE PLAN

CONTENTS

A. BACKGROUND 1

B. ENVIRONMENTAL ELEMENTS 3
1. Earth 3
2. Air 5
3. Water 5
4. Plants 7
5. Animals 8
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A. BACKGROUND

1. Name of proposed project, if applicable:

The name of this proposed project is the 1324-N/1324-NA Liquid Effluent Disposal Facilities Closure.

2. Name of applicants:

U.S. Department of Energy, Richland Operations Office (DOE-RL)

3. Address and phone number of applicants and contact persons:

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

Contact:

James E. Rasmussen, Program Manager
Office of Environmental Assurance,
Permits, and Policy
(509) 376-5441

David E. Olson, Project Manager
100-N Groundwater Project
(509) 376-7142

4. Date checklist prepared:

This SEPA checklist was prepared concurrently with the closure/postclosure plans.

5. Agency requesting the checklist:

Washington State Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600

6. Proposed timing or schedule (including phasing, if applicable):

This SEPA Checklist is being submitted concurrently with closure/postclosure plans. Actual closure/postclosure will not occur until post 1999.

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7. **Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.**

   No

8. **List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.**

   This SEPA Environmental Checklist is being submitted to Ecology concurrently with closure/postclosure plans.

   The Corrective Measure Study (CMS) will include the NEPA values; the closure/post closure plans will be addendums to the CMS. Cultural Resources reviews and Ecological Surveys will be completed for all sites.

   General information concerning the Hanford Facility environment can be found in the *Hanford Site National Environmental Policy Act (NEPA) Characterization,* PNL-6415, Revision 5, December 1992. This document is updated annually by Pacific Northwest Laboratory, and provides current information concerning climate and meteorology; ecology; history and archeology; socioeconomics; land use and noise levels; and geology and hydrology. These baseline data for the Hanford Site and its past activities are useful for evaluating proposed activities and their potential environmental impacts.

9. **Do you know whether applications are pending for government approvals of other proposals directly affecting the property covered by your proposal? if yes, explain.**

   No applications to government agencies are known to be pending for this proposed action.

10. **List any government approvals or permits that will be needed for your proposal, if known.**

    The proposed activities will be conducted under *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). Actions conducted under CERCLA are exempt from obtaining federal, state and local permits (CERCLA, Section 121[e][i]. However, the substantive provisions of requirements that are ARARs must be met for the proposed action. ARARs are standards, requirements, criteria on limitations promulgated under federal or state environmental laws. Appendix C of the CMS provides a list of the ARARs.

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11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page.

Unit descriptions are provided in the response to question B.8.c.

Two samples will be taken along the North fence line. Results of the sampling effort will be used to assess whether clean closure can be achieved with no further sampling. If further sampling is not required, closure activities will begin. If further sampling is required, a Sampling and Analysis Plan will be developed to ensure clean closure.

All structures (see B.8.c and B.8.d) will also be removed and disposed of in an approved landfill. The unit will be backfilled with clean borrow material from a nearby borrow pit. The site will then be contoured to blend with the surrounding terrain in a manner that will reduce surface runon/runoff in order to prevent soil erosion

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The 1324-N/NA units are located in the 100-N Area of the Hanford Site 160 meters southeast of 100-N Reactor. Maps and plans are included in the main body of this corrective measures study. The units are located within 14N, 26E, Section 28 of the Coyote Rapids, Washington, Quadrangle Map, Willamette Principle Meridian.

B. ENVIRONMENTAL ELEMENTS

1. Earth

a. General description of the site (circle one): Flat, rolling, hilly, steep slopes, mountainous, other_____.

Flat.

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b. What is the steepest slope on the site (approximate percent slope)?

The approximate slope of the land at the proposed project is less than 2 percent.

c. What general types of soils are found on the site? (for example, clay, sandy gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.

The soil types in the 100 Area and around the proposed project consist mainly of eolian and fluvial sands and gravel. More detailed information concerning specific 100 Area soil classifications can be found in the *Hanford Site National Environmental Policy Act (NEPA) Characterization,* PNL-6415, Revision 5, December 1992. Farming is not permitted on the Hanford Site.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

No.

e. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.

The units will be backfilled with material from a nearby borrow pit. This fill material would be comprised of the same basaltic sandy gravel in which the ponds are constructed. It is anticipated the fill material would have the same general composition and particle size distribution as the soils surrounding the units as a result of having the same depositional environment. The fill would be used to restore the terrain to its approximate original configuration and to reduce runon/runoff and prevent soil erosion.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

The surface, once backfilling is completed, will be contoured and revegetated to reduce runon/runoff, and these actions will help prevent soil erosion.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

None

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h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

The finished grade and the areas disturbed during activities would be stabilized on completion of this effort, while dust would be controlled by standard construction techniques (e.g., water sprays, crusting agents, etc.).

2. Air

a. What types of emissions to the air would result from the proposal (i.e., dust, automobile, odors, industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities, if known.

Minor amounts of exhaust and dust would be generated by vehicles and construction personnel during this project. On completion, vehicular traffic would cease supporting this action.

b. Are there any off-site sources of emissions or odors that may affect your proposal? If so, generally describe.

No.

c. Proposed measures to reduce or control emissions or other impacts to the air, if any?

In order to reduce the amount of dust generated during closure activities, dust suppressants (e.g., water, crusting agents) will be used as necessary. Near-field air emission monitors will be used during closure activities.

3. Water

a. Surface

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

The 1324-N and 1324-NA are approximately 400 m (1300 ft) from the Columbia

River, the nearest natural watercourse.

2) **Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.**

No.

3) **Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.**

None.

4) **Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.**

No.

5) **Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.**

The proposed activities are within the 100-or 500-year floodplains as described in the *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNL-6415, Revision 5, December 1992.

6) **Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.**

No.

b. **Ground**

1) **Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known.**

No groundwater would be withdrawn in support of this project, and water would not be discharged to the aquifer. In the vicinity of the proposed action, the depth to groundwater is approximately 19.8 m (65 ft).

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2) **Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals...; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.**

   Does not apply.

c. **Water Run-off (including storm water)**

1) **Describe the source of run-off (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.**

   The Hanford Site has a semi-arid climate and averages 15 to 18 cm (6 to 7 in.) of annual precipitation. Any precipitation that occurs at the site seeps into the soil on or near the site. Consequently, none would enter any surface waters.

2) **Could waste materials enter ground or surface waters? If so, generally describe.**
   There are no remaining contaminants within the vadose zone that can migrate to groundwater. A plume caused by contaminants from these sites currently exists in the groundwater beneath the sites. Remediation is not required to prevent further contamination of the groundwater.

d. **Proposed measures to reduce or control surface, ground, and run-off water impacts, if any:**

   The disposal of surface drainage from storm water and snow melt is through natural percolation. Finished grading of the site would provide both run-on and run-off control to prevent possible flooding.

4. **Plants**

a. **Check or circle the types of vegetation found on the site.**

   _ **deciduous tree: alder, maple, aspen, other**
   _ **evergreen tree: fir, cedar, pine, other**
   _ **shrubs**

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X **grass**
_ **pasture**
_ **crop or grain**
_ **wet soil plants: cattail, buttercup, bulrush, skunk cabbage, other**
_ **water plants: water lily, eelgrass, milfoil, other**
X **other types of vegetation** (sagebrush)

b. What kind and amount of vegetation will be removed or altered?

Sites are cobble and clear of vegetation. The nearby areas are dominated by cheatgrass, which may be disturbed with closure activities. All areas denuded of vegetation as a result of this project will be revegetated appropriately.

c. List threatened or endangered species known to be on or near the site.

There are no threatened or endangered plants know to be on or adjacent to the site; however, an updated biological survey in the general vicinity of the proposed project would be conducted before construction.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

The surface will be regraded then revegetated with perennial grass species well sutied to the local climate to reduce runon/runoff which will help prevent soil erosion.

5. Animals

a. Indicate (by underlining) any birds and animals which have been observed on or near the site or are known to be on or near the site:

birds: hawk, heron, eagle, songbirds, other:.....
mammals: deer, bear, elk, beaver, other:.....
fish: bass, salmon, trout, herring, shellfish, other:.....

Raptors (burrowing owls, ferruginous, redtail, and Swainson's hawks) are seen occasionally in the 100 Area. Small passerines (sparrows, starlings, finches) also may be present in the general vicinity. Mule deer, rabbits, badgers, and coyotes occasionally are seen in the general area.

b. List any threatened or endangered species known to be on or near the site.

Two federal and state listed threatened or endangered species have been identified on the 560 square mile (1,450 square kilometer) Hanford Site along the Columbia River: the bald eagle and peregrine falcon. In addition, the state listed white pelican, sandhill crane, and ferruginous hawk also occur on or migrate through the Hanford Site. However, since this proposed action does not disturb any natural habitat, and there are no known nesting or roosting locations near the project site, none of these species will be impacted by the proposed activities.

c. Is the site part of a migration route? If so, explain.

The Hanford Site is a part of the broad migratory waterfowl Pacific Flyway.

d. Proposed measures to preserve or enhance wildlife, if any:

The project-specific Environmental Survey will indicate any necessary measures. However, because of the lack of habitat, few adverse impacts requiring preservation measures are anticipated. Revegetation after closure will enhance habitat for the future.

6. Energy and Natural Resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Postclosure monitoring activities will require the use of petroleum products to power motor vehicles.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

No.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

None.

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7. **Environmental Health**

a. **Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.**

The closure activities may create minor amounts of exhaust and dust by vehicles and construction equipment.

1) **Describe special emergency services that might be required.**

Hanford Site security, fire response, and ambulance services are on call at all times in the event of an on-site emergency. Hanford Site emergency services personnel are specially trained to manage a variety of circumstances involving chemical and/or radioactive constituents and situations.

2) **Proposed measures to reduce or control environmental health hazards, if any:**

Stringent administrative controls and engineered barriers would be employed to minimize the probability of even a minor incident and/or accident.

b. **Noise**

1) **What type of noise exists in the area which may affect your project (for example: traffic, equipment, operation, other)?**

While there is a minor amount of traffic, operation, and equipment noise in the vicinity, it is not expected to affect personnel at the proposed sites.

2) **What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.**

Some amount of noise from grading equipment and construction would occur and would cease upon completion.

3) **Proposed measures to reduce or control noise impacts, if any:**

If Occupational Safety and Health Administration noise standards are exceeded, appropriate measures to protect workers would be employed.

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties?

The proposed activities are part of the U.S. Government-owned Hanford Site, which is used for the management of waste associated with the cleanup from past and/or present production of special nuclear materials, and for energy research. Commercial activities on the Hanford Site include a nuclear power plant and a Washington State administered low-level burial area operated by U.S. Ecology.

b. Has the site been used for agriculture? If so, describe.

No portion of the 100 Area on the Hanford Site has been used for agricultural purposes since 1943.

c. Describe any structures on the site.

The 1324-NA unit is an unlined percolation pond approximately 4.5 m (15 ft) deep with a capacity of approximately 11.4 million L (3 million gal). The 1324-N unit is a double lined surface impoundment with a leak detection system. It measures approximately 4.5 m (15 ft) deep and has a capacity of approximately 1.6 million L (424,000 gal). Also addressed in this closure plan are the North and South Settling Ponds, the surface areas surrounding all these ponds where fines dredged from the settling ponds may have been deposited, and the pipelines associated with the units. The South Settling Pond has been backfilled to grade and the 1324-N Surface Impoundment was built within the North Settling Pond. There are several pipelines, both surface and buried, connecting the ponds and an abandoned sample building approximately 3 m by 3 m (10 ft by 10 ft). In addition, there are approximately 400 m (1,300 ft) of underground pipelines coming from the demineralization plant that discharged to these ponds. The site is bounded on all sides by a 2.4 m (8 ft) high chain link fence.

d. Will any structures be demolished? If so, what?

The double liner and leak detection system in the 1324-N Surface Impoundment will be removed. All pipelines, both surface and underground, will be removed, as will the sample building. The fence will also be taken down.

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e. What is the current zoning classification of the site?

The Hanford Site is zoned as an Unclassified Use (U) district by Benton County.

f. What is the current comprehensive plan designation of the site?

The 1985 Benton County Comprehensive Land Use Plan designates the Hanford Site as the "Hanford Reservation." Under this designation, land on the Hanford Site may be used for "activities nuclear in nature." Non-nuclear activities are authorized "if and when DOE approval for such activities is obtained." Future land use has not been determined. Land use alternatives are presented in the *Draft Hanford Remedial Action EIS,* which was issued for public review in 1996, and a second draft of the EIS will be issued for public review in 1998.

g. If applicable, what is the current shoreline master program designation of the site?

Does not apply.

h. Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.

No.

i. Approximately how many people would reside or work in the completed project?

No additional staff would be added as a result of the proposed activities.

j. Approximately how many people would the completed project displace?

Minimal.

k. Proposed measures to avoid or reduce displacement impacts, if any:

Does not apply.

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

The proposed project would remediate existing contamination and be compatible with future land use alternatives under consideration.

9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

None.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

None.

c. Proposed measures to reduce or control housing impacts, if any:

Does not apply.

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

Does not apply.

b. What views in the immediate vicinity would be altered or obstructed?

None.

c. Proposed measures to reduce or control aesthetic impacts, if any:

None.

11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

None.

b. **Could light or glare from the finished project be a safety hazard or interfere with views?**

No.

c. **What existing off-site sources of light or glare may affect your proposal?**

None.

d. **Proposed measures to reduce or control light and glare impacts, if any:**

None.

12. Recreation

a. **What designated and informal recreational opportunities are in the immediate vicinity?**

Fishing and boating on the Columbia River.

b. **Would the proposed project displace any existing recreational uses? If so, describe.**

No.

c. **Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any?**

None.

13. Historic and Cultural Preservation

a. **Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.**

At this time, no places or objects on or next to the proposed site activities are listed on any registers.

b. Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

The 1324 N/NA units are located in a culturally sensitive location. Archaeological sites are located across the river and upstream from the N Reactor. Also, the knobs and kettles west of the area were known to the Wanapum as *"Mooli Mooli"* (Little Stacked Hills). The area was known as a salmon fishing location. Finally, surveys by Hanford archaeologists have recorded rock cairns on some of the mounds, indicating use of the area by native peoples. Qualified site personnel will conduct a cultural resources review prior to any excavation activities.

c. Proposed measures to reduce or control impacts, if any:

The 1324 N/NA units are located in areas that are heavily disturbed as a result of construction of the N-Area facilities. Project activities will be restricted to disturbed areas, thereby eliminating risks to cultural resources. Any need to locate project activities in undisturbed locations will be subjected to the cultural resource review process to ensure that no resources are disturbed. Cultural resource contacts from the local Indian tribes will be informed about the project and provided an opportunity to get involved. Workers in all areas will be directed to watch for cultural material during all work activities.

14. Transportation

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.

The 100 Area is not served by public streets or highways.

b. Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

The proposed activities are not accessible to the public, and the site is not served by public transit.

c. How many parking spaces would the completed project have? How many would the project eliminate?

None.

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d. **Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).**

No.

e. **Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.**

No.

f. **How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.**

None.

g. **Proposed measures to reduce or control transportation impacts, if any:**

None.

15. Public Services

a. **Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.**

No.

b. **Proposed measures to reduce or control direct impacts on public services, if any:**

None.

16. Utilities

a. **Circle utilities currently available at the site: electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other:**

The only utility currently available at the site is fresh water.

b. **Describe the utilities that are proposed for the project, the utility providing the**

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service, and the general construction activities on the site or in the immediate vicinity which might be needed.

A portable air supply for pneumatically operated equipment and a portable electrical generator will be necessary for closure operations. Water trucks may be available on site to periodically spray the area, thereby reducing airborne particles generated during construction activities. After closure, the only utility necessary for operation will be portable electrical generators for powering groundwater monitoring well pumps during inspection and sampling.

General construction activities are outlined in the answer to checklist question A.ll.

C. SIGNATURES

The above answers are true and complete to the best of my knowledge. We understand that the lead agency is relying on them to make its decision.

James E. Rasmussen, Acting Program Manager — Date
Office of Environmental Assurance,
Permits, and Policy
U.S. Department of Energy, Richland Operations Office

ATTACHMENT B-4

DATA FOR ICP METALS, MERCURY, CYANIDE, pH, AND ANIONS

Table B-4-1. Data for ICP Metals, Mercury, Cyanide, pH, and Anions (Page 1 of 6)

WELL_NAME	SAMP_N	Aluminum	Q	Antimony	Q	Arsenic	Q	Barium	Q	Beryllium	Q
100-NR-1-TP1	B07Q52	4330	J	4.4	UJ	1.2	J	83.2		0.21	U
100-NR-1-TP1	B07Q53	5520	J	4.1	UJ	1.7	J	93.7		0.19	U
100-NR-1-TP1	B07Q54	3860		12.7	U	1.3	B	75.9		0.21	U
100-NR-1-TP1	B07Q56	3980		3.9	UJ	0.9	B	41.9		0.18	U
100-NR-1-TP1	B07Q57	4610		4.2	UJ	1.2	B	75.5		0.2	U
100-NR-1-TP1	B07Q58	4610		4	UJ	0.93	B	67		0.19	U
100-NR-1-TP1	B07Q59	3270		4	UJ	0.75	U	55.1		0.19	U
100-NR-1-TP1	B07Q60	3110		3.7	UJ	0.73	U	44.2		0.17	U
100-NR-1-TP1	B07Q61	3300		3.9	UJ	0.76	U	39.4	B	0.19	U
100-NR-1-TP1	B07Q62	3280		4	UJ	0.74	U	43.4		0.19	U
100-NR-1-TP1	B07Q64	2570		3.7	UJ	0.84	B	50.8	J	0.17	U
100-NR-1-TP1	B07Q65	4760		4.2	UJ	1.5	B	38.7	J	0.2	U
100-NR-1-TP1	B07Q66	5210		3.8	UJ	1.4	B	51	J	0.18	U
100-NR-1-TP1	B07Q67	3170		3.6	UJ	0.97	B	43.1	J	0.17	U
100-NR-1-TP1	B07Q68	2730		3.6	UJ	0.76	B	30.3	J	0.17	U
100-NR-1-TP1	B07Q69	3650		3.9	UJ	0.79	B	27.4	J	0.18	U
100-NR-1-TP1	B07Q70	2070		12.6	U	0.57	B	36.9	B	0.21	U
100-NR-1-TP1	B07Q71	4360	J	3.8	UJ	2.1	B	37.2	J	0.18	U
100-NR-1-TP1	B07Q72	3500	J	3.9	UJ	0.89	B	54.5	J	0.19	U
100-NR-1-TP1	B07Q73	4130		4.3	UJ	0.72	B	32.3	J	0.2	U
199-N-88	B07Q87	6500		3.4	U	2.1		59.3		0.09	B
199-N-88	B07Q88	6540		3.4	U	2.4		57.7		0.1	B
199-N-88	B07Q89	6230		3.6	U	1.2	B	48.4		0.11	B
199-N-88	B07Q90	8120		3.5	U	3.5		63.6		0.11	B
199-N-88	B07Q91	4600		3.5	U	1.5	B	44.8		0.2	B
199-N-88	B07Q92	4330		3.4	U	2.7		53.3		0.15	B
199-N-88	B07Q93	4330		3.7	UJ	1.6	B	65.6		0.21	U
199-N-88	B07Q94	3940		3.7	UJ	1.1	J	41.5		0.19	U
199-N-88	B07Q95	4620		5	J	0.82	B	52.4		0.25	U
199-N-88	B07Q96	3310	J	3.7	UJ	1.1	J	50.3		0.18	U
199-N-88	B07Q97	1830	J	12.5	U	0.46	UJ	26.2	B	0.21	U
199-N-88	B07Q98	3460		3.6	UJ	0.79	B	49.6		0.25	U
199-N-88	B07Q99	4590		4.9	J	1	B	59.2		0.3	U
199-N-88	B07QB0	4490		3.7	UJ	1.4	B	45		0.18	U
199-N-88	B07QB1	5370		3.8	UJ	1.6	B	61.1		0.23	U
199-N-88	B07QB2	4090		3.6	UJ	0.68	B	51.5		0.12	U
199-N-88	B07QB3	1890		4.1	UJ	0.83	B	16.8	B	0.11	U
199-N-89	B07QB5	8200		3.7	UJ	2.9		72.7		0.35	B
199-N-89	B07QB6	9010		3.7	UJ	2.9		56.5		0.34	B
199-N-89	B07SW7	4800		3.8	U	1	B	54.3		0.23	B
199-N-89	B07SW8	3480		3.6	U	0.83	B	44.7		0.2	B
199-N-89	B07SW9	4530		3.8	U	0.85	B	49.7		0.22	B
199-N-89	B07SX0	4140		3.8	U	1	B	48.7		0.2	B
199-N-89	B07SX1	3570		3.8	U	1	B	52.3		0.22	B
199-N-89	B07SX2	3850		3.8	U	1	B	51.3		0.18	B
199-N-89	B07SX3	3500		3.8	U	1.1	B	48.9		0.19	B
199-N-89	B07WV0	3450		3.8	U	0.71	B	45.8		0.18	B
199-N-89	B07WV2	3540		3.6	U	0.68	B	62.9		0.21	B
199-N-89	B07WV3	4510		3.7	U	1.4	B	42.9		0.17	B
199-N-89	B07WV4	5050		3.5	U	1.2	B	50		0.2	B
199-N-89	B07WV6	5380		4	U	0.97	B	74		0.39	B
199-N-89	B07WV8	3520		4	U	0.96	B	40.1	B	0.29	B
199-N-89	B07WV9	2990		4.6	U	0.85	B	23.7	B	0.22	U

Table B-4-1. Data for ICP Metals, Mercury, Cyanide, pH, and Anions (Page 2 of 6)

WELL_NAME	SAMP_N	Cadmium	Q	Calcium	Q	Chromium	Q	Cobalt	Q	Copper	Q
100-NR-1-TP1	B07Q52	0.32	U	6720	J	5.9	U	9.8	B	27.8	
100-NR-1-TP1	B07Q53	0.3	U	9170	J	8.4	U	10.7	B	28.7	
100-NR-1-TP1	B07Q54	1.48	U	8270		6.6		5.7	B	18.8	
100-NR-1-TP1	B07Q56	0.28	U	4420	J	2.7	U	8.8	B	18.5	
100-NR-1-TP1	B07Q57	0.31	U	5490	J	5.5	U	11.2		20	
100-NR-1-TP1	B07Q58	0.29	U	4940	J	5.6	U	13.4		18.2	
100-NR-1-TP1	B07Q59	0.3	U	3320	J	2.4	U	10.2	B	11.3	
100-NR-1-TP1	B07Q60	0.27	U	3990	J	1.4	U	8.8	B	14.6	
100-NR-1-TP1	B07Q61	0.29	U	4270	J	1.4	U	10	B	17.1	
100-NR-1-TP1	B07Q62	0.29	U	4460	J	1.3	U	10	B	15.2	
100-NR-1-TP1	B07Q64	0.27	U	3930		2.3	U	7.8	B	19.1	U
100-NR-1-TP1	B07Q65	0.31	U	2060		10.7		4.8	B	18	U
100-NR-1-TP1	B07Q66	0.28	U	2030		12.2		5.5	B	17.5	U
100-NR-1-TP1	B07Q67	0.27	U	4410		3.4	U	9.2	B	16.7	U
100-NR-1-TP1	B07Q68	0.27	U	1080		4.9	U	2.7	B	8.8	U
100-NR-1-TP1	B07Q69	0.29	U	1220		7.7		6.2	B	9.5	U
100-NR-1-TP1	B07Q70	1.48	U	3000		1.9	U	5	B	13.8	
100-NR-1-TP1	B07Q71	0.28	U	1960		9.3		6.4	B	16.2	U
100-NR-1-TP1	B07Q72	0.29	U	2400		6.2		6.6	B	13.1	U
100-NR-1-TP1	B07Q73	0.31	U	1880		5.8	U	6.5	B	13.1	U
199-N-88	B07Q87	0.2	U	6360		10.7		7.9	B	14.8	
199-N-88	B07Q88	0.2	U	6750		12.1		8.2	B	13.8	
199-N-88	B07Q89	0.21	U	7860		8.9		9.9	B	16.7	
199-N-88	B07Q90	0.21	U	7860		10.4		11.2		17.9	
199-N-88	B07Q91	0.21	U	3730		7		13.1		13.2	
199-N-88	B07Q92	0.2	U	4910		6.5		11.3		15.3	
199-N-88	B07Q93	0.32	U	5140		7.4		13.6		30.6	
199-N-88	B07Q94	0.32	U	4370		4.9		12		21.2	
199-N-88	B07Q95	0.32	U	5310		4.8		15.8		18.4	
199-N-88	B07Q96	0.32	U	5060		3		11.9		17.4	
199-N-88	B07Q97	1.45	U	3390		1.87	UJ	6.1	U	11	
199-N-88	B07Q98	0.32	U	5120		3.6		12.4		15.4	
199-N-88	B07Q99	0.3	U	5680		6.3		14.1		17.8	
199-N-88	B07QB0	0.32	U	2000		9.2		5.6	B	16.4	
199-N-88	B07QB1	0.33	U	2170		11.2		10	B	16.8	
199-N-88	B07QB2	0.32	U	5390		7.6		4.3	B	8.6	U
199-N-88	B07QB3	0.35	U	3670		4.5		2.1	U	5.2	U
199-N-89	B07QB5	0.32	U	5500		10.1	J	10.8		17.6	U
199-N-89	B07QB6	0.32	U	6130		13.7	J	10.4		19.9	
199-N-89	B07SW10	0.33	U	6670		5.9		13.7		31.5	
199-N-89	B07SW11	0.31	U	6010		3.2		11.1		24.2	
199-N-89	B07SW12	0.33	U	6240		5.4		13.6		24.2	
199-N-89	B07SX4	0.33	U	5770		4.6		13.6		19.5	
199-N-89	B07SX5	0.33	U	5540		3.6		11.9		17.6	
199-N-89	B07SX6	0.33	U	5800		3.8		13		17.9	
199-N-89	B07SX7	0.33	U	5870		2.8		12.2		16.3	
199-N-89	B07WV0	0.33	U	5550		4.3		12.1		16.3	
199-N-89	B07WV2	0.32	U	5260		4.6		11		17.4	
199-N-89	B07WV3	0.32	U	2570		10.4		5.8	B	13.2	
199-N-89	B07WV4	0.31	U	2020		13.1		5.4	B	12.6	
199-N-89	B07WV6	0.3	U	3390		14.6		3.9	B	24.8	
199-N-89	B07WV8	0.29	U	4090		12.6		4.7	B	19.8	
199-N-89	B07WV9	0.34	U	4500		6.4		2.6	B	14.3	

Table B-4-1. Data for ICP Metals, Mercury, Cyanide, pH, and Anions (Page 3 of 6)

WELL_NAME	SAMP_N	Cyanide	Q	Fluoride	Q	Iron	Q	Lead	Q	Magnesiu	Q
100-NR-1-TP1	B07Q52	0.61	J	0.8	J	20400		4	J	3950	J
100-NR-1-TP1	B07Q53	0.55	UJ	0.7	J	23800		5.5	J	5320	J
100-NR-1-TP1	B07Q54	1.05	U	2.6	U	11600		5.9		3710	
100-NR-1-TP1	B07Q56	0.52	UJ	2.7	J	23100		2.8		2880	
100-NR-1-TP1	B07Q57	0.57	UJ	1.4	J	24600		4.1		3400	
100-NR-1-TP1	B07Q58	0.51	UJ	3.2	J	29500		2.7		4260	
100-NR-1-TP1	B07Q59	0.5	UJ	1.8	J	23000		2.6		2330	
100-NR-1-TP1	B07Q60	0.52	UJ	1.1	J	23500		1.9		3410	
100-NR-1-TP1	B07Q61	0.51	UJ	0.3	J	23600		1.5		3430	
100-NR-1-TP1	B07Q62	0.5	UJ	0.8	J	19100		2.2		2730	
100-NR-1-TP1	B07Q64	0.52	U	0.3	J	19200		1.9	J	2730	
100-NR-1-TP1	B07Q65	0.62	U	1	J	11700		2	J	3620	
100-NR-1-TP1	B07Q66	0.51	U	1.2	J	12200		2.4	J	4160	
100-NR-1-TP1	B07Q67	0.5	U	0.7	J	22000		2.3	J	3270	
100-NR-1-TP1	B07Q68	0.48	U	1.1	J	4650		2	J	1720	
100-NR-1-TP1	B07Q69	0.49	U	1	J	5260		2.1	J	1950	
100-NR-1-TP1	B07Q70	1.05	U	2.6	U	13600		1.6		2030	
100-NR-1-TP1	B07Q71	0.52	U	0.6	J	10500	J	2	J	3120	
100-NR-1-TP1	B07Q72	0.5	U	0.6	J	13900	J	2.5	J	2850	
100-NR-1-TP1	B07Q73	0.55	U	1.3	J	8840		2.2	J	2240	
199-N-88	B07Q87	0.53	U	1.6		16500		4.5		4000	
199-N-88	B07Q88	0.53	U	1.8		17100		5.1		4640	
199-N-88	B07Q89	0.54	U	3		21800		4.9		4580	
199-N-88	B07Q90	0.55	U	2.1		21300		6		5140	
199-N-88	B07Q91	0.54	U	1.3		25900		3.7		3470	
199-N-88	B07Q92	0.51	U	0.8		26600		4.3		3970	
199-N-88	B07Q93	0.53	UJ	1.5	J	25400		2.8		4060	
199-N-88	B07Q94	0.52	UJ	0.9	J	20700		1.9		3790	
199-N-88	B07Q95	0.52	UJ	1.4	J	25300		2.2		3990	
199-N-88	B07Q96	0.51	UJ	1.2	J	19500	J	2		3470	
199-N-88	B07Q97	1.04	U	2.6	U	9820	J	1.5	UJ	1870	
199-N-88	B07Q98	0.51	UJ	0.9	J	22200		1.8		3850	
199-N-88	B07Q99	0.51	UJ	1.2	J	25500		2.7		4270	
199-N-88	B07QB0	0.49	UJ	2.1	J	9770		6.4		2810	
199-N-88	B07QB1	0.5	UJ	2.9	J	10700		2.9		3610	
199-N-88	B07QB2	0.52	UJ	0.8	J	7560		3.1		2470	
199-N-88	B07QB3	0.59	UJ	0.8	J	3520		2		1320	
199-N-89	B07QB5	0.52	U	2.4	J	20000		5.1		4390	
199-N-89	B07QB6	0.49	U	1.8	J	19500		5.9		4390	
199-N-89	B07SW13	0.53	U	1.5		26100		2.4		4790	
199-N-89	B07SW14	0.51	U	1		20000		2		3810	
199-N-89	B07SW15	0.51	U	1.3		24300		2.3		4570	
199-N-89	B07SX8	0.51	U	1.2		23100		2.5		3970	
199-N-89	B07SX9	0.48	U	1		21000		2.3		3800	
199-N-89	B07SX10	0.5	U	1.1		22600		2.5		4090	
199-N-89	B07SX11	0.5	U	0.8		22800		2.4		4180	
199-N-89	B07WV0	0.5	U	1		22100		2.1		3450	
199-N-89	B07WV2	0.51	U	0.9		19400		2.2		3260	
199-N-89	B07WV3	0.52	U	1.3		11500		3.1		3600	
199-N-89	B07WV4	0.48	U	1.7		10300		2.9		3550	
199-N-89	B07WV6	0.52	U	1		9380		3.8		2920	
199-N-89	B07WV8	0.55	U	0.6		7840		2.8		1910	
199-N-89	B07WV9	0.6	U	0.5		5350		2.1		1860	

Table B-4-1. Data for ICP Metals, Mercury, Cyanide, pH, and Anions (Page 4 of 6)

WELL_NAME	SAMP_N	Manganes	Q	Mercury	Q	Nickel	Q	Nitrite Nit	Q	pH	Q
100-NR-1-TP1	B07Q52	180	J	0.14	J	7.7	B	2.51	UJ	8.8	R
100-NR-1-TP1	B07Q53	227	J	0.37	J	8.2	B	8.01	J	9	R
100-NR-1-TP1	B07Q54	112		0.27		6.7	B	2.9		8.6	
100-NR-1-TP1	B07Q56	186	J	0.07	B	3.8	B	2.49	U	7.8	R
100-NR-1-TP1	B07Q57	219	J	0.15		5.8	B	2.55	U	8.6	R
100-NR-1-TP1	B07Q58	275	J	0.12		5.8	B	2.6	U	7.7	R
100-NR-1-TP1	B07Q59	167	J	0.19		3.9	B	2.49	U	7.1	R
100-NR-1-TP1	B07Q60	169	J	0.06	B	5.1	B	2.53	U	6.5	R
100-NR-1-TP1	B07Q61	197	J	0.06	B	4.2	B	2.51	U	5.8	R
100-NR-1-TP1	B07Q62	174	J	0.06	B	4.7	B	2.58	U	6	R
100-NR-1-TP1	B07Q64	165		0.05	U	3.6	B	2.51	U	5.6	J
100-NR-1-TP1	B07Q65	169		0.05	U	11.8		2.42	U	6.2	J
100-NR-1-TP1	B07Q66	186		0.05	U	11.8		2.42	U	6.9	J
100-NR-1-TP1	B07Q67	184		0.05	U	4.2	B	2.67	U	6.3	J
100-NR-1-TP1	B07Q68	113		0.05	U	8		2.49	U	6.7	J
100-NR-1-TP1	B07Q69	193		0.05	U	8.9		2.41	U	6.4	J
100-NR-1-TP1	B07Q70	114		0.05	U	8	B	0.74		6.8	
100-NR-1-TP1	B07Q71	189		0.05	U	10.2		2.55	U	6.2	J
100-NR-1-TP1	B07Q72	187		0.05	U	8.1	B	2.48	U	6.3	J
100-NR-1-TP1	B07Q73	217		0.06	U	9.4		2.43	U	7.1	J
199-N-88	B07Q87	263		0.05	B	10.1		2.53	U	8.8	
199-N-88	B07Q88	271		0.07	B	9.4		16.1		8.7	
199-N-88	B07Q89	284		0.06	B	8.2	B	2.46	U	8.3	
199-N-88	B07Q90	285		0.09	B	9.9		2.53	U	8.5	
199-N-88	B07Q91	236		0.1	B	6.2	B	3.95		7.9	
199-N-88	B07Q92	243		0.08	B	6.1	B	2.51	U	7.1	
199-N-88	B07Q93	277		0.05	U	7.9	B	4.29		7.7	J
199-N-88	B07Q94	262		0.05	U	7.9	B	2.57	U	6.9	J
199-N-88	B07Q95	338		0.05	U	7.6	B	2.41	U	7.3	J
199-N-88	B07Q96	251	J	0.05	U	6.1	B	2.81	U	8.8	J
199-N-88	B07Q97	135	J	0.05	U	4.15	U	0.52	U	8.4	J
199-N-88	B07Q98	284		0.05	U	7.5	B	2.52	U	8.9	J
199-N-88	B07Q99	310		0.04	U	8.5		2.49	U	9	J
199-N-88	B07QB0	192		0.05	U	10.2		2.56	U	8.8	J
199-N-88	B07QB1	702		0.05	U	17.6		2.53	U	8.4	J
199-N-88	B07QB2	163		0.05	U	8.7		2.64	U	9.7	J
199-N-88	B07QB3	73.8		0.06	U	5.4	B	2.52	U	9.2	J
199-N-89	B07QB5	326		0.05	U	10.3		2.47	U	8.9	J
199-N-89	B07QB6	290		0.05	U	11.9		16.2		8.7	J
199-N-89	B07SW16	316		0.05	U	8.7		2.49	U	9.3	
199-N-89	B07SW17	237		0.05	U	7.8		2.42	U	9	
199-N-89	B07SW18	292		0.05	U	8.3		2.46	U	9.1	
199-N-89	B07SX12	288		0.05	U	7	B	2.43	U	9.1	
199-N-89	B07SX13	261		0.05	U	6.2	B	2.44	U	9	
199-N-89	B07SX14	269		0.05	U	7	B	2.47	U	9	
199-N-89	B07SX15	269		0.05	U	5.7	B	2.43	U	9.1	
199-N-89	B07WV0	247		0.05	U	6	B	2.46	U	9.1	
199-N-89	B07WV2	214		0.05	U	6	B	2.48	U	9	
199-N-89	B07WV3	182		0.05	U	12.6		2.47	U	9.1	
199-N-89	B07WV4	247		0.05	U	15.5		2.48	U	9.1	
199-N-89	B07WV6	190		0.05	U	10.3		12		9.8	
199-N-89	B07WV8	148		0.06	U	10		2.49	U	9.5	
199-N-89	B07WV9	91.8		0.06	U	7.2	B	5.3		8.9	

Table B-4-1. Data for ICP Metals, Mercury, Cyanide, pH, and Anions (Page 5 of 6)

WELL_NAME	SAMP_N	Potassium	Q	Selenium	Q	Silver	Q	Sodium	Q	Sulfate	Q
100-NR-1-TP1	B07Q52	305	B	0.76	UJ	1.1	U	268	B	61	J
100-NR-1-TP1	B07Q53	427	B	0.69	UJ	0.99	U	320	B	23	J
100-NR-1-TP1	B07Q54	283	U	0.42	U	2.11	U	202	B	25.7	
100-NR-1-TP1	B07Q56	327	B	0.7	UJ	0.93	U	508	B	21	J
100-NR-1-TP1	B07Q57	376	B	0.72	UJ	1	U	442	B	135	J
100-NR-1-TP1	B07Q58	409	B	0.67	UJ	0.96	U	516	B	72	J
100-NR-1-TP1	B07Q59	296	B	0.67	UJ	0.97	U	522	B	25	J
100-NR-1-TP1	B07Q60	351	B	0.65	UJ	0.89	U	523	B	43	J
100-NR-1-TP1	B07Q61	249	B	0.68	UJ	0.95	U	474	B	85	J
100-NR-1-TP1	B07Q62	236	B	0.66	UJ	1	U	458	B	62	J
100-NR-1-TP1	B07Q64	213	B	0.78	UJ	0.89	U	345	B	62	J
100-NR-1-TP1	B07Q65	427	B	0.92	UJ	1	U	194	B	27	J
100-NR-1-TP1	B07Q66	909	B	0.74	UJ	0.92	U	237	B	29	J
100-NR-1-TP1	B07Q67	302	B	0.77	UJ	0.88	U	497	B	48	J
100-NR-1-TP1	B07Q68	413	B	0.73	UJ	0.87	U	123	U	17	J
100-NR-1-TP1	B07Q69	560	B	0.75	UJ	0.94	U	121	U	51	J
100-NR-1-TP1	B07Q70	282	U	0.42	U	2.11	U	381	B	60.8	
100-NR-1-TP1	B07Q71	552	B	0.79	UJ	0.93	U	234	B	45	J
100-NR-1-TP1	B07Q72	388	B	0.8	UJ	0.95	U	270	B	41	J
100-NR-1-TP1	B07Q73	469	B	0.83	UJ	1	U	216	B	38	J
199-N-88	B07Q87	957	B	0.78	U	0.5	U	227	B	6	
199-N-88	B07Q88	1110		0.8	U	0.5	U	319	B	51	
199-N-88	B07Q89	899	B	0.82	U	0.53	U	344	B	103	
199-N-88	B07Q90	1080		1.9		0.52	U	368	B	92	
199-N-88	B07Q91	459	B	1.4		0.52	U	350	B	130	
199-N-88	B07Q92	375	B	1.5		0.51	U	323	B	74	
199-N-88	B07Q93	486	B	0.99	UJ	1.2	B	368	B	50	J
199-N-88	B07Q94	387	B	0.92	U	1.2	B	285	B	21	J
199-N-88	B07Q95	455	B	2.3	UJ	1.5	B	356	B	30	J
199-N-88	B07Q96	395	B	1.1	U	0.89	B	305	B	15	J
199-N-88	B07Q97	278	U	0.42	UJ	2.5	UJ	161	B	11.3	
199-N-88	B07Q98	407	B	0.9	UJ	1.3	B	316	B	12	J
199-N-88	B07Q99	625	B	0.61	U	1.3	B	407	B	17	J
199-N-88	B07QB0	535	B	1.2	U	0.78	U	333	B	20	J
199-N-88	B07QB1	731	B	0.91	U	0.82	U	216	B	29	J
199-N-88	B07QB2	886	B	0.8	UJ	0.77	U	263	B	13	J
199-N-88	B07QB3	390	B	1.1	U	0.86	U	104	B	44	J
199-N-89	B07QB5	1320		0.64	UJ	1.2	U	212	B	9	J
199-N-89	B07QB6	1110		0.6	UJ	1.3	U	254	B	33	J
199-N-89	B07SW19	718	B	0.8	U	0.82	U	452	B	24	
199-N-89	B07SW20	482	B	0.73	U	1.1	B	302	B	17	
199-N-89	B07SW21	592	B	0.79	U	0.84	B	445	B	16	
199-N-89	B07SX16	594	B	0.79	U	1.4	B	493	B	25	
199-N-89	B07SX17	509	B	0.73	U	1	B	339	B	23	
199-N-89	B07SX18	540	B	0.78	U	1.2	B	310	B	27	
199-N-89	B07SX19	485	B	0.75	U	0.9	B	295	B	41	
199-N-89	B07WV0	463	B	0.75	U	1.3	B	356	B	34	
199-N-89	B07WV2	539	B	0.79	U	0.96	B	334	B	34	
199-N-89	B07WV3	675	B	0.75	U	0.79	U	192	B	24	
199-N-89	B07WV4	737	B	0.77	U	0.75	U	254	B	23	
199-N-89	B07WV6	1370		2.5		0.97	U	513	B	26	
199-N-89	B07WV8	588	B	0.83	U	0.96	U	321	B	48	
199-N-89	B07WV9	527	B	0.92	U	1.1	U	221	B	63	

Table B-4-1. Data for ICP Metals, Mercury, Cyanide, pH, and Anions (Page 6 of 6)

WELL_NAME	SAMP_N	Thallium	Q	Vanadium	Q	Zinc	Q
100-NR-1-TP1	B07Q52	0.44	U	56.6		76.1	J
100-NR-1-TP1	B07Q53	0.4	U	61.2		94.4	J
100-NR-1-TP1	B07Q54	0.42	U	14.9		76.2	
100-NR-1-TP1	B07Q56	0.4	UJ	47.3		42.2	J
100-NR-1-TP1	B07Q57	0.42	U	69.4		77.4	J
100-NR-1-TP1	B07Q58	0.39	U	70.7		57.4	J
100-NR-1-TP1	B07Q59	0.39	U	66.1		41.6	J
100-NR-1-TP1	B07Q60	0.37	U	43.8		36.2	J
100-NR-1-TP1	B07Q61	0.39	U	46.9		41.2	J
100-NR-1-TP1	B07Q62	0.38	UJ	37.3		39.4	J
100-NR-1-TP1	B07Q64	0.54	U	36.4		32.3	
100-NR-1-TP1	B07Q65	0.63	U	24.5		28	
100-NR-1-TP1	B07Q66	0.5	U	24.7		30.1	
100-NR-1-TP1	B07Q67	0.53	U	47.2		36.6	
100-NR-1-TP1	B07Q68	0.5	U	8.5	U	15.5	U
100-NR-1-TP1	B07Q69	0.52	U	10.4		17.5	U
100-NR-1-TP1	B07Q70	0.42	U	18.3		17.1	
100-NR-1-TP1	B07Q71	0.54	U	21.7	J	27.7	J
100-NR-1-TP1	B07Q72	0.55	U	28.2	J	27.8	J
100-NR-1-TP1	B07Q73	0.57	UJ	16.1		24.1	
199-N-88	B07Q87	0.35	U	37.6		42.4	
199-N-88	B07Q88	0.36	U	38.8		35.3	
199-N-88	B07Q89	0.37	U	45.3		42.5	
199-N-88	B07Q90	0.33	U	46.6		51.5	
199-N-88	B07Q91	0.36	U	81.1		48.7	
199-N-88	B07Q92	0.36	U	60.4		41	
199-N-88	B07Q93	0.3	U	59.1		47.8	
199-N-88	B07Q94	0.3	U	44.5		44.9	
199-N-88	B07Q95	0.29	U	56.9		53.6	
199-N-88	B07Q96	0.3	U	36.8		36.6	
199-N-88	B07Q97	0.42	UJ	7.4	U	16.2	
199-N-88	B07Q98	0.31	U	48.7		39.6	
199-N-88	B07Q99	0.3	U	62.6		49.1	
199-N-88	B07QB0	0.3	U	23.2		28.5	
199-N-88	B07QB1	0.31	U	23.9		37.1	
199-N-88	B07QB2	0.31	U	13.8		24.1	
199-N-88	B07QB3	0.33	U	6.6	B	13.6	U
199-N-89	B07QB5	0.54	UJ	45.9		48.7	J
199-N-89	B07QB6	0.5	U	48.2		61.5	J
199-N-89	B07SW22	0.55	U	60		45.4	
199-N-89	B07SW23	0.5	U	40		35.8	
199-N-89	B07SW24	0.54	U	56.9		43.1	
199-N-89	B07SX20	0.54	U	54.5		39.4	
199-N-89	B07SX21	0.5	U	46.1		37.1	
199-N-89	B07SX22	0.54	U	52.8		40.2	
199-N-89	B07SX23	0.52	U	50.9		40.2	
199-N-89	B07WV0	0.51	U	52		38.4	
199-N-89	B07WV2	0.54	U	44.1		38.9	
199-N-89	B07WV3	0.51	U	25.6		29.2	
199-N-89	B07WV4	0.53	U	24.7		30.3	
199-N-89	B07WV6	0.32	U	19.9		27	
199-N-89	B07WV8	0.57	U	19.6		19.8	
199-N-89	B07WV9	0.63	U	11.4	B	16.3	

ATTACHMENT B-5

1324-N SURFACE IMPOUNDMENT AND 1324-NA PERCOLATION POND TRAINING PLAN

1324-N SURFACE IMPOUNDMENT AND 1324-NA PERCOLATION POND TRAINING PLAN

This is the dangerous waste training plan for the 1324-N Surface Impoundment (1324-N) and 1324-NA Percolation Pond (1324-NA). It is intended to meet the requirements of WAC 173-303-330 and the Hanford Dangerous Waste Permit. Training unrelated to compliance with WAC 173-303-330 is not addressed in this training plan. WAC 173-303-330(1)(d)(ii, v, vi) requires that personnel be familiarized, where applicable, with waste feed cut-off systems, response to groundwater contamination incidents, and shutdown of operations. These are not applicable to the 1324-N and 1324-NA and are therefore not covered in this training plan.

Training Matrix

Facility Personnel: The following matrix indicates the training that facility personnel must receive relative to their position each calendar year in order to perform work at 1324-N and 1324-NA. After a course has been taken once, a refresher course only is necessary for subsequent years. Training must be successfully completed by personnel within six months after employment at or assignment to 1324-N and 1324-NA, or to a new position at 1324-N and 1324-NA. Within the six-month period, employees must be supervised until they complete training required for their position.

Nonfacility personnel: If nonfacility personnel (such as delivery truck drivers or Ecology inspectors) will be anywhere near dangerous waste management activities, they must receive site-specific training relative to 1324-N and 1324-NA prior to the visit or they must be escorted by trained personnel.

Course requirements by job type are contained in the following matrix:

COURSE	WASTE HANDLERS	GENERAL WORKERS	SUPERVISORS	EMERGENCY COORDINATORS
Hazardous Waste Operations	Yes	No	Yes	Yes
NESO/HGET	Yes	Yes	Yes	Yes
Site-Specific	Yes	Yes	Yes	Yes
Building Warden/ BED	No	No	No	Yes

Course Descriptions

Hazardous Waste Operations 24-Hour or 40-Hour Refresher: Provides training relative to dangerous waste management, hazard identification, and protective clothing.

Hanford Employee Safety Orientation Refresher (Hanford General Employee Training [HGET]: Provides training relative to contingency plan implementation, effective response to emergencies, communications systems, alarm systems, and response to fire or explosion.

Site-Specific (Attachment B-5-A): Provides unit-specific training relative to dangerous waste management hazards, contingency plan implementation, effective response to emergencies, communications systems, alarm systems, response to fire or explosion, emergency equipment, and procedures for using, inspecting, repairing, and replacing emergency and monitoring equipment.

Building Warden Training or Building Emergency Director Training Refresher for either course: Provides training relative to emergency coordinator responsibilities.

Training Director

Personnel directing training under this plan shall be knowledgeable in dangerous waste management procedures.

Records Retention

This training plan includes employee training records. The employee training records are maintained electronically and are available on HLAN soft reporting. This training plan shall be kept at the Hanford Facility and be readily retrievable. A hard copy of any site-specific training that is not recorded in soft reporting must be kept on file and be readily retrievable.

Revision

This training plan shall be revised whenever:

- Training courses change names or numbers,
- Employees change positions,
- New employees are assigned to 1324-N and 1324-NA
- Training requirements in WAC 173-303-330 or the Hanford Dangerous Waste Permit are revised.

Dangerous Waste Management Position Descriptions

This training plan applies only to employees who perform work at 1324-N and 1324-NA or are 1324-N and 1324-NA Emergency Coordinators. If employees fit into more than one position, they shall be placed in the position that requires the higher level of training.

Job Title: Waste Handler

Duties: Performs inspections, treats wastes, performs treatability tests, takes samples, packages and ships waste, responds to emergencies.
Required Skills: Basic communication skills and ability to follow instructions
Required Education: None
Other Required Qualifications: None

Job Title: General Workers

Duties: Perform inspections, respond to emergencies, provide maintenance services, operate equipment, set up equipment..
Required Skills: Basic communication skills and ability to follow instructions
Required Education: None
Other Required Qualifications: None

Job Title: Supervisors

Duties: Supervise waste handlers and general workers, assure personnel training, perform inspections, respond to emergencies.
Required Skills: Management
Required Education: 4 year college degree or equivalent knowledge and experience
Other Required Qualifications: None

Job Title: Emergency Coordinators

Duties: Respond to emergencies per WAC 173-303-360
Required Skills: Management
Required Education: 4 year college degree or equivalent knowledge and experience
Other Required Qualifications: None

ATTACHMENT B-5-1

SITE-SPECIFIC TRAINING PLAN

1324-N SURFACE IMPOUNDMENT AND 1324-NA PERCOLATION POND

Objectives

Site-specific training will provide the facility worker with the facility-specific knowledge relative to the following: dangerous waste management hazards, contingency plan implementation, effective response to emergencies, communications and alarm systems, response to fire or explosion, emergency equipment, and procedures for using, inspecting, repairing, and replacing emergency and monitoring equipment.

Description

The 1324-N Surface Impoundment is a lined pond with a treatment design capacity of 1,514,160 L (400,000 gal) per day. The impoundment was used to treat waste from the regeneration of demineralizer columns. The waste exhibited the characteristics of corrosivity (D002). Successive additions to the pond of acidic and caustic waste served to neutralize the waste. The nonregulated neutralized waste was transferred to the 1324-NA Percolation Pond. The 1324-N Surface Impoundment and the 1324-NA Percolation Pond no longer receive waste and will be closed.

Present routine activities for the 1324-N and 1324-NA are scheduled inspections as required in the 1324-N/NA Inspection plan. All other activities have ceased since this unit in no longer receiving or treating hazardous wastes. In order to close this unit under dangerous waste regulations, closure activities will be initiated which include removing structures, such as piping, from the area or characterizing them as clean.

Dangerous Waste Management Hazards

The facility no longer receives or treats waste. Since no waste is being treated or discharged, no immediate dangerous waste hazards are present. The facility is secured by fencing and locked gates.

Implementation of the Site-Specific Contingency Plan

The site-specific contingency plan is located at the facility. Each worker must be familiar with the site-specific contingency plan and its requirements. The site-specific contingency plan will be implemented by the Facility Emergency Coordinator. The contingency plan will be implemented whenever there is an immediate threat to human health or the environment.

Response to Emergencies

All emergencies (e.g., fires, explosions, personnel injury, etc.) shall be reported to the Facility Emergency Coordinator. The Facility Emergency Coordinator will respond to all emergencies as outlined in the Facility-Specific Contingency Plan and the Hanford Site Contingency Plan.

Communications

There are no fixed communication systems at 1324-N and 1324-NA. Communication equipment may be obtained by the 105-N Shift Manager when deemed necessary.

Alarms

Normal Hanford Site-Wide Audible emergency signals will be observed. No facility-specific alarms are necessary for 1324-N and 1324-NA.

Monitoring

Required monitoring is outlined in the Facility-Specific Inspection Plan.

Inspections

It is required that 1324-N and 1324-NA be inspected at least once each calendar quarter of the year. The inspections must be done in accordance with the Facility-Specific Inspection Plan.

Environmental Hazards

The 1324-N and 1324-NA units are located adjacent to the outside perimeter fence at the South/East corner of the N-Reactor Facility. Environmental hazards consist of snakes, spiders, varmints, tripping hazards, extreme heat in the summer, and extreme cold in the winter.

Radiological Hazards

The 1324-N and 1324-NA units are not radiologically controlled areas. A Radiation Work Permit is not required prior to entering the facility.

Documents to be Reviewed

Each facility worker must review and be cognizant of the following site-specific documents:

1324-N Site-Specific Contingency Plan
1324-N Site-Specific Inspection Plan
1324-N Site-Specific Waste Analysis Plan
1324-N Site-Specific Training Plan

Stringent administrative controls and engineered barriers would be employed to minimize the probability of even a minor incident and/or accident.

ATTACHMENT B-6

GROUNDWATER MOVEMENT AND TRAVEL TIME THROUGH THE 1324-N/NA FILL LAYER

GROUNDWATER MOVEMENT AND TRAVEL TIME THROUGH THE 1324-N/NA FILL LAYER

Rainfall or snowmelt requires more than 200 years to travel through the 1324-N/NA fill layer. Precipitation movement and travel time through the 18.3 m (60 ft) thick fill layer was calculated using a one-dimensional piston flow model. The piston flow model simulated the downward migration of recharge (the wetting front) as an annual series of discrete one-dimensional movements. Precipitation was assumed to enter the soil each year as a single slug. Evapotranspiration then removed soil water from the shallow subsurface such that the quantity of moisture remaining in soil equaled the estimated annual recharge volume. The precipitation and net recharge from each successive year displaced the wetting front farther down in the fill layer. The travel time required for the wetting front to reach the bottom of the fill layer was then determined based on the annual displacement of the wetting front.

Model Description and Assumptions

A one-dimensional model was used to calculate the minimum expected time required for precipitation to travel from the surface through the fill layer at 1324-N/NA. The depth of water penetration or wetting front was calculated as a function of the ambient soil water content, the soil water field capacity, and the precipitation and recharge rates. Movement of precipitation through the fill layer was assumed to occur as piston flow. Piston flow refers to all annual precipitation entering the soil at once as a single slug. The depth of the slug depends on the quantity of water required to increase the water content of the soil from ambient conditions to field capacity,

$$D = \frac{P}{(\Theta_{FC} - \Theta_a)}$$

where
D is the depth of the precipitation slug or wetting front (cm)
P is the annual precipitation (cm)
Θ_{FC} is the field capacity volumetric water content (cm/cm)
Θ_a is the ambient volumetric water content (cm/cm)

The wetting front is the lowest depth in soil where the water content is at field capacity. Field capacity is an agricultural term used to describe the water content of the soil after deep percolation caused by irrigation has virtually ceased (Smedema and Rycroft, 1983). Between the annual precipitation events, evapotranspiration removes water from the shallow subsurface, lowering the water content back to the ambient level. Water remaining in the soil after evapotranspiration occurs becomes recharge. The soil column then consists of three segments with each segment having a uniform water content: the segment below the wetting front, which remains at the ambient water content, the segment containing recharge, which remains at field capacity, and the shallow subsurface segment, where evapotranspiration occurs. Subsequent

precipitation continually raises the water content to field capacity, displaces the wetting front downward, and increases the depth of soil remaining at field capacity. Figure 1 presents a simple schematic of the model.

Summarizing the primary assumptions of the model,

- the fill layer is composed of material similar to sands and gravels sampled for moisture content,
- all annual precipitation occurs at once as a single slug,
- the precipitation enters the ground and migrates to a depth such that the moisture content of the soil is raised from ambient condition to field capacity,
- no upward or downward movement of water occurs from within the recharge segment, and
- the wetting front moves downward through the fill layer as subsequent years precipitation continually displaces retained moisture

Recharge Estimates

Rockhold et al. (1995) reported that the long term average annual precipitation at the Hanford Site is 16.2 cm/year (6.4 in). About 42 percent falls from November through January when evapotranspiration is at a minimum. Recharge estimates based on lysimeter data indicate that for sand or silt loam soils with natural vegetation (i.e., tumbleweed, grass, or sagebrush), the annual recharge rate was 6 percent or less, and often zero. The one exception was a Buried Waste Test Facility lysimeter vegetated with cheatgrass. The recharge rate (6.2 cm/yr [2.4 in/yr]) was 35 percent of the precipitation. However, after two years, tumbleweed displaced the cheatgrass, and the recharge rate dropped to 5-6 percent of precipitation (less than 1 cm/yr [0.39 in/yr]) (Rockhold et al., 1995). Tracer tests indicate that the recharge rates representative of the last 40 years are around 0.5 cm/yr (0.20 in/yr) or less.

Based on these studies, unless the fill layer is deliberately maintained free of vegetation, the recharge rate should be about 5 percent of the precipitation. If the annual precipitation is assumed to be 20 cm/yr (7.87 in/yr), then the average recharge rate should be about 1 cm/yr (0.39 in/yr). The remainder of the precipitation would be removed from the soil by evapotranspiration.

Soil Moisture Content, Field Capacity, and Bulk Density

The ambient and saturated soil water content were determined from samples collected during the drilling of wells 199-N-88 and 199-N-89. The average gravimetric water content of 17 samples collected from Well 199-N-88 was 0.05, and 0.06 from 16 samples collected from Well 199-N-89. The maximum water content measured in samples collected from both wells was 0.17 (see Table 1). The maximum values, from samples collected near the water table, were assumed to

equal the saturated water content. Field capacity generally ranges from 50 to 90 percent of saturation, depending on the soil type. For this calculation, the field capacity was assumed to be 75 percent of saturation. Soil bulk density data were not available, so a value of 1.8 kg/L (112 lb/ft^3) was assumed to convert the gravimetric moisture content to volumetric moisture content.

Calculations and Conclusion

Using the moisture content, bulk density, and field capacity estimates mentioned above, the average volumetric moisture content is

$$\Theta_{v_{avg}} = 0.06\frac{kg(water)}{kg(soil)} \times 1.8\frac{kg(soil)}{L(soil)} = 0.11\frac{kg\ or\ L(water)}{L(soil)}$$

Using the same equation, the saturated volumetric moisture content calculates to be 0.31, with a field capacity of 0.23. Thus the volume of water necessary to raise the moisture content from average or ambient condition to field capacity is 0.23 - 0.11 or 0.12. For annual precipitation of 20 cm/yr (7.87 in/yr), the depth of soil brought to field capacity is 20 cm/0.12 or 167 cm (5.5 ft). For annual recharge of 1 cm/yr (0.39 in/yr), the depth of soil remaining at field capacity is 1 cm/0.12, or 8 cm (3 in). Figure 2 presents a schematic diagram of the flow model using the parameter values associated with 1324-N/NA. Reviewing Figure 2 shows that the wetting front, after advancing 167 cm (5.5 ft) downward the first year, continues advancing 8 cm/yr (3 in/yr) afterward. The time (T) for the wetting front to travel 60 ft (18.3 m) to the bottom of the fill layer can then be calculated

$$T = \frac{(1830\,cm - 167\,cm)}{8\,cm/yr} + 1\,yr = 209\,yrs$$

If the fill layer is compacted to about 1.8 kg/L (112 lb/ft^3), which is approximately mid-range for naturally occurring sands and gravels (Holtz and Kovacs, 1981), rainfall or snowmelt entering the top of the layer requires over 200 years to travel through the layer. Because of the conservative nature of the assumptions regarding piston flow (all precipitation occurring at once, no upward wicking of water from the recharge zone), 200 years represents the minimum expected travel time. The actual travel time may be much greater. If the fill layer revegetates naturally, the vegetation may prevent any recharge from occurring at all during years of below normal precipitation.

Table 1. Moisture Content Data from Wells 199-N-88 and 199-N-89

Well 199-N-88			Well 199-N-89		
Sample Number	Sample Depth	Moisture Decanted (%)	Sample Number	Sample Depth	Moisture Decanted (%)
B07Q87	0 - 0.5	7	B07QB5	0 - 2	9
B07Q88	4 - 5	6	B07QB6	4 - 6.5	3
B07Q89	9 - 11	9	B07SW7	10 - 11.5	4
B07Q90	14 - 16	9	B07SW8	14 - 16	3
B07Q91	19 - 21	8	B07SW9	19 - 21	3
B07Q92	24 - 26	5	B07SX0	24 - 26	3
B07Q93	29 - 31	6	B07SX1	29 - 31	4
B07Q94	34 - 36	4	B07SX2	34 - 36	4
B07Q95	39 - 41	5	B07SX3	39 - 41	4
B07Q96	44 - 46	4	B07WV0	44 - 46	3
B07Q97	44 - 46	4	B07WV2	51 - 53	3
B07Q98	49 - 51	4	B07WV3	55 - 57	3
B07Q99	54 - 56	4	B07WV4	58 - 60	2
B07QB0	59 - 61	3	B07WV6	64 - 66	2
B07QB1	64 - 66	3	B07WV8	69 - 71	8
B07QB2	69.5 - 70.5	4	B07WV9	74 - 76	17
B07QB3	76 - 78	17			
Average		6			5

REFERENCES

Holtz, R. D. and W. D. Kovacs, 1981, An Introduction to Geotechnical Engineering, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Rockhold, M. L., M. J. Fayer, C. T. Kincaid, and G. W. Gee, 1995, *Estimation of Natural Ground Water Recharge for the Performance Assessment of a Low-Level Waste Disposal Facility at the Hanford Site*, PNL-10508, Pacific Northwest Laboratory, Richland, Washington.

Smedema, L. K. and D. W. Rycroft, 1983, Land Drainage, Cornell University Press, Ithaca, New York.

APPENDIX C

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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- C1.2 WASTE MANAGEMENT STANDARDS C-17
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ABBREVIATIONS AND ACRONYMS

AEA	*Atomic Energy Act*
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirements
BACT	best available control technology
BARCT	best available radionuclide control technology
bgs	below ground surface
CAA	*Clean Air Act*
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CMS	corrective measures study
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ERDF	environmental restoration disposal facility
LDR	land disposal restriction
LLW	low-level radioactive waste
MCL	maximum contaminant level
MEI	maximum exposed individual
MTCA	*Model Toxics Control Act*
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
PRG	preliminary remediation goal
RCRA	*Resource Conservation and Recovery Act of 1976*
SDWA	*Safe Drinking Water Act*
TBC	to be considered
WAC	*Washington Administrative Code*

C1.0 INTRODUCTION

Applicable or relevant and appropriate requirements (ARARs) are standards, requirements, criteria, or limitations promulgated under federal or state environmental laws and which, as required by Section 121 of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), must be met or waived in order for remedial actions to proceed. This section provides that only the substantive provisions of ARARs must be met (or waived) for actions conducted entirely on site (CERCLA §121[d][2]) because such on-site actions are exempted from federal, state, and local permit requirements (§121[e][1]). A criterion (or component) in assessing an action's protectiveness is its ability to comply with ARARs. The to-be-considered (TBC) materials are other federal or state guidance criteria, advisories, proposed regulations, or similar materials that are neither mandated nor enforceable, but may be pertinent in selecting or designing a remedy. The potential federal ARARS, state ARARS, and TBCs are presented in Tables C-1, C-2, and C-3, respectively.

C1.1 STANDARDS FOR SOIL REMEDIATION AND GROUNDWATER/ RIVER PROTECTION

The state *Model Toxics Control Act* (MTCA) is implemented by Chapter 173-340 *Washington Administrative Code* (WAC) and establishes cleanup standards (including cleanup levels and points of compliance) for nonradioactive contaminants in soil. In setting standards, MTCA prescribes a methodology for calculating cleanup levels based on potential land use and exposure assumptions and also draws on other standards, such as maximum contaminant levels (MCLs) established for drinking water under the *Safe Drinking Water Act* (SDWA). In addition, the MTCA specifies that soil cleanup must be accomplished so that other interconnected media, such as groundwater and adjacent surface waters, are protected. The criteria for selection of cleanup alternatives is contained in WAC 173-340-360 and WAC 173-303-360(4) contains preferences for consideration of remedial alternatives. For alternatives that will leave waste in place, WAC 173-340-360(8) requires long-term monitoring and appropriate institutional controls. The MTCA standards are considered relevant and appropriate and are incorporated into the remediation goals for all remedial alternatives evaluated in this Corrective Measures Study (CMS).

Few standards exist for determining acceptable levels of radioactive constituents in environmental media. Standards for MCLs for certain radionuclides, based on an annual dose limit, are provided in 40 *Code of Federal Regulations* (CFR) 141. These are regarded as relevant and appropriate and are incorporated into the remediation goals for alternatives that address groundwater protection. Standards for remediation of radioactive constituents in soil have not been promulgated. Two agencies (U.S. Environmental Protection Agency [EPA] and the U.S. Nuclear Regulatory Commission [NRC]) have proposed regulations for acceptable levels of residual radioactivity for cleanup of soil. These are TBC materials rather than ARARs, but in the absence of ARARs, they are incorporated into the remediation goals for soil cleanup.

Table C-1. Potential Federal ARARs. (Page 1 of 6)

Description	Citation	Requirements	Remarks
Atomic Energy Act of 1954, as amended	42 USC 2011 et seq.	Authorizes DOE to set standards and restrictions governing facilities used for research, development, and use of atomic energy.	
Department of Energy Occupational Radiation Protection (Final Rule)	10 CFR 835	Establishes occupational and visitor radiological exposure limits.	DOE Radiological Control Manual DOE/EH-02561, which is encompassed within the Hanford Site Radiological Control Manual, adheres to these requirements.
Nuclear Regulatory Commission Standards for Protection Against Radiation	10 CFR 20, Subpart C	Sets occupational dose limits for adult workers. Total effect dose equivalent equal to 5 rem/year. Sets dose limits to members of the public.	Occupational dose limits will be followed during remediation in radiological areas.
Nuclear Regulatory Commission Licensing Requirements for Land Disposal of Radioactive Wastes	10 CFR 61	Provides regulations for the management and land disposal of radioactive wastes.	Cover performance standards are contained in this regulation.
Archaeological and Historical Preservation Act of 1974	26 USC 469	Requires action to recover and preserve artifacts in areas where activity may cause irreparable harm, loss, or destruction of significant artifacts.	Applicable when remedial action threatens significant scientific, prehistorical, historical, or archeological data.
Archaeological Resources Protection Act of 1979	16 USC 4170aa mm (1990)	Protects archaeological and traditional cultural properties associated with archaeological sites. Requires notification of Indian Tribes of possible harm to or destruction of sites having religious or cultural significance.	Applicable when remedial action threatens archaeological and traditional cultural properties.
Protection of Archaeological Resources	43 CFR 7	Establishes procedures to be followed by federal land managers to protect archaeological resources on federal lands. Sets civil and criminal penalties for violations; protects confidentiality of archaeological resource information.	Applicable when remedial action threatens archaeological resources.
American Indian Religious Freedom Act of 1978	42 USC 1996	Provides for access by Native Americans to religious sites and development of migration measures if actions will deny such access. Requires agency to consult with traditional religious leaders regarding activities that might affect religious sites.	Applicable when remedial action threatens Native American religious sites.

Table C-1. Potential Federal ARARs. (Page 2 of 6)

Description	Citation	Requirements	Remarks
The Religious Freedom Restoration Act of 1993	42 USC 2000bb; P.L. 103-141	Requires agency to demonstrate compelling need for a project that will deny the free exercise of religion by Native Americans. If activities threaten access to religious site, consultation with tribes will be necessary.	Applicable when remedial action threatens Native American religious sites.
Antiquities Act of 1906	16 USC 431-433	Protects all historic and prehistoric ruins and objects of antiquity located on federal lands. Provides for criminal sanctions against excavation, injury, or destruction of such resources.	Applicable when remedial action threatens historic or prehistoric ruins.
Endangered Species Act of 1973	16 USC 1531 et seq.	Prohibits federal agencies form jeopardizing threatened or endangered species or adversely modifying habitats essential to their survival. If waste site remediation is within sensitive habitat or buffer zone surrounding threatened and endangered species, migration measures must be taken to protect this resource.	This law is applicable as threatened or endangered species have been identified within the 100 Area.
Migratory Bird Treaty Act	16 USC 703 et seq. 50 CFR 10-24	Makes it illegal to pursue, hunt, take, capture, kill, possess, trade, or transport any migratory bird, part, nest, or egg included in the terms of the conventions between the U.S. and Great Britain, the U.S. and Mexico, and the U.S. and Japan. Although this Act does not require ecological assessments be done for federal agency projects, if a disturbance is expected in an area where migratory birds may be affected, such an assessment should be done to ensure the law's intent.	If remedial actions potentially impact migrating birds, this Act is applicable.
Fish and Wildlife Services List of Endangered and Threatened Wildlife and Plants	50 CFR 17, 22, 225, 226, 227, 402 and 424	Requires identification of activities that may affect listed species. Actions must not threaten the continued existence of a listed species or destroy critical habitat. Requires consultation with the Fish and Wildlife Service to determine if threatened or endangered species could be impacted by activity.	Since threatened or endangered species have been identified within the 100 Area, this law is applicable.
Historic Sites, Buildings, and Antiques Act	16 USC 461	Establishes requirements for preservation of historic sites, buildings, or objects of minimal significance. Undesirable impacts to such resources must be mitigated.	Applicable to properties listed in the National Register of Historic Places, or eligible for such listing.

Table C-1. Potential Federal ARARs. (Page 3 of 6)

Description	Citation	Requirements	Remarks
National Historic Preservation Act of 1966, as amended	16 USC 470 et seq.	Prohibits impacts on cultural resources. Where impacts are unavailable, requires impact mitigation through design and data recovery.	Applicable to properties listed in the National Register of Historic Places, or eligible for such listing.
Protection of Historic Properties	36 CFR 800	Sets criteria to assess effects, to develop migration measures to address unavoidable adverse impacts, and to address properties discovered during implementation of an undertaking.	Applicable when remedial action threatens a historic property discovered during remedial activity.
Historic Sites Act of 1935	16 USC 461-467 36 CFR 65	Requires action to undertake the recovery, protection, and preservation of sites, buildings, objects, and antiquities of national significance.	Applicable when remedial action threatens sites, buildings, objects, and antiquities of National significance.
Native American Graves Protection and Repatriation Act of 1990	25 USC 3001-3013 Public Law 101 601 (1993)	Requires action by federal agency when Native American human remains and associated funerary objects are inadvertently discovered during excavation. Requires work stoppage, protection of items, and notification to appropriate Indian Tribes.	Applicable if, during remedial action, Native American human remains or burial objects are discovered. Construction activities may resume 30 days after certification that agency head and Indian tribes have been notified.
Hanford Reach Study Act	P.L. 100-605	Provides for a comprehensive river conservation study. Prohibits the construction of any dam, channel, or navigation project by a federal agency for 8 years after enactment. New federal and nonfederal projects and activities are required, to the extent practicable, to minimize direct and adverse effects on the values for which the river is under study and to use existing structures.	This law as enacted November 4, 1988. Consultation and coordination with the national Park Service will be done to minimize and provide mitigation for any direct and adverse effects on the river.
Floodplains/Wetlands Environmental Review	10 CFR 1022	Requires DOE to avoid, to the extent possible, adverse effects associated with the development of a floodplain or the destruction or loss of wetlands (DOE Implementation of E.O. 11988 and 11990)	Applicable if remedial activities take place in a floodplain or wetlands.
Clean Air Act, as amended	42 USC 7401 et seq.	A comprehensive environmental law designed to regulate any activities that affect air quality, providing the national framework for controlling air pollution.	Some parts delegated to State.
National Emissions Standards for Hazardous Air Pollutants (NESHAP)	40 CFR 61	Establishes numerical standards for hazardous air pollutants.	

Table C-1. Potential Federal ARARs. (Page 4 of 6)

Description	Citation	Requirements	Remarks
Radionuclide Emissions from DOE Facilities (except airborne radon-222, and radon-230	40 CFR 61.92	Prohibits emissions of radionuclides to the ambient air exceeding an effective dose equivalent of 10 mrem/year.	Applicable to point and diffuse sources.
Emission Standards for Asbestos for Waste Disposal Operations for Demolition and Renovation	40 CFR 61.150	States there must either be no visible emissions to the outside air during the collection, processing (including incineration), packaging, or transporting of any asbestos-containing waste material generated by the source, or specified waste treatment methods must be used.	Applicable to recovery and handling of asbestos wastes.
Asbestos Standard for Active Waste Disposal Sites	40 CFR 61.154	States there must either be no visible emissions to the outside air during the collection, processing (including incineration), packaging, or transporting of any asbestos-containing waste material generated by the source, or specified waste treatment methods must be used.	Applicable to landfill disposal of asbestos.
Protection of Stratospheric Ozone	40 CFR 82	Management of refrigerant systems.	Applicable to all buildings/ facilities containing refrigerant systems.
Federal Water Pollution Control Act (FWPCA), as amended by the Clean Water Act of 1988 (CWA)	33 USC 1251 et seq.	Creates the basic national framework for water pollution control and water quality management in the United States.	Applicable to discharges of pollutants to navigable waters.
Water Quality Standards	40 CFR 131	Provides federal ambient water quality criteria for use in surface water cleanup.	Also provides requirements for approving State Water Quality Standards.
NPDES Criteria and Standards	40 CFR 125.104	Best management practices program shall be developed in accordance with good engineering practices.	Applicable if remediation includes wastewater discharge; also applies to storm water runoff associated with industrial activities. Effluent limitations established by EPA are included in NPDES permit.
Discharge of Oil	40 CFR 110	Prohibits discharge of oil that violates applicable water quality standards or causes a sheen of oil on water surface. Runoff from site will need control for oily water discharge to waters of the United States.	
Safe Drinking Water Act (SDWA)	42 USC 300 et seq.	Creates the basic framework for protection of drinking water supplies from pollutants	Applicable to remedial action objectives for soil and groundwater
National Primary Drinking Water Regulations	40 CFR 141	Identifies primary contaminants and concentration levels protective of drinking water supplies	Provides MCLs for medial action objective consideration

Table C-1. Potential Federal ARARs. (Page 5 of 6)

Description	Citation	Requirements	Remarks
National Secondary Drinking Water Regulations	40 CFR 143	Identifies contaminants and concentration levels for aesthetic quality of drinking water supplies	Provides secondary MCLs for remedial action objective consideration
Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA)	40 USC 6901 et seq.	Establishes the basic framework for federal regulation of solid waste. Subtitle C of RCRA controls the generation, transportation, treatment, storage, and disposal of hazardous waste through a comprehensive "cradle to grave" system of hazardous waste management techniques and requirements. Subtitle D of RCRA controls the disposal of solid waste.	The State has been authorized to implement most of Subtitle C, although certain HSWA provisions (e.g., LDR requirements) have not yet been delegated. Additionally, EPA has approved the State Subtitle D Program.
Land Disposal Restrictions (LDR)	40 CFR 268	Generally prohibits placement of restricted RCRA hazardous wastes in land-based units such as landfills, surface impoundments, and waste piles.	Applicable unless waste has been treated, treatment has been waived, a treatment variance has been set for the waste, an equivalent treatment method has been established, or waste qualifies for delisting.
Dilution Prohibition	40 CFR 268.3	Requires remediation waste to be appropriately treated excluding dilution. Generators are required to identify applicable treatment standards at the point of generation and prior to mixing with other remediation wastes.	Applicable if waste is a RCRA hazardous waste.
Debris Rule	40 CFR 268.45	Establishes the alternative treatment standards of hazardous waste debris by using technologies specified in 40 CFR 268.45, Table 1.	Applicable if waste is a RCRA hazardous waste.
Prohibition and Treatment Standards	40 CFR 268.40-268.48 [WAC 173-303-140]	Establishes treatment standards that must be met prior to land disposal.	Applicable if waste is a RCRA hazardous waste.
Prohibition on Storage	40 CFR 268.50	The storage of nonradioactive hazardous waste restricted from land disposal under RCRA Section 3004 and 40 CFR 268, Subpart C, is prohibited unless wastes are stored in tanks and containers by a generator or the onsite operator of a TSD facility solely for the purpose of accumulation of such quantities as to facilitate proper treatment or disposal. TSD facility operators may store wastes for up to one year under these circumstances. Radioactive mixed waste is not prohibited from storage pursuant to the Tri-Party Agreement.	Applicable only to nonradioactive hazardous waste.

Table C-1. Potential Federal ARARs. (Page 6 of 6)

Description	Citation	Requirements	Remarks
Toxic Substances Control Act (TSCA), as amended	15 USC 2601 et seq.	Provides EPA with authority to regulate the production, use, distribution, and disposal of toxic substances.	

Table C-2. Potential State ARARs. (Page 1 of 4)

Description	Citation	Requirements	Remarks
Nuclear Energy and Radiation	RCW 70.98	Establishes the framework to regulate sources of ionizing radiation for the protection of the occupational and public health and safety.	
Radiation Protection--Air Emissions	WAC 246-247	Establishes procedures to monitor and control airborne radionuclide emissions.	Applicable if airborne radionuclide emissions are anticipated during remedial action.
New and Modified Sources	WAC 246-247-120 (Appendix B)	Requires the use of best available radionuclide control technology (BARCT).	Substantive requirements applicable if airborne radionuclide emissions are anticipated during remedial action.
Habitat Buffer Zone for Bald Eagle Rules	RCW 77.12.655		
Bald Eagle Protection Rules	WAC 232-12-292	Prescribes action to protect bald eagle habitat, such as nesting or roost sites, through the development of a site management plan.	Applicable if the areas of remedial activities include bald eagle habitat.
The Indian Graves and Records Act of the State of Washington	RCW 27.44	Prohibits the willful removal, mutilation, defacement, or destruction of any cairn, grave, or glyphic or painted record of any Native Indian or prehistoric people. Requires agency to consult with traditional religious leaders regarding activities that might affect religious sites.	There are Native American burial grounds and cultural areas within the 100 Area operable units; therefore, this is applicable.
Department of Game State Environmental Policy Act	WAC 232-012	Requires management plans if endangered or sensitive wildlife or habitat are affected. Washington State Department of Fish and Wildlife will be consulted to minimize ecological impacts.	Upon the determination of impacts to threatened, endangered, or sensitive species or habitat by the remedial actions, this may be applicable.
U.S. Department of Ecology	43.12A RCW	Vests the Washington Department of Ecology with the state authority to undertake the state air regulation and management program.	
Air Pollution Regulations	WAC 173-400	Establishes requirements to control and/or prevent the emission of air contaminants.	Applicable if emission sources are created during remedial action.

Table C-2. Potential State ARARs. (Page 2 of 4)

Description	Citation	Requirements	Remarks
Standards for Maximum Emissions	WAC 173-400-040	Requires best available control technology to used to control fugitive emissions of dust from materials handling, construction, demolition, or any other activities that are sources of fugitive emissions. Restricts emitted particulates from being deposited beyond the Hanford Site. Requires control of odors emitted from the source. Prohibits masking or concealing prohibited emissions. Requires measures to prevent fugitive dust from becoming airborne.	Applicable to dust emissions from cutting of concrete and metal and from vehicular traffic during remediation.
Emission Limits for Radionuclides	WAC 173-480	Controls air emissions of radionuclides from specific sources.	Applicable to remedial activities that result in air emissions.
New and Modified Emission Units	WAC 173-480-060	Requires the best available radionuclide control technology be used in planning constructing, installing, or establishing a new emissions unit.	Applicable to remedial actions that result in air emissions.
Washington Clean Air Act	RCW 70.94	Establishes a statewide framework for the planning, regulation control, and management of air pollution sources.	
Controls for New Sources of Toxic Air Pollutants	WAC 173-460	Establishes systematic control of new sources emitting toxic air pollutants.	Applicable if new sources emitting toxic air pollutants are established.
Decontaminating Ambient Impact Compliance	WAC 173-460-080	Requires the owner or operator of a new source to complete an acceptable source impact level analysis using dispersion modeling to estimate maximum incremental ambient impact of each Class A or B toxic air pollutant. Establishes numerical limits for small quantity emission rates.	Applicable to remedial alternatives with the potential to release toxic air pollutants.
Hazardous Waste Management Act of 1976, as amended in 1980 and 1983	70.105 RCW	Establishes a statewide framework for the planning, regulation, control, and management of hazardous waste.	
Dangerous Waste Regulations	WAC 173-303	Establishes the design, operation, and monitoring requirements for management of dangerous waste. Includes requirements for generators of dangerous waste. Dangerous waste includes the full universe of wastes regulated by WAC 173-303, including extremely hazardous waste.	Applicable if dangerous or extremely hazardous waste is generated and/or managed during remedial action.

Table C-2. Potential State ARARs. (Page 3 of 4)

Description	Citation	Requirements	Remarks
Waste Designation	WAC 173-303-070, 071, 080, 082, 090, 100, 110	Exceeds federal RCRA program by requiring designation of waste including additional parameters (i.e., toxicity and persistence), additional listed wastes, and PCBs.	If remediation wastes, based on process knowledge/analysis, exceed the parameters.
Land Disposal Restrictions	WAC 173-303-140	State LDR requirements exceed the federal requirements for extremely hazardous, organic/carbonaceous and solid acid wastes.	Applicable if remediation wastes meet additional categories.
Container Storage	WAC 173-303-160-173-303-161	Condition of containers, compatibility of waste with containers, container management, containment, special requirements for ignitable or reactive wastes.	May be applicable if container storage is to occur. Inspection requirements may be in potential conflict with ALARA requirements.
Tanks	WAC 173-303-640	Design operating standards for tanks including secondary containment and leak detection systems; tank management; containment; special requirements for ignitable or reactive wastes.	May be applicable if tank storage is to occur. Inspection requirements may be potential conflict with ALARA requirements. May be applicable for soil washing process.
Temporary Units	WAC 173-3-3-646(7)	Establishes alternative performance standards for temporary tanks and containers used for treatment or storage of hazardous remediation wastes for up to 1 year.	Applicable if temporary unit is used.
Closure	WAC 173-303-610	Establishes requirements for closure of dangerous waste treatment, storage, and disposal units.	Closure performance standards and required closure activities are contained in these requirements.
Corrective Action Management Unit (CAMU)	WAC 173-303-646(4)	Authorizes designation of a corrective action management unit, which does not constitute land disposal of dangerous waste.	May be used if dangerous waste not meeting LDR standards is placed on the land.
Model Toxics Control Act	70.105D RCW	Authorizes the state to investigate releases of hazardous substances, conduct remedial actions, carry out state programs authorized by federal cleanup laws, and take other actions.	
Hazardous Waste Cleanup Regulations	WAC 173-340	Model Toxics Control Act Regulation. Addresses releases of hazardous substances caused by past activities and potential and ongoing releases from current activities.	Relevant and appropriate to facilities where hazardous substances have been released, or there is a threatened release that may pose a threat to human health or the environment.
Selection of Cleanup Actions	WAC 173-340-360	Establishes criteria for selection of cleanup actions.	Must be considered within feasibility studies or corrective measures studies.
Institutional Controls	WAC 173-340-440	Requires physical measures, such as fences and signs, to limit interference with cleanup.	Physical measures may be applicable if institutional controls are used.

Table C-2. Potential State ARARs. (Page 4 of 4)

Description	Citation	Requirements	Remarks
Cleanup Standards	WAC 173-340-700 through -750	Establishes cleanup standards for remedial and corrective actions.	Soil, groundwater, and surface water standards are contained in these requirements.
Solid Waste Management Act	70.95 RCW	Establishes a statewide program for solid waste handling, recovery, and/or recycling.	
Minimum Functional Standards for Solid Waste Handling	WAC 173-304	Establishes requirements to be met statewide to handle all solid waste.	Applicable if management of solid waste occurs during remediation. Solid waste controlled by this Act includes garbage, industrial waste, construction waste, ashes, and swill.
Onsite Containerized Storage, Collection, and Transportation Standards	WAC 173-304-200	Sets requirements for containers and vehicles to be used on site.	Applicable if containers are used during remediation.
Water Pollution Control Act	90.48 RCW	Prohibits discharge of polluting matter in waters.	
Water Quality Standards for Groundwater	WAC 173-200	Establishes water quality standards for groundwaters of the State of Washington.	Provides groundwater standards based on MCLs.
Water Quality Standards for Surface Waters	WAC 173-201A	Establishes water quality standards for surface waters of the State of Washington.	Defines the Columbia River as a Class A river.
State Waste Discharge Permit Program	WAC 173-216	Requires the use of all known available and reasonable methods of prevention, control, and treatment. Discharges must meet limits that ensure that groundwater and surface water standards are not exceeded.	Applicable for any discharges of liquids to the ground.
Water Well Construction Act	18.104 RCW		
Standards for Construction and Maintenance of Wells	WAC 173-160	Establishes minimum standards for design, construction, capping, and sealing of all wells; sets additional requirements, including disinfection of equipment, abandonment of wells, and quality of drilling water.	Applicable if water supply wells, monitoring wells, or other wells are used during remediation.

Table C-3. Potential To Be Considered Requirements. (Page 1 of 4)

Description	Citation	Requirements	Remarks
Benton Clean Air Authority	Regulation 1, Article 8	Establishes regulations relative to asbestos.	Must be considered if asbestos is found during remediation.
U.S. Department of Energy Orders		Select DOE Orders are contractual requirements of the ERC.	
Radiation Dose Limit (All Pathways)	DOE-5400.5, Chapter II, Section 1a	The exposure of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem from all exposure pathways, except under specified circumstances.	If remedial activities are considered "routine DOE activities," this order would be relevant and appropriate.
Radioactive Waste Management	DOE Order 5820.2A	Defines waste designation for TRU, high- and low-level waste and establishes criteria for the management and disposal of LLW.	
Safety Requirements for the Packaging of Fissile and Other Radioactive Materials	DOE 5480.3, Sections 7 and 8	Establishes requirements for packaging and transportation of radioactive materials for DOE facilities.	Requirements must be met if radioactive material is packaged and transported to disposal facility.
Radioactive Waste Management	DOE 5820.2A Chapters III and IV	Establishes policies and guidelines by which DOE manages radioactive waste, waste byproducts, and radioactive contaminated surplus facilities. Disposal shall be on the site at which it was generated, if practical, or at another DOE facility. DOE waste containing byproduct material shall be stored, stabilized in place, and/or disposed of consistent with the requirements of the residual radioactive material guidelines contained in 40 CFR 192.	Must be met when managing radioactive waste created by remediation activities.
Department of Ecology Liquid Effluent Consent Order	DE 91NM-177	Requires discharges of liquid effluent to the soil to column to be eliminated, treated, or otherwise minimized.	Must be considered if discharges of liquid effluent to the soil column are part of the remedial alternative.
Tri-Party Agreement		Establishes requirements, guidelines, and schedules for the environmental restoration program at the Hanford Site.	Must be adhered to and complied with by all parties with regard to remedial actions at all operable units.
NRC Draft Radiological Criteria for Decommissioning	10 CFR 20 (proposed revision)	This rule provides a clear and consistent regulatory basis to determine the extent to which lands and structures must be remediated before a site can be considered decommissioned.	This will be applicable upon promulgation.

Table C-3. Potential To Be Considered Requirements. (Page 2 of 4)

Description	Citation	Requirements	Remarks
Draft EPA Radiation Site Cleanup Regulations	40 CFR 196 (draft notice of proposed rulemaking)	This draft notice of proposed rulemaking will set standards for the remediation of soils, groundwater, surface water, and structures at federal facilities.	These standards are intended to set limits for radiation doses to the public.
Draft Department of Energy Radiation Protection of the Public and the Environment	10 CFR 834	Additional requirements above 5400.5 that are more prescriptive.	Substantive requirements largely the same as 5400.5.
Environmental Restoration Disposal Facility Waste Acceptance Criteria	BHI-00139	Contains criteria for acceptance of wastes from CERCLA actions.	Applicable to radioactive, hazardous/dangerous, and mixed wastes.
Wild and Scenic Rivers Act	16 USC 1271	Prohibits federal agencies from recommending authorization of any water resource project that would have a direct and adverse effect on the values for which a river was designated as a wild and scenic river or included as a study area.	The Hanford Reach of the Columbia River has been recommended for inclusion as a recreational river under the Wild and Scenic Rivers Program.
Benton Clean Air Authority	Regulation 1, Article 5	Establishes a regional program for open burning.	These county regulations are authorized by the state Clean Air Act.
Fish and Wildlife Coordination Act	16 USC 661 et seq.	This Act ensures that wildlife conservation is given equal consideration with other values during the planning of activities that affect water resources. The Act authorizes the Secretary of the Interior to provide assistance to federal, state, and public or private agencies in the "development, protection, rearing, and stocking of all species of wildlife, resources thereof, and their habitat...". The Act also requires a consultation with the U.S. Fish and Wildlife Service (USFWS) when a federal agency plans to impound, deepen, or otherwise modify a body of water.	While the recommendations by the USFWS are not legally binding, DOE is required to give them full consideration.

Table C-3. Potential To Be Considered Requirements. (Page 3 of 4)

Description	Citation	Requirements	Remarks
Executive Orders Protection of Wetlands	EO 11990	This Executive Order requires that each federal agency "...take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for (1) acquiring, managing, and disposing of federal lands and facilities; and (2) providing federally undertaken, finance, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, including but not limited to, water and related land resources planning, regulating, and licensing activities."	Must be considered if action is taken that may impact wetland area.
Floodplain Management	EO 11988	This Order requires federal agencies to take floodplain management into account when formulating or evaluating water or land use plans. The Order specifies that "...each agency shall...restore and reserve the natural and beneficial values served by floodplains in carrying out its responsibilities for (1) acquiring, managing, and disposing of federal land and facilities; (2) providing federally undertaken, financial, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, and licensing conducting activities."	Must be considered if actions are taken within a floodplain.
Protection and Enhancement of the Cultural Environment	EO 11593	Provides direction to federal agencies to preserve, restore, and maintain cultural resources.	Pertains to sites, structures, and objects of historical, archeological, or architectural significance.
Exotic Organisms	EO 11987	This Order requires federal agencies to restrict, to the extent possible, the introduction of exotic species into the lands or waters that they own, lease, or hold for purposes of administration. It also restricts the use of federal funds and programs for importation and introduction of exotic species.	Must be considered during revegetation.

Table C-3. Potential To Be Considered Requirements. (Page 4 of 4)

Description	Citation	Requirements	Remarks
Environmental Justice	EO 12898	This order requires federal agencies to make achieving 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.	Must be considered during decisionmaking process as a NEPA value.

The following information provides an analysis of how each remedial alternative discussed in Section 6.3 is anticipated to comply with these ARARs and TBCs.

No Action (RRES-1/MCRIS-1) - The No-Action Alternatives would not result in compliance with soil and groundwater protection ARARs or TBCs.

Remove/Treat if Required/Dispose/Backfill for Rural-Residential (RRES-6) - Removal of contaminated soils would be expected to provide compliance with all soil cleanup standards, including protection of groundwater and the river. (The introduction of an ex situ treatment action on contaminated soils would not affect compliance with soil cleanup standards.) The degree of removal that would be required at each site in order to reach compliance with soil cleanup standards has been estimated; however, a potential exists that it would become technically impracticable to excavate deep vadose-zone soils should contamination above preliminary remedial goals (PRGs) be found at those depths.

Remove/Treat if Required/Dispose/Backfill for Modified CRCIA Ranger/Industrial (MCRIS-6) - Removal of contaminated soils would be expected to provide compliance with all soil cleanup standards, including protection of groundwater and the river. (The introduction of an ex situ treatment action on contaminated soils would not affect compliance with soil cleanup standards.) The degree of removal that would be required at each site in order to reach compliance with soil cleanup standards has been estimated; however, a potential exists that it would become technically impracticable to excavate deep vadose-zone soils should contamination above PRGs be found at those depths.

Remove 3.0 m (10 ft) Below Ground Surface (bgs)/Treat if Required/ Dispose/Backfill/Cap (MCRIS-7) - The combination of removal of some contaminants and containment of others for groundwater protection would provide compliance with all soil cleanup standards for both dangerous waste and radioactive constituents during the design life of the chosen cap (e.g., modified *Resource Conservation and Recovery Act of 1976* [RCRA] Subtitle C cap, which has a design life of approximately 500 years). Because some contaminants would remain in soils, there is a potential that, after failure of the cap, contaminants exceeding the soil cleanup standards could still be in place in the soils, resulting in failure to meet groundwater cleanup standards. Compliance with the containment action provisions of MTCA (WAC 173-340-360[8]) can be met through long-term monitoring of the site and implementation of appropriate institutional controls.

Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Vitrify/Backfill (MCRIS-8) - The combination of removing some contaminants and in situ vitrification of others for groundwater protection would provide compliance with soil cleanup levels for constituents expected to remain in the soils for these waste sites. It is possible that not all the contaminated soils would be vitrified due to lateral distribution of contaminants that might go undetected, but this possibility is considered unlikely. Institutional controls to prevent access to the soils or some type of cover (e.g., clean fill, cap) may be required under this scenario due to remaining radiological constituents; therefore, compliance with direct exposure standards by means of long-term maintenance of the cover would be a concern. Compliance with the containment action

provisions of MTCA (WAC 173-340-360[8]) can be met through long-term monitoring of the site and implementation of appropriate institutional controls.

C1.2 WASTE MANAGEMENT STANDARDS

The RCRA regulates the generation, transportation, storage, treatment, and disposal of solid and hazardous waste. Authority to implement much of the hazardous waste provisions of RCRA has been delegated to the state and is implemented through WAC 173-303. The state has also obtained EPA approval for the nondangerous solid waste program implemented by WAC 173-304. Authority for land disposal restrictions (LDRs), including standards for the treatment of hazardous wastes prior to land disposal, is retained at the federal level and implemented via 40 CFR 268. The *Atomic Energy Act* (AEA) establishes standards for the management of radioactive wastes. Regulations pertaining to the management and land disposal of low-level radioactive waste (LLW) are contained in 10 CFR 61.

Alternatives that involve the removal of waste or contaminated media or in situ or ex situ treatment may generate solid, dangerous, or radioactive LLW. Other alternatives may leave waste in place. The RCRA requirements are applicable to those alternatives that may generate, treat, store, or dispose of solid or dangerous waste or that leave waste in place. The substantive requirements of 10 CFR 61 are relevant and appropriate to those alternatives that generate, treat, or dispose of radioactive LLW or leave LLW in place. All waste generated under any alternative would be evaluated and managed in compliance with the appropriate waste designation. Waste disposal would be to the Environmental Restoration Disposal Facility (ERDF), which is designed to meet the requirements of both RCRA and the radioactive waste standards. For alternatives that involve leaving solid or dangerous waste in place, RCRA performance standards for landfill covers are applicable or relevant and appropriate (depending on the date when the waste was first placed at the site) and are incorporated into the design. Cover performance and boundary requirements, locators, and post-operational monitoring contained in 10 CFR 61 are relevant and appropriate to the in-place disposal of radioactive waste.

The following information provides an analysis of how each remedial alternative discussed in Section 6.3 is anticipated to comply with these ARARs and TBCs.

No Action (RRES-1/MCRIS-1) - Because the No-Action Alternatives does not result in waste generation, information specific to compliance with ARARs and TBCs has not been provided.

Remove/Treat if Required/Dispose/Backfill for Rural-Residential (RRES-6) - Potentially large quantities of soil and debris (piping, structures, and cleanup materials) may be generated under this alternative. All wastes generated are expected to be below levels that would cause them to be designated as dangerous waste (under an assumption that listed wastes are subject to a contained-in determination or treatability variances); however, if wastes are encountered that are not below those values, treatment would be required prior to disposal. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in

WAC 173-303. Although unlikely, the treatment activity may generate a residual that may potentially require treatment prior to disposal to the ERDF or disposal at another on-site unit in order to comply with waste management ARARs.

Remove/Treat if Required/Dispose/Backfill for Modified CRCIA Ranger/Industrial (MCRIS-6) - Potentially large quantities of soil and debris (piping, structures, and cleanup materials) may be generated under this alternative. All wastes generated are expected to be below levels that would cause them to be designated as dangerous waste (under an assumption that listed wastes are subject to a contained-in determination or treatability variances); however, if wastes are encountered that are not, treatment would be required prior to disposal. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. Although unlikely, the treatment activity may generate a residual that may potentially require treatment prior to disposal to the ERDF or disposal at another on-site unit in order to comply with waste management ARARs.

Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Backfill/Cap (MCRIS-7) - Potentially large quantities of soil and debris (piping, structures, and cleanup materials) may be generated under this alternative. All wastes generated are expected to be below levels that would cause them to be designated as dangerous waste (under an assumption that listed wastes are subject to a contained-in determination or treatability variances); however, if wastes are encountered that are not, treatment would be required prior to disposal. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. Additional small quantities of waste, such as contaminated soils and cleanup debris, may also be generated from the site preparation for and construction of a cap.

Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Vitrify/Backfill (MCRIS-8) - Potentially large quantities of soil and debris (piping, structures, and cleanup materials) may be generated under this alternative. All wastes generated are expected to be below levels that would cause them to be designated as dangerous waste (under an assumption that listed wastes are subject to a contained-in determination or treatability variances); however, if wastes are encountered that are not, treatment would be required prior to disposal. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. Additional small quantities of waste, such as contaminated soils and cleanup debris, may be generated from the site preparation for or during the in situ vitrification treatment. These wastes may or may not require treatment in order to be disposed to the ERDF. However, the type and extent of waste treatment cannot be defined. It is anticipated, however, that compliance with waste management standards would be achievable.

C1.3 WASTEWATER MANAGEMENT STANDARDS

Requirements for discharges to waters of the state are established in WAC 173-216, including effluent discharges to the soil column, but excluding discharges subject to a National Pollutant Discharge Elimination System (NPDES) permit under the *Clean Water Act* or discharges to an underground aquifer subject to WAC 173-218.

The following information provides an analysis of how each remedial alternative discussed in Section 6.3 is anticipated to comply with these ARARs and TBCs.

No Action (RRES-1/MCRIS-1) - Because the No-Action Alternative does not result in wastewater generation, information specific to compliance with ARARs and TBCs has not been provided.

Remove/Treat if Required/Dispose/Backfill for Rural-Residential (RRES-6) - Other than decontamination wastewaters, no wastewater is expected to be generated by this alternative. Treatment and disposal options for the decontamination wastewaters would include trucking them to a water-treatment facility within the Hanford Site or testing the waters, and, if they comply with ARARs associated with WAC 173-216, discharging them to the ground. Regardless of which treatment and disposal option is chosen, the ARARs associated with wastewater management would be complied with.

Remove/Treat if Required/Dispose/Backfill for Modified CRCIA Ranger/Industrial (MCRIS-6) - Other than decontamination wastewaters, no wastewater is expected to be generated by this alternative. Treatment and disposal options for the decontamination wastewaters would include trucking them to a water-treatment facility within the Hanford Site or testing the waters and, if they comply with ARARs associated with WAC 173-216, discharging them to the ground. Regardless of which treatment and disposal option is chosen, the ARARs associated with wastewater management would be complied with.

Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Backfill/Cap (MCRIS-7) - For decontamination wastewaters, treatment and disposal options would include trucking them to a water-treatment facility within the Hanford Site or testing the waters and, if they comply with ARARs associated with WAC 173-216, discharging them to the ground. Operational wastes may include run-on and run-off waters. Wastes may also be generated during maintenance of the cap. These wastes may or may not require treatment prior to disposal to the ERDF; however, the type and extent of waste treatment cannot be defined. It is anticipated, however, that treatment and subsequent compliance with waste management standards would be achievable. Regardless of which treatment and disposal option is chosen, the ARARs associated with wastewater management would be complied with.

Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Vitrify/Backfill (MCRIS-8) - Other than decontamination wastewaters, no wastewater is expected to be generated by this alternative. Treatment and disposal options for the decontamination wastewater would include trucking them to a water-treatment facility within the Hanford Site or testing the waters, and, if they comply

with ARARs associated with WAC 173-216, discharging them to the ground. Regardless of which treatment and disposal option is chosen, the ARARs associated with wastewater management would be complied with.

C1.4 STANDARDS FOR PROTECTION OF THE COLUMBIA RIVER FROM DIRECT DISCHARGES

Title 40 CFR 122 addresses limitations to and standards for technological activities, control of toxic pollutants, and monitoring of direct discharges to waters of the United States, including stormwater. At the Hanford Site, all stormwater must be managed in accordance with site-wide stormwater permit conditions.

No direct wastewater discharges to the Columbia River are planned under any of the alternatives. Water treatment units permitted under the NPDES may be utilized as identified above. Erosion and stormwater controls would be used as necessary in working near the river. A stormwater management plan would be prepared to prevent discharges of contaminated stormwater to the Columbia River.

C1.5 AIR STANDARDS

The *Clean Air Act* (CAA) establishes standards for the control of air emissions. Authority has been partially delegated to the state. Under 40 CFR 61, Subpart H, and Chapter 246-247 WAC, airborne radionuclide emissions from all combined operations at the Hanford Site may not exceed 10-mrem/yr effective-dose equivalent to the hypothetical off-site maximally exposed individual (MEI). For an emission unit with a potential to emit less than 0.1 mrem/yr total effective dose equivalent to the MEI, WAC 246-247 allows for an estimate of those emissions in lieu of monitoring and requires verification of compliance through periodic confirmatory measurements. An emission unit is defined as a point source, nonpoint source, or source of fugitive emissions. Chapter 246-247 WAC requires verification of compliance through monitoring. Chapter 173-400 WAC establishes requirements for the control and/or prevention of the emission of air contaminants, including particulates. Chapter 173-460 WAC establishes acceptable source impact levels for more than 500 carcinogenic, acutely toxic air pollutants. In addition, WAC-173-480-050 requires that emissions are kept as low as is reasonably achievable (ALARA).

The radionuclide emission limits would apply to all fugitive, diffuse, and point source air emissions of radionuclides generated by any of the removal or treatment (in situ or ex situ) alternatives. If there is the potential for any nonzero radioactive emissions, best available radionuclide control technology (BARCT) would be required. If the alternative would generate an increase of toxic air pollutants to the atmosphere above the small quantity emission rates, implementation of best available control for toxics would be required.

The following information provides an analysis of how each remedial alternative discussed in Section 6.3 is anticipated to comply with these ARARs and TBCs.

No Action (RRES-1/MCRIS-1) - Because the No-Action Alternatives would leave contaminants in place, compliance with ARARs and TBCs would not be provided.

Remove/Treat if Required/Dispose/Backfill for Rural-Residential (RRES-6) - Remove, treat, and dispose activities have the potential to increase emissions of radionuclides through the generation of airborne particulates during excavation and transportation. Thus, BARCT would be required as specified in WAC 246-247. BARCT may consist of standard dust suppression techniques such as wetting soils with water prior to excavation, using dust suppression additives, and/or closed containers for transportation. WAC 246-247 requires verification of compliance, which can be accomplished by periodic confirmatory air sampling. No toxic emissions are expected.

Remove/Treat if Required/Dispose/Backfill for Modified CRCIA Ranger/Industrial (MCRIS-6) - Remove, treat, and dispose activities have the potential to increase emissions of radionuclides through the generation of airborne particulates during excavation and transportation. Thus, BARCT would be required as specified in WAC 246-247. BARCT may consist of standard dust suppression techniques such as wetting soils with water prior to excavation, using dust suppression additives, and/or using closed containers for transportation. WAC 246-247 requires verification of compliance, which can be accomplished by periodic confirmatory air sampling. No toxic emissions are expected.

Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Backfill/Cap (MCRIS-7) - Remove, treat, and dispose activities have the potential to increase emissions of radionuclides through the generation of airborne particulates during excavation and transportation. Thus, BARCT would be required as specified in WAC 246-247. BARCT may consist of standard dust suppression techniques such as wetting soils with water prior to excavation, using dust suppression additives, and/or using closed containers for transportation. Containment is a standard practice on the Hanford Site for surface contaminants. The Radiation Area Remedial Action program uses clean fill to cover and stabilize surface contamination. The placement of a cover to contain radiation units has a small potential to generate airborne emissions of radionuclides. Thus, BARCT would be employed as specified in WAC 246-247 to ensure that the no release of particulates occurs during placement of the cover. Potential BARCT techniques would include those used for excavation and transportation. WAC 246-247 requires verification of compliance, which can be accomplished by periodic confirmatory air sampling. No toxic emissions are expected.

Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Vitrify/Backfill (MCRIS-8) - Remove, treat, and dispose activities have the potential to increase emissions of radionuclides through the generation of airborne particulates during excavation and transportation. Thus, BARCT would be required as specified in WAC 246-247. BARCT may consist of standard dust suppression techniques such as wetting soils with water prior to excavation, using dust suppression additives, and/or using closed containers for transportation. Preparation for in situ vitrification may require limited surface disturbance of the surface radiation area, and BARCT would be required as

specified in WAC 246-247. WAC 246-247 requires verification of compliance, which can be accomplished by periodic confirmatory air sampling. Vitrification of soils may produce off gas vapors. The off-gas vapors would be controlled using best available control technology (BACT). WAC 173-400 requires verification of compliance, which can be accomplished by source monitoring. No toxic emissions are expected.

C1.6 STANDARDS FOR THE PROTECTION OF CULTURAL AND ECOLOGICAL RESOURCES

The *National Historic Preservation Act of 1966* (16 USC 470 et seq., implemented in regulation by 36 CFR 800) requires federal agencies to take into account the effect of an activity on any significant cultural resource, including properties listed, or eligible for inclusion, on the National Register of Historic Places. The *Native American Graves Protection and Repatriation Act* establishes statutory provisions for the treatment of inadvertent discoveries of Native American remains and cultural objects. The *Archeological and Historical Preservation Act of 1974* (16 USC 469a) requires action to recover and preserve archaeological or historical data in areas where activity may cause irreparable harm, loss, or destruction of significant data.

The *Endangered Species Act of 1973* (16 USC 1531) is implemented by 50 CFR 402 and Chapter 232-12-297 WAC and prohibits activities that threaten the continued existence of listed species or destroy critical habitat. The *Migratory Bird Treaty Act* makes it illegal to take, capture, or kill as applicable any migratory bird, or any part, nest, or egg of any such birds.

The cultural resource protection requirements would be applicable if any properties in the 100-N Area are determined to be historically significant. Cultural reviews are currently being performed to determine whether the buildings are eligible for inclusion on the National Register of Historic Places, and this determination may affect alternatives for nearby waste sites. The 100 Area in general is rich in cultural resources related to Native Americans, and several of the alternatives involve ground-disturbing activities. If any discoveries related to Native American remains or cultural objects are made during such activities, activity in the area would cease, and appropriate notifications and negotiations regarding further actions would be made.

Threatened and endangered species are known to be present in the 100 Area, and the area is within an established migration route; however, no adverse impacts on protected species or critical habitat from any of the alternatives are anticipated. Area-specific ecological reviews would be conducted prior to implementing any alternative to identify potential adverse impacts and plan necessary mitigation actions.

The Hanford Reach Preservation Act (Public Law 100-605) provides fora comprehensive river conservation study and prohibits the construction of any dam, channel, or navigation project by a federal agency for 8 years from enactment. Projects are required to be performed under the consultation and coordination of the National Park Service on any proposed remediation alternative.

The following information provides an analysis of how each remedial alternative discussed in Section 6.3 is anticipated to comply with these ARARs and TBCs.

No Action (RRES-1/MCRIS-1) - Because the No-Action Alternatives leaves waste in place, ARARs or TBCs relative to these standards may not be complied with due to threat of contamination.

Remove/Treat if Required/Dispose/Backfill for Rural-Residential (RRES-6) - This alternative would comply with all cultural and ecological resource ARARs and TBCs. There has been extensive disturbance within the units, and it would not be likely to further impact cultural, historical or traditional-use areas there. However, there would be a high potential to impact cultural, historical, or traditional-use areas adjacent to the units due to the need for extensive excavation of those areas (e.g., lay-back of side walls for worker safety). Care would be required with this alternative for completion of preconstruction surveys and development of mitigative measures should cultural or natural resources be encountered. Recontouring and revegetation of the disturbed areas would be required to ensure restoration of the natural resources. Delays in remediation may be required during periods of bald eagle residency. A benefit of this option is that no future threat of recontamination of the site or contamination of adjacent areas would occur once the contaminants are removed and appropriately disposed. Treatment action for LDR waste should not require additional actions to comply with these standards.

Remove/Treat if Required/Dispose/Backfill for Modified CRCIA Ranger/Industrial (MCRIS-6) - This alternative would comply with all cultural and ecological resource ARARs and TBCs. There has been extensive disturbance within the units, and it would not be likely to further impact cultural, historical or traditional-use areas there. However, there would be a high potential to impact cultural, historical, or traditional-use areas adjacent to the units due to the need for extensive excavation of those areas (e.g., lay-back of side walls for worker safety). Care would be required with this alternative for completion of preconstruction surveys and development of mitigative measures should cultural or natural resources be encountered. Recontouring and revegetation of the disturbed areas would be required to ensure restoration of the natural resources. Delays in remediation may be required during periods of bald eagle residency. A benefit of this option is that no future threat of recontamination of the site or contamination of adjacent areas would occur once the contaminants are removed and appropriately disposed. Treatment action for LDR waste should not require additional actions to comply with these standards.

Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Backfill/Cap (MCRIS-7) - This alternative would comply with all cultural and ecological resource ARARs and TBCs. There has been extensive disturbance within the units, and it would not be likely to further impact cultural, historical or traditional-use areas there. However, there would still be a potential to impact cultural, historical, or traditional-use areas adjacent to the units due to the need for extensive excavation of those areas (e.g., lay-back of side walls for worker safety). Because the amount of soil excavated for this alternative is less extensive than other alternatives, the affected areas would be less extensive. Care would be required with this alternative for completion of preconstruction surveys and development of mitigative measures should cultural or natural

resources be encountered. Recontouring and revegetation of the disturbed areas would be required to ensure restoration of the natural resources. Delays in remediation may be required during periods of bald eagle residency. A benefit of this option is that no future threat of recontamination of the site or contamination of adjacent areas would occur once the contaminants are removed and appropriately disposed. Treatment action for LDR waste should not require additional actions to comply with these standards. Placement of a cap is anticipated to cause minimal or no impacts to cultural resources since the area of concern has already been previously disturbed as a result of operations. This alternative would protect adjacent cultural resources from becoming contaminated by removing some contaminants and retaining other contaminants in place. Compliance with these standards can readily be achieved during construction of the cap through proper preconstruction surveys and mitigative measures, should resources be encountered. Implementation of this alternative would most likely enhance ecological resources by eliminating the exposure of contaminants and by providing an opportunity to revegetate the surface of the cap with plant species that provide for a viable and sustainable ecological environment.

Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Vitrify/Backfill (MCRIS-8) - This alternative would comply with all cultural and ecological resource ARARs and TBCs. There has been extensive disturbance within the units and it would not be likely to further impact cultural, historical or traditional-use areas there. However, there would still be a potential to impact cultural, historical, or traditional-use areas adjacent to the units due to the need for extensive excavation of those areas (e.g., lay-back of side walls for worker safety). Because the amount of soil excavated for this alternative is less extensive than other alternatives, the affected areas would be less extensive. Care would be required with this alternative for completion of preconstruction surveys and development of mitigative measures should cultural or natural resources be encountered. Recontouring and revegetation of the disturbed areas would be required to ensure restoration of the natural resources. Delays in remediation may be required during periods of bald eagle residency. A benefit of this option is that no future threat of recontamination of the site or contamination of adjacent areas would occur once the contaminants are removed and appropriately disposed. Any treatment action for LDR waste should not require additional actions to comply with these standards. The vitrification activities are anticipated to cause minimal or no impacts to cultural resources since the area of concern has already been previously disturbed as a result of operations. Because this alternative would remove some contaminants and immobilize others, protection of adjacent cultural resources would be ensured. Recontouring and revegetation efforts that could impact cultural resources would require mitigative measures. Compliance with these standards can readily be achieved through proper preconstruction surveys and mitigative measures should resources be encountered.

C1.7 RADIATION PROTECTION STANDARDS

The AEA establishes radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of U.S. Department of Energy (DOE) activities. Title 10 CFR 835 establishes limits for doses to occupational workers

and visitors and also requires that measures be taken to maintain radiation exposure as low as reasonably achievable. Regulations regarding radiation protection of the public and the environment have been promulgated by the NRC in 10 CFR 20 and 10 CFR 61.

A combination of personal protective equipment, personnel training, physical design features (e.g., confinement and remote handling), and nonengineered controls (e.g., limiting time in radiation zones) would be used to ensure that the substantive requirements of 10 CFR 835 are met for all alternatives.

The following information provides an analysis of how each remedial alternative discussed in Section 6.3 is anticipated to comply with these ARARs and TBCs.

No Action (RRES-1/MCRIS-1) - Because the No-Action Alternatives would leave contamination in place, ARARs or TBCs associated with radiation protection standards would not be complied with.

Remove/Treat if Required/Dispose/Backfill for Rural-Residential (RRES-6) - Compliance with radiation worker exposure standards (10 CFR 835) can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during all phases of the operation. Radiation protection standards for the public (10 CFR 20 and 10 CFR 61) would be complied with during excavation of radiologically contaminated soils through adequate planning and design of the excavation and disposal activities. Upon removal of soils, these requirements would cease to be applicable at the site.

Remove/Treat if Required/Dispose/Backfill for Modified CRCIA Ranger/Industrial (MCRIS-6) - Compliance with radiation worker exposure standards (10 CFR 835) can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during all phases of the operation. Radiation protection standards for the public (10 CFR 20 and 10 CFR 61) would be complied with during excavation of radiologically contaminated soils through adequate planning and design of the excavation and disposal activities. Upon removal of soils, these requirements would cease to be applicable at the site.

Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Backfill/Cap (MCRIS-7) - Compliance with radiation worker exposure standards (10 CFR 835) can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during all phases of the operation. Compliance with radiation protection standards for the public (10 CFR 20 and 10 CFR 61) can be achieved throughout excavation and construction activities and during operation and maintenance of the cap. Compliance would be achieved through access prevention to areas that would result in doses that exceed radiation protection standards for the public.

Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Vitrify/Backfill (MCRIS-8) - Compliance with radiation worker exposure standards (10 CFR 835) can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during all phases of the operation. In situ vitrification by itself may not ensure compliance with radiation protection standards for the public (10 CFR 20 and 10 CFR 61). Institutional controls would be

required to prevent intrusion into the solidified mass and to prevent access should post-vitrification radiation levels exceed protection standards. In this manner, compliance with these standards can be achieved.

C2.0 REFERENCES

Archeological and Historical Preservation Act of 1974, 16 U.S.C. 469a, et seq.

Atomic Energy Act of 1954, 42 U.S.C. 2011, et seq.

Clean Air Act of 1955, 42 U.S.C. 7401, et seq.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601, et. seq.

Endangered Species Act of 1973, 16 U.S.C. 1531, et seq.

Migratory Bird Treaty Act, 16 U.S.C. 703, et seq.

National Historic Preservation Act of 1966, 16 U.S.C. 470, et seq.

Native American Graves Protection and Repatriation Act, 25 U.S.C. 3001, et seq.

Resource Conservation and Recovery Act of 1976, 42 U.S.C. Sections 6901, et. seq.

Safe Drinking Water Act, 42 U.S.C. 300, et seq.

WAC 173-216, "State Waste Discharge Permit Program," *Washington Administrative Code*, as amended.

WAC 173-303, 193, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

WAC 173-304, "Minimum Functional Standards for Solid Waste Handling," *Washington Administrative Code*, as amended.

WAC 173-340, 1992, "Model Toxics Control Act Cleanup Regulation," *Washington Administrative Code,* as amended.

WAC 173-400, "Standards for Maximum Emissions," *Washington Administrative Code*, as amended.

WAC 173-460, "Decontaminating Ambient Impact Compliance," *Washington Administrative Code,* as amended.

WAC-173-480, "New and Modified Emission Units," *Washington Administrative Code*, as amended.

10 CFR 835, "Department of Energy Occupational Radiation Protection," *Code of Federal Regulations*, as amended.

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," *Code of Federal Regulations*, as amended.

40 CFR 61, "National Emissions Standards for Hazardous Air Pollutants," *Code of Federal Regulations*, as amended.

40 CFR 122, "EPA Administered Permit Programs: The National Pollutant Discharge Elimination System," *Code of Federal Regulations*, as amended.

40 CFR 141, 1993,"Federal Safe Drinking Water Act," *Code of Federal Regulations*, as amended.

40 CFR 268, "Land Disposal Restriction," *Code of Federal Regulations*, as amended.

APPENDIX D

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D1.0 SOIL VOLUMES

D1.1 SOIL VOLUME SUMMARY

Tables D-1 and D-2 summarize the soil volumes for 116-N-1 and 116-N-3 for the rural-residential and the modified CRCIA ranger/industrial exposure scenarios. Tables D-3 through D-12 provide details on how these volumes were calculated. These detailed calculations are shown in English units and are then converted to metric units in Tables D-1 and D-2.

References are made to figures in Section 4.0 of the Treatment, Storage, and Disposal Corrective Measures Study (TSD CMS). These figures show generic cross sections of the various units in order to depict the elevations of certain features and the depths of contamination. These figures do not show all of the dimensions used in the calculations. Other dimensions come from the unit descriptions. Finally, some dimensions are derived from the unit dimensions, using side slope ratios and depths to calculate widths and lengths.

Volumes were not calculated for 120-N-1/120-N-2/100-N-58 because there are no contaminants of concern associated with these facilities. If required, removal of the pipelines associated with these units would require the excavation of about 3,300 m^3 (120,000 ft^3) of soil to access the pipes. Approximately 270 m (870 ft) of nominal 8-inch pipe would be disposed representing a volume of approximately 11 m^3 (400 ft^3).

Soil Volume Calculation Methodology

The volume of high and low activity soil in each crib and trench was calculated in the engineering study (BHI 1997), and the method of calculating those volumes is described there. The volume of uncontaminated soil (clean overburden) was calculated as simply the difference in volume between the total volume of the excavated site and the sum of the the void volumes (if any), and the high and low activity contaminated soil volumes. The cribs and trenches can generally be described in terms of trapezoidal cross sections with one vertical wall where each crib ajoins its trench. The cross sections used for each crib and trench are shown in Tables D-3 through D-12 and the dimensions are taken from Figures 4-1 and 4-2 in the main text.

Table D-1. TSD Unit Soil Volumes for Rural-Residential Exposure Scenario.

Unit	High Activity		Low Activity		Overburden Soil		Total Soil Volume	
	BCF	BCM	BCF	BCM	BCF	BCM	BCF	BCM
116-N-1 Crib[a]	36,250	1,026	507,500	14,369	124,031	3,512	667,781	18,907
116-N-1 Trench	45,149	1,278	423,434	11,989	539,096	15,263	1,007,679	28,530
Unit Total	**81,399**	**2,305**	**930,934**	**26,357**	**663,128**	**18,775**	**1,675,461**	**47,437**
116-N-3 Crib	60,000	1,699	240,000	6,795	50,414	1,427	350,414	9,921
116-N-3 Trench	33,833	958	256,793	7,270	211,984	6,002	502,610	14,230
Unit Total	**93,833**	**2,657**	**496,793**	**14,065**	**262,397**	**7,429**	**853,023**	**24,151**
UPR-100-N-31 Total	**0**	**0**	**70,875**	**2,007**	**0**	**0**	**70,875**	**2,007**
Grand Total	**175,232**	**4,961**	**1,498,602**	**42,429**	**925,525**	**26,204**	**2,599,359**	**73,595**

[a]Low activity volume includes contaminated boulder volume of 145,000 cubic feet.
BCF = Bank Cubic Feet
BCM = Bank Cubic Meters

Table D-2. TSD Unit Soil Volumes for Modified CRCIA Ranger/Industrial Exposure Scenario.

Unit	High Activity		Low Activity		Overburden Soil		Total Soil Volume	
	BCF	BCM	BCF	BCM	BCF	BCM	BCF	BCM
116-N-1 Crib[a]	36,250	1,026	326,250	9,237	54,375	1,539	416,875	11,803
116-N-1 Trench	45,149	1,278	423,434	11,989	539,096	15,263	1,007,679	28,530
Unit Total	**81,399**	**2,305**	**749,684**	**21,225**	**593,471**	**16,803**	**1,424,554**	**40,333**
116-N-3 Crib	60,000	1,699	240,000	6,795	50,414	1,427	350,414	9,921
116-N-3 Trench	33,833	958	256,793	7,270	211,984	6,002	502,610	14,230
Unit Total	**93,833**	**2,657**	**496,793**	**14,065**	**262,397**	**7,429**	**853,023**	**24,151**
UPR-100-N-31 Total	**0**	**0**	**36,750**	**1,040**	**0**	**0**	**36,750**	**1,040**
Grand Total	**175,232**	**4,961**	**1,283,227**	**36,331**	**855,869**	**24,232**	**2,314,328**	**65,525**

[a]Low activity volume includes contaminated boulder volume of 145,000 cubic feet.
BCF = Bank Cubic Feet
BCM = Bank Cubic Meters

Table D-3. 116-N-1 Crib Soil Volume Calculation Details (Rural-Residential: refer to Figure 4-1).

Volume Unit	Depth Dimensions				Bottom Dimensions		Volume, BCF
	Top Elev. (ft)	Bottom Elev. (ft)	Height (ft)	Side Slope Ratio (Run/Rise)	Length (ft)	Width (ft)	
Low Act. Cobbles[a]	455	450	5	2	290	125	181,250
Boulders[a]	450	446	4	2	290	125	145,000
High Act.[a]	446	445	1	0	290	125	36,250
Low Act. Soil[a]	445	440	5	0	290	125	181,250
Clean[b]	455	440	15	1.5	290	125	124,031
Total[c]	455	440	15	1.5	290	125	667,781

[a]Volume from Engineering Study (BHI-01092).

[b]Volume =Total - Low Act. Cobbles - Boulder Vol. - High Act. - Low Act. Soil

[c]Volume =Height*Bot. Length*Bot. Width+Run/Rise*Depth^2*(Bot. Length + Bot. Width/2)+3*Height^3/2

BCF = Bank Cubic Feet

Note: The formula for calculating the total volume accounts for the fact that the boundary between the crib and trench is a vertical plane.

Table D-4. 116-N-1 Trench Soil Volume Calculation Details (Rural-Residential: refer to Figure 4-1).

Volume Unit	Depth Dimensions				Bottom Dimensions		Volume (BCF)
	Top Elev. (ft)	Bottom Elev. (ft)	Height (ft)	Side Slope Ratio (Run/Rise)	Length (ft)	Width (ft)	
A[a]	455	444	11	1.5	1,615	55	1,277,185
B[a]	455	444	11	1.5	1,608	25	738,089
Overburden Soil Volume = Volume A - Volume B:							539,096
High Activity Cont. Soil Volume[b]:							45,149
Low Activity Cont. Soil Volume[b]:							423,434
Total Contaminated Soil Volume = Low Act. Vol. + High Act. Vol.							468,583

Volume Unit A is the volume of the excavation above the operating water level.

Volume Unit B is the volume of the void above the operating water level.

[a]Volume =Height*Bot. Length*Bot. Width+Run/Rise*Depth^2*(Bot. Length + Bot. Width/2)+3*Height^3/2

[b]Volume from Engineering Study (BHI-01092).

BCF = Bank Cubic Feet

ft = feet

Note: The formula for calculating volumes A and B accounts for the fact that the boundary between the crib and trench is a vertical plane.

Table D-5. 116-N-3 Crib Soil Volume Calculation Details (Rural-Residential: refer to Figure 4-1).

Volume Unit	Depth Dimensions				Bottom Dimensions		Volume, BCF
	Top Elev. (ft)	Bottom Elev. (ft)	Height (ft)	Side Slope Ratio (Run/Rise)	Length (ft)	Width (ft)	
$Void_1$[a]	451	447	4	1.5	283	273	319,200
$Void_2$[b]	447	441	6	0	250	240	360,324
High Exp.[c]	441	440	1	0	250	240	60,000
Low Exp.[c]	440	436	4	0	250	240	240,000
Clean[d]	447	441	6	1.5	250	240	50,414
Total[a]	451	436	15	1.5	250	240	1,029,938

[a]Volume = Height*Bot. Length*Bot. Width+Run/Rise*$Depth^2$*(Bot. Length + Bot. Width/2)+3*$Height^3$/2

[b]Volume = Length * Width * Depth

[c]Volume from Engineering Study (BHI-01092).

[d]Volume = Total - $Void_1$ - $Void_2$ - High Exp. - Low Exp.

BCF = Bank Cubic Feet

Notes:

1. The formula for calculating the total volume accounts for the fact that the boundary between the crib and trench is a vertical plane.
2. $Void_1$ is the void space above the concrete covers up to the local surface elevation. $Void_2$ is the void space between the operational water level and the concrete cover panels.

Table D-6. 116-N-3 Trench Soil Volume Calculation Details (Rural-Residential: refer to Figure 4-1).

Volume Unit	Depth Dimensions				Bottom Dimensions		Volume[a] (BCF)
	Top Elev. (ft)	Bottom Elev. (ft)	Height (ft)	Side Slope Ratio (Run/Rise)	Length (ft)	Width (ft)	
A[a]	451	442	9	1.5	765	70	580,244
B[a]	451	442	9	1.5	758	40	368,260
Overburden Soil Volume = Volume A - Volume B:							211,984
High Activity Cont. Soil Volume[b]:							33,833
Low Activity Cont. Soil Volume[b]:							256,793
Total Contaminated Soil Volume = Low Act. Vol. + High Act. Vol.							290,626

Volume Unit A is the volume of the excavation above the operating water level.

Volume Unit B is the volume of the void above the operating water level.

[a]Volume =Height*Bot. Length*Bot. Width+Run/Rise*Depth^2*(Bot. Length + Bot. Width/2)+3*Height^3/2

[b]Volume from Engineering Study (BHI-01092).

BCF = Bank Cubic Feet

ft = feet

Table D-7. UPR-100-N-31 Soil Volume Calculation Details (Rural-Residential: refer to Figure 4-1).

Depth Dimensions				Bottom Dimensions		Volume[a] (BCF)
Top Elev. (ft)	Bottom Elev. (ft)	Depth (ft)	Side Slope Ratio (Run/Rise)	Length (ft)	Width (ft)	
455	440	15	1.5	45	45	70,875

[a]Volume =Height*Bot. Length*Bot. Width+Run/Rise*Depth^2*(Bot. Length + Bot. Width)+3*Height^3
BCF = Bank Cubic Feet
ft = feet

Table D-8. 116-N-1 Crib Soil Volume Calculation Details (Modified CRCIA Ranger/Industrial: refer to Figure 4-2).

Volume Unit	Depth Dimensions				Bottom Dimensions		Volume, BCF
	Top Elev. (ft)	Bottom Elev. (ft)	Height (ft)	Side Slope Ratio (Run/Rise)	Length (ft)	Width (ft)	
Low Act. Soil[a]	455	450	5	2	290	125	181,250
Boulders[a]	450	446	4	2	290	125	145,000
High Act.[a]	446	445	1	0	290	125	36,250
Low Act. Soil[a]	445	445	0	0	290	125	0
Clean[b]	455	445	10	1.5	290	125	54,375
Total[c]	455	445	10	1.5	290	125	416,875

[a]Volume from Engineering Study (BHI-01092).

[b]Volume =Total - Low Act. Cobbles - Boulder Vol. - High Act. - Low Act. Soil

[c]Volume =Height*Bot. Length*Bot. Width+Run/Rise*Depth^2*(Bot. Length + Bot. Width/2)+3*Height^3/2

BCF = Bank Cubic Feet

Note: The formula for calculating the total volume accounts for the fact that the boundary between the crib and trench is a vertical plane.

Table D-9. 116-N-1 Trench Soil Volume Calculation Details (Modified CRCIA Ranger/Industrial: refer to Figure 4-2).

Volume Unit	Depth Dimensions				Bottom Dimensions		Volume (BCF)
	Top Elev. (ft)	Bottom Elev. (ft)	Height (ft)	Side Slope Ratio (Run/Rise)	Length (ft)	Width (ft)	
A[a]	455	444	11	1.5	1,615	55	1,277,185
B[a]	455	444	11	1.5	1,608	25	738,089
Overburden Soil Volume = Volume A - Volume B:							539,096
High Activity Cont. Soil Volume[b]:							45,149
Low Activity Cont. Soil Volume[b]:							423,434
Total Contaminated Soil Volume = Low Act. Vol. + High Act. Vol.							468,583

Volume Unit A is the volume of the excavation above the operating water level.

Volume Unit B is the volume of the void above the operating water level.

[a]Volume =Height*Bot. Length*Bot. Width+Run/Rise*Depth^2*(Bot. Length + Bot. Width/2)+3*Height^3/2

[b]Volume from Engineering Study (BHI-01092).

BCF = Bank Cubic Feet

ft = feet

Note: The formula for calculating volumes A and B accounts for the fact that the boundary between the crib and trench is a vertical plane.

Table D-10. 116-N-3 Crib Soil Volume Calculation Details (Modified CRCIA Ranger/Industrial: refer to Figure 4-2).

Volume Unit	Depth Dimensions				Bottom Dimensions		Volume, BCF
	Top Elev. (ft)	Bottom Elev. (ft)	Height (ft)	Side Slope Ratio (Run/Rise)	Length (ft)	Width (ft)	
$Void_1$[a]	451	447	4	1.5	283	273	319,200
$Void_2$[b]	447	441	6	0	250	240	360,324
High Exp.[c]	441	440	1	0	250	240	60,000
Low Exp.[c]	440	436	4	0	250	240	240,000
Clean[d]	447	441	6	1.5	250	240	50,414
Total[a]	451	436	15	1.5	250	240	1,029,938

[a]Volume = Height*Bot. Length*Bot. Width+Run/Rise*$Depth^2$*(Bot. Length + Bot. Width/2)+3*$Height^3$/2

[b]Volume = Length * Width * Depth

[c]Volume from Engineering Study (BHI-01092).

[d]Volume = Total - $Void_1$ - $Void_2$ - High Exp. - Low Exp.

BCF = Bank Cubic Feet

Notes:

1. The formula for calculating the total volume accounts for the fact that the boundary between the crib and trench is a vertical plane.
2. $Void_1$ is the void space above the concrete covers up to the local surface elevation. $Void_2$ is the void space between the operational water level and the concrete cover panels.

Table D-11. 116-N-3 Trench Soil Volume Calculation Details (Modified CRCIA Ranger/Industrial: refer to Figure 4-2).

Volume Unit	Depth Dimensions				Bottom Dimensions		Volume (BCF)
	Top Elev. (ft)	Bottom Elev. (ft)	Height (ft)	Side Slope Ratio (Run/Rise)	Length (ft)	Width (ft)	
A[a]	451	442	9	1.5	765	70	580,244
B[a]	451	442	9	1.5	758	40	368,260
Overburden Soil Volume = Volume A - Volume B:							211,984
				High Activity Cont. Soil Volume[b]:			33,833
				Low Activity Cont. Soil Volume[b]:			256,793
Total Contaminated Soil Volume = Low Act. Vol. + High Act. Vol.							290,626

Volume Unit A is the volume of the excavation above the operating water level.

Volume Unit B is the volume of the void above the operating water level.

[a]Volume =Height*Bot. Length*Bot. Width+Run/Rise*Depth^2*(Bot. Length + Bot. Width/2)+3*Height^3/2

[b]Volume from Engineering Study (BHI-01092).

BCF = Bank Cubic Feet

ft = feet

Note: The formula for calculating volumes A and B accounts for the fact that the boundary between the crib and trench is a vertical plane.

Table D-12. UPR-100-N-31 Soil Volume Calculation Details (Modified CRCIA Ranger/Industrial: refer to Figure 4-2).

Depth Dimensions				Bottom Dimensions		Volume[a] (BCF)
Top Elev. (ft)	Bottom Elev. (ft)	Depth (ft)	Side Slope Ratio (Run/Rise)	Length (ft)	Width (ft)	
455	445	10	1.5	45	45	36,750

[a]Volume =Height*Bot. Length*Bot. Width+Run/Rise*Depth^2*(Bot. Length + Bot. Width)+3*Height^3
BCF = Bank Cubic Feet
ft = feet

D2.0 DEMOLITION WASTE VOLUMES

D2.1 DEMOLITION WASTE VOLUME SUMMARY

Table D-13 summarizes the demolition waste volumes for 116-N-1 and 116-N-3. Following the table are the details on how these volumes were calculated. These detailed calculations are shown in English units in order to match the drawings from which the dimensions were derived, thus making it easier to follow the calculations. The volumes were then converted to metric units in the table. Demolition waste from the 120-N-1/120-N-2/100-N-58 ponds would include about 55 m^3 (3,900 ft^3) for the liner, 10 m^3 (350 ft^3) for the sampling shed, and about 500 m^3 (15,000 $ft^{3)}$ of fencing.

Unlike the soil volumes, no contingency is added to these volumes. Since these structures are well defined in various drawings, the volumes should be fairly precise, and contingencies are not needed.

Table D-13. TSD Unit Demolition Waste Volumes.

Unit	Structure	Volume	
		Cubic Feet	Cubic Meters
116-N-1 crib	Weir Box	2,364	67
	Unit Total	2,364	67
116-N-1 trench	Cover Panels	45,917	1,300
	Beams	8,690	246
	Foundations	2,220	63
	Overflow Weir Wall	238	7
	Shotcrete	6,504	184
	Misc. Debris	1,767	50
	Unit Total	65,336	1,850
116-N-3 crib	Cover Panels	19,740	559
	Beams	7,344	208
	Foundations	1,480	42
	Side Panels	1,859	53
	Effluent Distribution System	4,765	135
	Unit Total	35,188	996
116-N-3 trench	Tie-In Structure	8,056	228
	Cover Panels	60,300	1,707
	Foundations	12,000	340
	Side Panels	8,040	228
	End Panel	74	2
	Unit Total	88,470	2,505
	Grand Total	191,358	5,418

D2.2 DEMOLITION WASTE CALCULATION DETAILS

116-N-1 Crib Demolition Waste Volume

I. Weir box Volume (see drawing H-1-30581)

Top and Bottom:	2 x 1' x 12' x 52'	=1,248 ft^3
Sides (2):	2 x 1' x 9' x 52'	= 936 ft^3
Ends (2):	2 x 1' x 10' x 9'	= 180 ft^3
Total 116-N-1 Crib Demolition Waste Volume		**=2,364 ft^3**

116-N-1 Trench Demolition Waste Volume

I. Cover Beams (see drawing H-1-44541)

Cross-section area:			= 560 in^2 = 3.89 ft^2
Total beam lengths:	39 beams	x 50'	= 1,950 ft
	2 beams	x 54'	= 108 ft
	2 beams	x 58'	= 116 ft
	1 beam	x 60'	= 60 ft
	Total Length		= 2,234 ft
Total Beam Volume:	3.89 x 2,234		= 8,690 ft^3

II. Cover Panels (see drawing H-1-44542 through H-1-44547)

Typical Full Panel Volume: 8" x 4' x 36' = 96 ft^3

A. Leg 1 Panel Volume

Full Panels:

Number: = 117 full panels

Volume: 117 x 96 = 11,232 ft^3

Partial Panels:

Volume:([28.38 + 11.75] / 2) x 52 x 0.67 = 699 ft^3

Leg 1 Total Panel Volume: 11,232 + 699 = 11,931 ft^3

B. Leg 2 Panel Volume

Full Panels:

Number: = 52 full panels

Volume: 52 x 96 = 4,492 ft^3

Partial Panels:

Volume:([36.25 + 2.18] / 2) x 52 x 0.67 + (16.63 / 2) x 52 x 0.67 = 959 ft^3

Leg 2 Total Panel Volume: 4,492 + 959 = 5,451 ft^3

C. Leg 3 Panel Volume

Full Panels:

Number: = 78 full panels

Volume: 78 x 96 = 7,488 ft^3

Partial Panels:

Volume:([36.33 + 2.26] / 2) x 52 x 0.67 +
([29.74 + 3.02] / 2) x 52 x 0.67 +
(14.09 / 2) x 52 x 0.67 = 1,488 ft^3

Leg 3 Total Panel Volume: 7,488 + 1,488 = 8,976 ft^3

D. Leg 4 Panel Volume

Full Panels:

Number: = 78 full panels

Volume: 78 x 96 = 7,488 ft^3

Partial Panels:

Volume:([36.47 + 15.14] / 2) x 52 x 0.67 +
([36.50 + 9.78] / 2) x 52 x 0.67 +
(14.09 / 2) x 52 x 0.67 = 1,950 ft^3

Leg 4 Total Panel Volume: 7,488 + 1,950 = 9,438 ft^3

E. Leg 5 Panel Volume

Full Panels:

Number: = 78 full panels

Volume: 78 x 96 = 7,488 ft^3

Partial Panels:

Volume:([8.93 + 15.57] / 2) x 52 x 0.67 +
([36.5 + 15.17] / 2) x 52 x 0.67 = 1,327 ft^3

Leg 5 Total Panel Volume: 7,488 + 1,327 = 8,815 ft^3

F. Leg 6 Panel Volume

Full Panels:

Number: = 0 full panels

Volume: 0 x 96 = 0 ft^3

Partial Panels:

Volume:([36.5 + 29.86] / 2) x 52 x 0.67 +
12 x 18.67 x 0.67 = 1,306 ft^3

Leg 6 Total Panel Volume: 0 + 1306 = 1,306 ft^3

Cover Panel Volume Summary

A.	Leg 1 Total:		= 11,931 ft^3
B.	Leg 2 Total:		= 5,451 ft^3
C.	Leg 3 Total:		= 8,976 ft^3
D.	Leg 4 Total:		= 9,438 ft^3
E.	Leg 5 Total:		= 8,815 ft^3
F.	Leg 6 Total:		= 1,306 ft^3
		Total Cover Panel Volume	= 45,917 ft^3

III. Foundation Volume (see drawing H-1-44541 and H-1-44548)

Type A Foundations

Number:		=	80 foundations
Volume:	80 x 6.5 x 4 x 1	=	2,080 ft^3

Type B and C Foundations

Number:		=	2 foundations
Volume:	2 x 14 x 4 x 1.25	=	140 ft^3
	Total Foundation Volume: 2,080 + 140	=	2,220 ft^3

IV. Overflow Weir Wall Volume (see drawing H-1-44547)

Footer Volume:	4 x 1 x 38.5	=	154 ft^3
Wall Volume:	(0.67 x 3.77 x 38.5) - (10 x 2 x 0.67)	=	84 ft^3
	Total Overflow Weir Wall Volume	=	238 ft^3

V. Shotcrete Volume (see drawing H-1-44542)

Total Shotcrete Volume: (1,600 + 1,600 + 52) x 8 x 0.25 = 6,504 ft^3

VI. Miscellaneous Other Debris Volume (estimated from Figure 2-7)

Wooden Poles For Bird Netting

Spacing:	one pole every 20 ft		
Number:	(1600 / 20)	=	80 poles
Additional poles for the corners:		=	20 poles
Total number of poles:		=	100 poles

Assume: 100 poles
9 inch average diameter
40 ft average length

Total Pole Volume: $100 \times 40 \times \pi \times 0.38^2$ = 1,767 ft^3

116-N-1 Trench Demolition Volume Summary

I.	Beam Volume	= 8,690 ft^3
II.	Cover Panel Volume	= 45,917 ft^3
III.	Foundation Volume	= 2,220 ft^3
IV.	Overflow Weir Wall Volume	= 238 ft^3
V.	Shotcrete Volume	= 6,504 ft^3
VI.	Misc. Debris Volume	= 1,767 ft^3
Total 116-N-1 Trench Demolition Waste Volume		**= 65,336 ft^3**

116-N-3 Crib Demolition Waste Volume

1. Crib Cover Panel Volume (see drawing H-1-45094 sheets 1 and 2)

Number:	= 210 panels
Volume of a single panel: 0.67' x 4' x 35.17'	= 94 ft^3
Total Cover Panel Volume: 210 x 94	= 19,740 ft^3

II. Beam Volumes (see drawing H-1-45095 and H-1-45096)

Cross section area:		= 560 in^2 = 3.89 ft^2
Total beam lengths:	16 beams x 47.5'	= 760 ft
	24 beams x 47'	= 1,128 ft
	Total Length	= 1,888 ft
Total Beam Volume: 3.89 x 1,888		= 7,344 ft^3

III. Foundation Volumes (see drawing H-1-45095)

Type A & D Foundations		
Number:		= 16 foundations
Volume:	16 x ([1 x 5 x 6] + [0.75 x 2 x 5])	= 600 ft^3
Type B & C Foundations		
Number:		= 16 foundations
Volume:	16 x ([1 x 5 x 6] + [0.5 x 2 x 5])	= 560 ft^3
Type E Foundations		
Number:		= 4 foundations
Volume:	4 x 1.25 x 4 x 4	= 80 ft^3
Type F Foundations		
Number:		= 12 foundations
Volume:	12 x 1.25 x 4 x 4	= 240 ft^3
Total Foundation Volume: 600 + 560 + 80 + 240		= 1,480 ft^3

IV. Side Panel Volume (see drawing H-1-45092 and H-1-45094)

Number:	=	13 panels
Volume of each panel: 4 x 1 x 35.71	=	143 ft^3
Total Side Panel Volume: 13 x 143	=	1,859 ft^3

V. Effluent Distribution System Volume (see drawing H-1-45095 and H-1-45099)

A. Concrete Inlet Wall

Inlet Wall Volume: $(35.17 \times 4.5 \times 0.67) - (\pi \times 1.5^2)$	=	99 ft^3

B. Main Distribution Trough

Bottom: 0.5 x 8 x (240 - 17 + 3.5)	=	906 ft^3
Sides (2): 2 x 0.5 x 4 x (240 - 17 + 3.5)	=	906 ft^3
Ends (2): 2 x 0.5 x 7 x 4	=	28 ft^3
Total Volume of Main Dist. Trough	=	1,840 ft^3

C. Distribution Lateral Connectors

Number:	=	20 connectors
Bottom: 20 x 2.5 x 0.5 x 3	=	75 ft^3
Sides (2): 2 x 20 x 0.5 x 2.5 x 4	=	200 ft^3
End: 20 x 0.5 x 2 x 3	=	60 ft^3
Total Volume of Lateral Connectors	=	335 ft^3

D. Distribution Laterals

Number:	=	20 laterals
Bottom: 20 x 110.25 x 0.25 x 2.5	=	1,378 ft^3
Sides (2): 2 x 20 x 110.25 x 0.25 x 1	=	1,103 ft^3
End: 20 x 0.25 x 2 x 1	=	10 ft^3
Total Distribution Lateral Volume	=	2,491 ft^3

Effluent Distribution System Summary

A.	Inlet wall	=	99 ft^3
B.	Main Distribution Trough	=	1,840 ft^3
C.	Distribution Lateral Connectors	=	335 ft^3
D.	Distribution Laterals	=	2,491 ft^3
	Total Effluent Distribution System Volume	=	4,765 ft^3

116-N-3 Crib Demolition Volume Summary

I.	Cover Panel Volume	= 19,740 ft^3
II.	Beam Volume	= 7,344 ft^3
III.	Foundation Volume	= 1,480 ft^3
IV.	Side Panel Volume	= 1,859 ft^3
V.	Effluent Distribution System	= 4,765 ft^3
	Total 116-N-3 Crib Demolition Waste Volume	**= 35,188 ft^3**

116-N-3 Trench Demolition Waste Volume

I. Tie-In Structure (see drawing H-1-48896 and H-1-48897)

A. Level Section Volume

Total Length: 67.5 + 36.5 + 67.5	=	171.5 ft
Bottom: 0.5 x 171.5 x 8	=	686 ft^3
Top: 0.67 x 171.5 x 8	=	919 ft^3
Sides (2): 2 x 0.5 x 171.5 x 4.83	=	828 ft^3
Total Level Section Volume	=	2,433 ft^3

B. Inclined Section Volume

Total Length:	=	104 ft
Bottom: 0.67 x 104 x 8	=	557 ft^3
Top: 0.67 x 104 x 8	=	557 ft^3
Sides (2): 2 x 0.67 x 104 x (4.83 + 4.83 + 4.33)/2	=	975 ft^3
Total Inclined Section Volume	=	2,089 ft^3

C. Transition Section Volume

Bottom: 1.17 x ((39.31 + 9.09)/2) x 56	=	1,586 ft^3
Top: 0.67 x ((39.31 + 9.09)/2) x 56	=	908 ft^3
Side towards crib: 0.83 x 10 x 69.29	=	575 ft^3
Side towards trench: 0.83 x 10 x 56	=	465 ft^3
Total Transition Section Volume	=	3,534 ft^3

Tie-In Structure Volume Summary

A.	Level Section Volume:	=	2,433 ft^3
B.	Inclined Section Volume:	=	2,089 ft^3
C.	Transition Section Volume:	=	3,534 ft^3
	Total Tie-In Structure Volume	=	8,056 ft^3

II. Trench Cover Panels (see drawing H-1-48894 and H-1-48895 sheet 1 of 2)

Cross sectional area:	9.97 x 0.21 + (2 x [0.5 + 0.38]/2) x 1.79	=	3.66 ft^2
Length of each panel:		=	55 ft
Volume of each panel:	55 x 3.66	=	201 ft^3
Number of panels:		=	300 panels
Total Cover Panel Volume:	300 x 201	=	60,300 ft^3

III. Foundation Volume (see drawing H-1-48894 and H-1-48895 sheet 1 of 2)

Number:	=	2 foundations
Length of each foundation:	=	3,000 ft
Total Foundation Volume: 2 x 3000 x 1 x 2	=	12,000 ft^3

IV. Side Panel Volume (see drawing H-1-48894 and H-1-48895 sheet 1 of 2)

Number:	=	2 side panels
Length of each side panel:	=	3,000 ft
Total Side Panel Volume: 2 x 3000 x 0.67 x 2	=	8,040 ft^3

V. End Panel Volume (see drawing H-1-48894 and H-1-48895 sheet 1 of 2)

Number:	=	1 end panel
Length:	=	55 ft
Total End Panel Volume: 1 x 55 x 0.67 x 2	=	74 ft^3

116-N-3 Trench Demolition Waste Volume Summary

I.	Tie-In Structure Volume	= 8,056 ft^3
II.	Cover Panel Volume	= 60,300 ft^3
III.	Foundation Volume	= 12,000 ft^3
IV.	Side Panel Volume	= 8,040 ft^3
V.	End Panel Volume	= 74 ft^3
Total 116-N-3 Trench Demolition Waste Volume		**= 88,470 ft^3**

D3.0 PIPE VOLUMES

D3.1 PIPE VOLUME SUMMARY

The following assumptions were used to calculate a demolition waste volume and the associated soil volume for pipeline remediation:

- All pipe is steel.
- All pipe is contaminated.
- There were no leaks and all soils are clean.
- The average depth to the bottom of the pipe is 15 ft.
- Side slopes are 1.5 to 1.0.
- Bottom width is 5 ft.
- Total Clean Overburden Soil Volume is total excavation volume minus demolition waste volume.
- Demolition waste volume is equal to the pipe capacity, which is calculated with the following equation:

$$\pi r^2 L$$

π	=	pi (3.1415.....)
r	=	pipe radius (one half the diameter)
L	=	pipe length

Table D-14 presents the volumes associated with pipelines using the above assumptions.

Table D-14. 116-N-1 and 116-N-3 Pipeline Volumes.

Media	Volume	
	BCF	BCM
Contaminated Soils	0	0
Clean Overburden Soils	2,350,834	66,566
Demolition Waste	27,208	770

BCF=Bank Cubic Feet
BCM=Bank Cubic Meters

It should be noted that there were no volumes calculated for 120-N-1/120-N-2/100-N-58 because there are no contaminants of concern associated with them. However, Section D3.2 will present details about pipelines that will be encountered at these facilities during clean closure activities.

D3.2 PIPELINE DETAILS

Table D-15 summarizes the pipelines associated with 116-N-1 and 116-N-3. The drawing and sheet numbers used to determine the distances are also provided in the table. Figures 2-14 and 2-21 show the general location of these pipelines.

Table D-16 summarizes the pipelines associated with 120-N-1 and 120-N-2. The drawing and

sheet numbers used to determine the distances are also provided in the table. Figure 2-28 shows the general location of these pipelines.

Table D-15. Summary of Pipelines for 116-N-1 and 116-N-3.

Pipe Description/Location	Drawing H-1-45007 Sheet No.	Pipe Length					
		91 cm (36") Dia		61 cm (24") Dia		<30 cm (<12")	
		ft	m	ft	m	ft	m
116-N-1 LWDF							
1722-N to 1322-N feed line	37	155	47	0	0	155	47
	44	231	70	0	0	231	70
	51	235	72	0	0	235	72
	57	280	85	0	0	280	85
	58	303	92	0	0	303	92
	Subtotal	1,204	366	0	0	1,204	366
116-N-2 to 1322-N feed line	49	0	0	15	5	15	5
	50	0	0	83	25	83	25
	57	0	0	114	35	114	35
	Subtotal	0	0	212	65	212	65
1322-N to 116-N-1 weir box feed line	56	76	23	0	0	76	23
	57	174	53	0	0	174	53
	Subtotal	250	76	0	0	250	76
116-N-2 to 116-N-1 6" chemical waste line	50	0	0	0	0	12	4
	57	0	0	0	0	208	63
	Subtotal	0	0	0	0	220	67
1322-N to 116-N-1 3" drain	56	0	0	0	0	36	11
	57	0	0	0	0	129	39
	Subtotal	0	0	0	0	165	50
	116-N-1 Total	1,454	442	212	65	2,051	624
116-N-3 LWDF							
116-N-1 weir box to 116-N-3 crib feed line	55	343	105	0	0	0	0
	56	500	152	0	0	0	0
	59	400	122	0	0	0	0
	60	400	122	0	0	0	0
	61	430	131	0	0	0	0
	Subtotal	2,073	632	0	0	0	0
	116-N-3 Total	2,073	632	0	0	0	0
	Total Length of Piping	5,790 ft				1,763 m	

Table D-16. Summary of Pipelines for 120-N-1 and 120-N-2.

Pipe Description/Location	Drawing H-1-45007 Sheet No.	Pipe Length			
		30 cm (12") Dia		20 cm (8") Dia	
		ft	m	ft	m
120-N-2 to 120-N-1 overflow and underflow lines	7	60	18	0	0
	7	41	13	0	0
	Subtotal	101	31	0	0
163-N to 120-N-1/ 120-N-2 feed line	7	0	0	362	110
	8	0	0	86	26
	15	0	0	353	108
	16	0	0	70	21
	Subtotal	0	0	871	265
Pipe Diameter Subtotals		101	31	871	265
Total Length of Piping		972 ft		296 m	

APPENDIX E

COST ESTIMATES

CONTENTS

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ATTACHMENTS

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E1.0 COST ESTIMATES

E1.1 COST SUMMARY FOR 116-N-1, 116-N-3, AND UPR-100-N-31

Cost estimates were calculated for each of the 116-N-1, 116-N-3, and UPR-100-N-31 remedial alternatives discussed in Section 6.3. The cost estimates for removal and disposal of the concrete structures, high activity soil and low activity soil are taken from the engineering study (BHI 1997). The estimates for piping removal, capping and in situ vitrification (for the applicable scenarios) used the Micro Computer Aided Cost Estimating System (MCACES)™ remediation models. These models are run on the MCACES™ software (Release 5.30A) developed by Building Systems Design, Inc., for the U.S. Army Corp of Engineers.

The estimates are not intended to be all inclusive, but are expected to provide a rough order of magnitude estimate given the general assumptions used in the cost model. The accuracy of these estimates is expected to be within the normal range for feasibility study estimates of plus 50% to minus 30%.

Attachment E-1 to this appendix contains the MCACES™ summary report for pipeline removal applicable to all alternatives. In this model, costs are summarized into the following categories:

Code	Cost Category
01	Mobilization and Preparation Work
02	Monitoring, Sampling, and Analysis
08	Solids Collection and Containment
18	Disposal (Other than Commercial)
20	Site Restoration
21	Demobilization
70	Project/Construction Management and Support

The cost estimates are presented in Tables E-1 through E-5 for each of the 116-N-1, 116-N-3, and UPR-100-N-31 alternatives for both the rural-residential and modified CRCIA ranger/industrial exposure scenarios. Table E-1 is a summary of the cost estimates; Table E-2 presents the MCACES™ derived elements; and Tables E-3 through E-5 provide a further breakdown of the summary costs for 116-N-1, 116-N-3, and UPR-100-N-31 . The details of each of the individual estimates are not provided here but can be found in the project files. The model assumptions for MCACES™ are presented in Attachment E-2.

Table E-1. Cost Estimate Summary for 116-N-1 and 116-N-3.

Cost Category	Alternatives			
	Rural Residential	Modified CRCIA Ranger/Industrial		
	Removal RRES-6	Removal MCRIS-6	Capping MCRIS-7	Vitrification MCRIS-8
Remove Uncontaminated Concrete Panels & Beams	$522,418	$522,418	$522,418	$522,418
Remove High Dose Concrete	$114,309	$114,309	$0	$0
Remove Low Dose Concrete	$38,195	$38,195	$0	$0
Remove Low Dose Soil above Boulders, 116-N-1 Crib	$87,908	$70,515	$70,515	$70,515
Remove Boulders, 116-N-1 Crib	$5,327,964	$5,327,964	$5,327,964	$5,327,964
Remove High Dose Soil	$6,612,776	$6,612,776	$0	$0
Remove Low Dose Soil	$1,188,349	$1,024,710	$0	$0
Excavate Clean Overburden	$45,353	$47,450	$2,421	$2,421
Backfill	$1,037,209	$969,387	$508,015	$508,015
Site Restoration (Revegetation)	$36,350	$34,267	$5,337	$5,337
Support Functions	$1,476,475	$1,364,989	$408,241	$408,241
Mobilization /Demobilization	$545,808	$545,808	$537,698	$537,698
Subtotal	$17,033,114	$16,672,788	$7,382,609	$7,382,609
Engineering /Design (3%)	$510,993	$500,184	$221,478	$221,478
ERDF Disposal	$8,827,329	$7,955,904	$1,608,809	$1,608,809
ERC Support	$2,220,032	$2,047,582	$608,907	$608,907
Capping	$0	$0	$6,186,352	$0
In Situ Vitrification	$0	$0	$0	$47,341,730
Pipeline Removal	$1,967,804	$1,967,804	$1,967,804	$1,967,804
Subtotal	$30,559,272	$29,144,262	$17,975,959	$59,131,337
Direct Distributables (18.49%)	$5,650,409	$5,388,774	$3,323,755	$10,933,384
G & A (3.89%)	$1,408,557	$1,343,335	$828,559	$2,725,518
Contingency (0%)	$0	$0	$0	$0
Grand Total	$37,618,239	$35,876,371	$22,128,273	$72,790,239

MCRIS = Modified CRCIA Ranger/Industrial Scenario

Table E-2. Breakdown of MCACES™ Derived Cost Elements.

Project	Sub 01	Sub 02	Sub 08	Sub 18	Sub 20	Sub 21	Sub 70	Total
Removal for Rural-Residential (RRES-6)								
Pipelines	$85,555	$457,955	$662,304	$70,560	$367,521	$5,000	$318,909	$1,967,804
Removal for Modified CRCIA Ranger/Industrial (MCRIS-6)								
Pipelines	$85,555	$457,955	$662,304	$70,560	$367,521	$5,000	$318,909	$1,967,804
Capping for Modified CRCIA Ranger/Industrial (MCRIS-7)								
Cap	$306,620	$228,307	$4,730,407	$0	$203,892	$23,290	$693,836	$6,186,352
Pipelines	$85,555	$457,955	$662,304	$70,560	$367,521	$5,000	$318,909	$1,967,804
Vitrification forModified CRCIA Ranger/Industrial (MCRIS-8)								
Vitrify	$125,380	$3,101,420	$659,100	$36,480,210	$776,480	$24,130	$6,175,010	$47,341,730
Pipelines	$85,555	$457,955	$662,304	$70,560	$367,521	$5,000	$318,909	$1,967,804

Table E-3. Breakdown of RRES-6 Cost Estimate.

Item	Item Description	Equipment	Materials	Labor	S/C	Subtotal	Distrbs	Home Office	Profit	B&O Tax		Total
		$	$	$	$	Direct	25%	3.00%	5.00%	0.47%		Bid
												$
	Remove Panels & Beams	$ 33,230	$ 62,490	$ 239,382	$ 49,530	$ 384,632	$ 96,158	$ 14,424	$ 24,761	$ 2,444	$ -	$ 522,418
	Remove High Dose Concrete	$ 2,657	$ 78,180	$ 2,738	$ 585	$ 84,160	$ 21,040	$ 3,156	$ 5,418	$ 535	$ -	$ 114,309
	Remove LLW Concrete	$ 16,994	$ 534	$ 10,593	$ -	$ 28,121	$ 7,030	$ 1,055	$ 1,810	$ 179	$ -	$ 38,195
	Remove LLW soil above Boulders	$ 25,185	$ 16,602	$ 22,936	$ -	$ 64,723	$ 16,181	$ 2,427	$ 4,167	$ 411	$ -	$ 87,908
	Remove Boulders 1301 Crib	$ 53,069	$ 3,789,035	$ 71,265	$ 9,360	$ 3,922,729	$ 980,682	$ 147,102	$ 252,526	$ 24,924	$ -	$ 5,327,964
	High Dose Soil 1301 Crib & Trench	$ 18,001	$ 1,181,852	$ 23,101	$ 2,925	$ 1,225,880	$ 306,470	$ 45,970	$ 78,916	$ 7,789	$ -	$ 1,665,025
	High Dose Soil 1325 Crib & Trench	$ 58,929	$ 3,505,780	$ 71,508	$ 8,580	$ 3,642,797	$ 910,699	$ 136,605	$ 234,505	$ 23,146	$ -	$ 4,947,751
	Medium Dose Soil 1301 Crib & Trench	$ 176,165	$ 122,709	$ 159,755	$ 6,565	$ 465,194	$ 116,299	$ 17,445	$ 29,947	$ 2,956	$ -	$ 631,841
	Medium Dose Soil 1325 Crib & Trench	$ 155,756	$ 107,233	$ 140,956	$ 5,785	$ 409,730	$ 102,433	$ 15,365	$ 26,376	$ 2,603	$ -	$ 556,508
	Excavate Clean Overburden 1301	$ 14,310	$ -	$ 8,174	$ -	$ 22,484	$ 5,621	$ 843	$ 1,447	$ 143	$ -	$ 30,539
	Excavate Clean Overburden 1325	$ 6,941	$ -	$ 3,966	$ -	$ 10,907	$ 2,727	$ 409	$ 702	$ 69	$ -	$ 14,814
	Backfill	$ 407,740	$ -	$ 355,908	$ -	$ 763,648	$ 190,912	$ 28,637	$ 49,160	$ 4,852	$ -	$ 1,037,209
	Site Restoration (Reveg)	$ -	$ -	$ -	$ 36,350	$ 36,350	$ -	$ -	$ -	$ -	$ -	$ 36,350
	Support Functions	$ 16,520	$ 120,863	$ 949,676	$ -	$ 1,087,059	$ 271,765	$ 40,765	$ 69,979	$ 6,907	$ -	$ 1,476,475
	Mobilization/Demobilization	$ 32,841	$ 245,447	$ 4,565	$ 118,000	$ 401,852	$ 100,463	$ 15,069	$ 25,869	$ 2,553	$ -	$ 545,806
	Subtotals:	$ 1,016,338	$ 9,231,726	$ 2,064,524	$ 237,680	$ 12,550,267	$ 3,126,479	$ 469,272	$ 805,583	$ 79,511	$ -	$ 17,033,113
	Engineering/Design @ 3%											$ 510,993
	ERDF Disposal	$ 457,496	$ -	$ -	$ 8,369,833	$ 8,827,329						$ 8,827,329
	ERC Support	$ -	$ -	$ 1,720,032	$ 500,000	$ 2,220,032						$ 2,220,032
										Subtotal		$ 28,591,467
	Case 3: Containerized shipments of High dose materials to ERDF with blending of Medium dose materials for free dumping with modified operations at ERDF.								Direct Distrbs @ 18.49%			$ 5,286,562
	High dose materials (top 1 foot + shielding) containerized in B-25 boxes and shipped to ERDF											
	Medium dose soil (next 4 feet) blended at 1.2:1. Assume blended with 1 foot of shielding on top and 3.8 feet LLW material beneath the medium dose layer and shipped to ERDF.									Subtotal		$ 33,878,029
	Engineering/Design @ 3% by direction of the Project								G&A @ 3.89%			$ 1,317,855
										TOTAL:		$ 35,195,885

Table E-4. Breakdown of MCRIS-6 Cost Estimate.

Item	Item Description	Equipment $	Materials $	Labor $	S/C $	Subtotal Direct	Distribs 25%	Home Office 3.00%	Profit 5.00%	B&O Tax 0.47%		Total Bid $
	Remove Panels & Beams	$ 33,230	$ 62,490	$ 239,382	$ 49,530	$ 384,632	$ 96,158	$ 14,424	$ 24,761	$ 2,444	$ -	$ 522,418
	Remove High Dose Concrete	$ 2,657	$ 78,180	$ 2,738	$ 585	$ 84,160	$ 21,040	$ 3,156	$ 5,418	$ 535	$ -	$ 114,309
	Remove LLW Concrete	$ 16,994	$ 534	$ 10,593	$ -	$ 28,121	$ 7,030	$ 1,055	$ 1,810	$ 179	$ -	$ 38,195
	Remove LLW soil above Boulders	$ 20,208	$ 13,318	$ 18,391	$ -	$ 51,917	$ 12,979	$ 1,947	$ 3,342	$ 330	$ -	$ 70,515
	Remove Boulders 1301 Crib	$ 53,069	$ 3,789,035	$ 71,265	$ 9,360	$ 3,922,729	$ 980,682	$ 147,102	$ 252,526	$ 24,924	$ -	$ 5,327,964
	High Dose Soil 1301 Crib & Trench	$ 18,001	$ 1,181,852	$ 23,101	$ 2,925	$ 1,225,880	$ 306,470	$ 45,970	$ 78,916	$ 7,789	$ -	$ 1,665,025
	High Dose Soil 1325 Crib & Trench	$ 56,929	$ 3,505,780	$ 71,508	$ 8,580	$ 3,642,797	$ 910,699	$ 136,605	$ 234,505	$ 23,146	$ -	$ 4,947,751
	Medium Dose Soil 1301 Crib & Trench	$ 130,154	$ 91,411	$ 118,210	$ 4,940	$ 344,715	$ 86,179	$ 12,927	$ 22,191	$ 2,190	$ -	$ 468,202
	Medium Dose Soil 1325 Crib & Trench	$ 155,756	$ 107,233	$ 140,956	$ 5,785	$ 409,730	$ 102,433	$ 15,365	$ 26,376	$ 2,603	$ -	$ 556,508
	Excavate Clean Overburden 1301	$ 15,291	$ -	$ 8,737	$ -	$ 24,028	$ 6,007	$ 901	$ 1,547	$ 153	$ -	$ 32,636
	Excavate Clean Overburden 1325	$ 6,941	$ -	$ 3,966	$ -	$ 10,907	$ 2,727	$ 409	$ 702	$ 69	$ -	$ 14,814
	Backfill to Grade	$ 381,239	$ -	$ 332,475	$ -	$ 713,714	$ 178,429	$ 26,764	$ 45,945	$ 4,535	$ -	$ 969,387
	Site Restoration (reveg)	$ -	$ -	$ -	$ 34,267	$ 34,267	$ -	$ -	$ -	$ -	$ -	$ 34,267
	Support Functions	$ 15,286	$ 111,475	$ 878,217	$ -	$ 1,004,977	$ 251,244	$ 37,687	$ 64,695	$ 6,385	$ -	$ 1,364,989
	Mobilization/Demobilization	$ 32,641	$ 246,447	$ 4,565	$ 118,000	$ 401,652	$ 100,463	$ 15,069	$ 25,869	$ 2,553	$ -	$ 545,808
	Subtotals:	$ 938,595	$ 9,187,756	$ 1,924,104	$ 233,972	$ 12,284,427	$ 3,062,548	$ 459,381	$ 788,604	$ 77,835	$ -	$ 16,672,787
	Engineering/Design @ 3%											$ 500,184
	ERDF Disposal	$ 457,496	$ -	$ -	$ 7,498,408	$ 7,955,904						$ 7,955,904
	ERC Support	$ -	$ -	$ 1,589,842	$ 457,740	$ 2,047,582						$ 2,047,582
										Subtotal		$ 27,176,457
	Case 3: Containerized shipments of High dose materials to ERDF with blending of Medium dose materials for free dumping with modified operations at ERDF.								Direct Distribs @ 18.49%			$ 5,024,927
	High dose materials (top 1 foot + shielding) containerized in B-25 boxes and shipped to ERDF											
	Medium dose soil (next 4 feet) blended at 1 2:1 Assume blended with 1 foot of shielding on top and 3.8 feet LLW material beneath the medium dose layer and shipped to ERDF.									Subtotal		$ 32,201,384
	Medium Dose soil beneath boulders (1301 Crib) is left in place.								G&A @ 3.89%			$ 1,252,634
	Engineering/Design at 3% by project direction											
	Site Restoration (Reveg) include Subcontractor markups from MCACES Model for RREC-7 & 8									TOTAL		$ 33,454,018

Table E-5. Breakdown of MCRIS-7 and MCRIS-8 Cost Estimates.

Item	Item Description	Equipment $	Materials $	Labor $	S/C $	Subtotal Direct	Distribs 25%	Home Office 3.00%	Profit 5.00%	B&O Tax 0.47%		Total Bid $
	Remove Panels & Beams	$ 33,230	$ 62,490	$ 239,362	$ 49,530	$ 384,632	$ 96,158	$ 14,424	$ 24,761	$ 2,444	$ -	$ 522,418
	Remove LLW soil above Boulders	$ 20,208	$ 13,318	$ 18,391	$ -	$ 51,917	$ 12,979	$ 1,947	$ 3,342	$ 330	$ -	$ 70,515
	Remove Boulders 1301 Crib	$ 53,069	$ 3,789,035	$ 71,265	$ 9,360	$ 3,922,729	$ 980,682	$ 147,102	$ 252,526	$ 24,924	$ -	$ 5,327,964
	Excavate Clean Overburden 1301	$ 1,135	$ -	$ 648	$ -	$ 1,783	$ 446	$ 67	$ 115	$ 11	$ -	$ 2,421
	Backfill Sites to Grade	$ 199,043	$ -	$ 174,985	$ -	$ 374,028	$ 93,507	$ 14,026	$ 24,078	$ 2,377	$ -	$ 508,015
	Site Restoration (Reveg)	$ -	$ -	$ -	$ 5,337	$ 5,337	$ -	$ -	$ -	$ -	$ -	$ 5,337
	Support Functions	$ 5,610	$ 33,858	$ 261,100	$ -	$ 300,568	$ 75,142	$ 11,271	$ 19,349	$ 1,910	$ -	$ 408,241
	Mobilization/Demobilization	$ 26,870	$ 246,447	$ 4,565	$ 118,000	$ 395,881	$ 98,970	$ 14,846	$ 25,485	$ 2,515	$ -	$ 537,698
	Subtotals:	$ 339,164	$ 4,145,149	$ 770,335	$ 182,227	$ 5,436,875	$ 1,357,884	$ 203,683	$ 349,655	$ 34,511	$ -	$ 7,382,608
	Engineering/Design @ 3%											$ 221,478
	ERDF Disposal	$ 216,002	$ -	$ -	$ 1,392,806	$ 1,608,809						$ 1,608,809
	ERC Support	$ -	$ -	$ 551,171	$ 57,736	$ 608,907						$ 608,907
	1301 Crib:									Subtotal		$ 9,821,802
	Containerized shipments of High dose materials to ERDF with blending of Medium dose materials for free dumping with modified operations at ERDF.								Direct Distribs @ 18.49%			$ 1,816,051
	Boulders plus High dose layer plus 2 feet of shielding containerized in B-25 boxes and shipped to ERDF									Subtotal		$ 11,637,853
	Medium dose soil (next 4 feet) blended at 1.2:1. Assume blended with 1 foot of shielding on top and 3.8 feet LLW material beneath the medium dose layer and shipped to ERDF.								G&A @ 3.89%			$ 452,712
	Engineering/Design at 3% by Project direction									TOTAL:		$ 12,090,566
	Entire Site: Backfilled to Grade											

E1.2 AREA AND VOLUME SUMMARY FOR 116-N-1, 116-N-3, AND UPR-100-N-31

Table E-6 presents a summary of the volumes from Appendix D that are used for each remedial alternative cost estimate. Volumes for pipelines are presented in Appendix D.

MCACES™ cost models were used for capping and in situ vitrification. The input parameters for these cost models are shown Table E-7.

E1.3 COST FOR 120-N-1 AND 120-N-2

The cost to clean close 120-N-1/120-N-2 (1324-N/NA) and 100-N-58 has been estimated as $424,154. These costs include design, the removal of liner and leak detection system, the removal of sampling shed and perimeter fence, backfilling, grading, revegetating, and monitoring. An additional $28,000 will be needed to remove the associated piping, if required.

Table E-6. Volume Summary for Cost Estimates.

Facility	High Activity Contaminated Soils Volume[a]	Low Activity Contaminated Soils Volume[a]	Clean Overburden Volume[a]	Demolition Waste[b]	Pipelines[c]
	bcf[d]	bcf	bcf	bcf	ft
Removal (RRES-6)					
116-N-1 Crib[e]	36,250	507,500	124,031	2,364	
116-N-1 Trench	45,149	423,434	539,096	65,336	
116-N-3 Crib	60,000	240,000	50,414	35,188	
116-N-3 Trench	33,833	256,793	211,984	88,470	
UPR-100-N-31	0	70,875	0	0	
Total	175,232	1,498,602	925,525	191,358	5,790
Removal (MCRIS-6)					
116-N-1 Crib[e]	36,250	326,250	54,375	2,364	
116-N-1 Trench	45,149	423,434	539,096	65,336	
116-N-3 Crib	60,000	240,000	50,414	35,188	
116-N-3 Trench	33,833	256,793	211,984	88,470	
UPR-100-N-31	0	36,750	0	0	
Total	175,232	1,283,227	855,869	191,358	5,790
Capping (MCRIS-7)					
116-N-1 Crib[e]	36,250	326,250	54,375	2,364	
116-N-1 Trench	0	0	0	65,336	
116-N-3 Crib	0	0	0	35,188	
116-N-3 Trench	0	0	0	88,470	
UPR-100-N-31	0	36,750	0	0	
Total	36,250	363,000	54,375	191,358	5,790
In Situ Vitrification (MCRIS-8)					
116-N-1 Crib[e]	36,250	326,250	54,375	2,364	
116-N-1 Trench	0	0	0	65,336	
116-N-3 Crib	0	0	0	35,188	
116-N-3 Trench	0	0	0	88,470	
UPR-100-N-31	0	36,750	0	0	
Total	36,250	363,000	54,375	191,358	5,790

[a]Volumes from Appendix D, Table D-1.

[b]Volumes from Appendix D, Table D-13.

[c]Volumes associated with pipelines are presented in Appendix D and are identical for all alternatives.

[d]bcf = Bank Cubic Feet

[e]Volumes of low dose contaminated soil includes 145,000 BCF of boulders.

MCRIS = Modified CRCIA Ranger/Industrial Scenario

Table E-7. Input Parameters for MCACES™ Capping and In Situ Vitrification Models.

Unit	MCRIS-7	MCRIS-8	
	Cap Area (ft^2)	Vitrif. Area (ft^2)	Vitrif. Depth, (ft bgs)
116-N-1 crib	0	0	0
116-N-1 trench	168,000	40,000	19
116-N-3 crib	105,600	60,000	19
116-N-3 trench	93,600	29,600	19
UPR-100-N-31	0	0	0
Total	367,200	129,600	19

bgs = below ground surface
MCRIS = Modified CRCIA Ranger/Industrial Scenario

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ATTACHMENT E-1

MCACES™ SUMMARY REPORT FOR PIPELINE REMOVAL

HANFORD: ER PROGRAM
CORRECTIVE MEASURES STUDY
RESIDENTIAL SCENARIO
TRENCH MODEL - Large
TSD CMS 100-N/ RRES-6

Designed By: BHI- FY96 Baseline Model Update
Estimated By: BHI - Estimating Group

Prepared By: BHI Estimating
01/13/96 -- Final Update

Preparation Date: 01/10/97
Effective Date of Pricing: 09/01/95

Sales Tax: 7.90%

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Release 5.30A

Wed 22 Jan 1997
Eff. Date 09/01/95
DETAILED ESTIMATE

U.S. Army Corps of Engineers
PROJECT RRES-6: HANFORD: ER PROGRAM - CORRECTIVE MEASURES STUDY
Estimate Quantities
XXX. Estimate Quantities

TIME 10:27:14
DETAIL PAGE 1

XXX.XX. Input Quantities

XXX. Estimate Quantities
XXX.XX. Input Quantities

			QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
USR	<	> Non-Contaminated Soil	1126616	BCF		0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Contaminated Soil	2391656	BCF		0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Top Excavation Length	3121.50	LF		0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Top Excavation Width	122.60	LF		0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Bottom Area	167875	SF		0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Hauling Distance for Borrow	1.00	MI		0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Hauling Distance for Contam Soil (Cost Included w/ ERDF ADS)	12.00	MI		0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Transition Zone Soil Percentage	40.00	%		0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Groundwater Protection Samples	21.00	EA		0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Depth of Excavation	19.00	LF		0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
		TOTAL Input Quantities				0	0	0	0	0	

Wed 22 Jan 1997
Eff. Date 09/01/95
DETAILED ESTIMATE

PROJECT RRES-6: U.S. Army Corps of Engineers
HANFORD: ER PROGRAM - CORRECTIVE MEASURES STUDY
Estimate Quantities
XXX. Estimate Quantities

TIME 10:27:14
DETAIL PAGE 2

XXX.YY. Additional Quantities			QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
XXX.YY. Additional Quantities									
USR	<	> Non-Contaminated Soil - Reduced	7238.00 LCY	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Contaminated Soil	101867 LCY	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Site Area	580942 SF	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Volume of Transition Zone Soil	40747 LCY	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Total Project Duration	706.00 DAY	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Total Excavation Duration	543.00 DAY	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Days to Irrigate Site (1 Crew)	0.83 DAY	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Low Level Waste (LLW) Volume	101867 LCY	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Bottom Area Closure Sample Qty.	156.00 EA	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Duration of In-Situ Monitoring	4338.00 HR	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Regular LLW Samples - Mobile Lab	509.00 EA	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> QC Sample Quantity and Analysis	46.00 EA	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Non-Contaminated Sample Quantity	240.00 EA	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Site Perimeter	6728.20 LF	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Spread/Compact Soil Quantity	144759 LCY	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
USR	<	> Total On-Site Samples	908.00 EA	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00

Wed 22 Jan 1997
Eff. Date 09/01/95
DETAILED ESTIMATE

PROJECT RRES-6:

U.S. Army Corps of Engineers
HANFORD: ER PROGRAM - CORRECTIVE MEASURES STUDY
Estimate Quantities
XXX. Estimate Quantities

TIME 10:27:14
DETAIL PAGE 3

XXX.YY. Additional Quantities	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
USR < > Total Off-Site Samples	46.00 EA	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00
TOTAL Additional Quantities		0	0	0	0	0	
TOTAL Estimate Quantities		0	0	0	0	0	

Wed 22 Jan 1997
Eff. Date 09/01/95

U.S. Army Corps of Engineers
PROJECT RRES-6: HANFORD: ER PROGRAM - CORRECTIVE MEASURES STUDY
100-N TSD CMS/ NEW RESIDENTIAL SCENARIO/ RRES-6
** PROJECT INDIRECT SUMMARY - FEATURE (Rounded to 10's) **

TIME 10:28:44
SUMMARY PAGE 1

	QUANTITY UOM	TOTAL DIRECT	FIELD OH	HOME OH	PROFIT	BOND	B&O TAX	TOTAL COST	UNIT COST
01 Mobilization & Prep Work		153,940	15,390	4,620	10,780	2,130	3,920	190,780	
02 Monitoring, Sampling, & Analysis		1,367,430	31,660	9,500	22,160	4,380	8,070	1,443,200	
08 Solids Collection & Containment		2,378,970	71,430	21,430	50,000	9,890	18,210	2,549,930	
18 Disposal (Other than Commercial)		3,565,350	0	0	0	0	0	3,565,350	
20 Site Restoration		710,140	71,010	21,300	49,710	9,830	18,100	880,110	
21 Demobilization		5,000	0	0	0	0	0	5,000	
70 Project/Construction Mgmt & Supt		1,585,520	0	0	0	0	0	1,585,520	
XXX Estimate Quantities									
TOTAL HANFORD: ER PROGRAM		9,766,340	189,500	56,850	132,650	26,240	48,300	10,219,880	
DIR DISTR	9.15 %							935,630	
SUBTOTAL								11,155,510	
G & A	3.63 %							405,310	
SUBTOTAL								11,560,820	
CONTINGN	23.51 %							2,718,460	
TOTAL INCL OWNER COSTS								14,279,280	

ATTACHMENT E-2

MODEL ASSUMPTIONS FOR MCACES™

Appendix E - Attachment E-2
MCACES™ Model Assumptions Page 1 of 9

RD/RA Baseline Cost Estimates
Notes, Qualifications & Assumptions
BL94 vs. BL95 Comparison
March 1995

EXHIBIT 6

MODEL ASSUMPTIONS

1.0 GENERAL

1.1 BACKGROUND

In June 1993, RL tasked the U.S. Army Corps of Engineers, Walla Walla District with the preparation of pre-conceptual baseline estimates for RD/RA for a number of solid waste management units (SWMU's) at the Hanford Site. The purpose of the effort was to assist the Richland ER Project in baseline planning for FY94 through FY2000. The FY95 Baseline effort by BHI represents a continued refinement of the Remedial Action Estimating system developed and/or updated at the beginning of FY94. Note that the estimates were and still are considered Preconceptual because Remedial Design work has not begun.

1.2 METHODOLOGY

Ten (10) estimating models were created by the USACE using MCACES™ Gold for the FY94 Baseline. The models were based on the type of site and the remediation approach. The models reflect how work actually is performed at the Hanford Site in terms of division of work scope onsite and offsite contractors, labor rates, and contractor markups. Six (6) models were revised and used for the BL95. (See 2.11 for model list).

The MCACES™ models are used to create base cost estimates for each waste site or group of waste sites requiring remediation. Subproject estimates are then created using EXCEL Spreadsheets to roll up the MCACES™ site remedial action estimates by operable unit and subproject.

1.3 OPERABLE UNIT AND WASTE SITE SUMMARY

The following table summarizes the total number of waste sites in the BL95.

Appendix E - Attachment E-2
MCACES™ Model Assumptions Page 2 of 9

RD/RA Baseline Cost Estimates
Notes, Qualifications & Assumptions
BL94 vs. BL95 Comparison
March 1995

	WBS	OPERABLE UNIT	NO. OF FACILITIES
100 AREA			
	1.4.10.1.1.5.1.	100-BC-1	43
	1.4.10.1.1.5.2.	100-BC-2	22
	1.4.10.1.1.4.1.	100-DR-1	30
	1.4.10.1.1.4.2.	100-DR-2	18
	1.4.10.1.1.7.1.	100-FR-1	42
	1.4.10.1.1.7.2.	100-FR-2	16
	1.4.10.1.1.8.1.	100-HR-1	13
	1.4.10.1.1.8.2	100-HR-2	14
	1.4.10.1.1.8.2	100-IU-2	6
	1.4.10.1.1.8.6.	100-IU-6	14
	1.4.10.1.1.6.1.	100-KR-1	5
	1.4.10.1.1.6.2	100-KR-2	51
	1.4.10.1.1.9.1.	100-NR-1	66
	100 AREA TOTAL		340
200 AREA			
	1.4.10.1.1.10.1.	200-BP-1	14
	1.4.10.1.1.10.2.	200-BP-2	27
	1.4.10.1.1.10.3.	200-BP-3	8
	1.4.10.1.1.10.4.	200-BP-4	5
	1.4.10.1.1.10.6.	200-BP-6	41
	1.4.10.1.1.10.8.	200-BP-8	6
	1.4.10.1.1.10.9.	200-BP-9	8
	1.4.10.1.1.10.10.	200-BP-10	9
	1.4.10.1.1.1.10.11.	200-BP-11	13
	1.4.10.1.1.11.1.	200-NO-1	16
	1.4.10.1.1.12.2.	200-PO-2	62
	1.4.10.1.1.12.4.	200-PO-4	5
	1.4.10.1.1.12.5.	200-PO-5	22
	1.4.10.1.1.12.6.	200-PO-6	4
	1.4.10.1.1.13.1.	200-RO-1	16
	1.4.10.1.1.13.2.	200-RO-2	32
	1.4.10.1.1.13.3.	200-RO-3	17
	1.4.10.1.1.14.1.	200-SO-1	27

Appendix E - Attachment E-2
MCACES™ Model Assumptions Page 3 of 9

RD/RA Baseline Cost Estimates
Notes, Qualifications & Assumptions
BL94 vs. BL95 Comparison
March 1995

	WBS	OPERABLE UNIT	NO. OF FACILITIES
	1.4.10.1.1.15.1.	200-TP-1	9
	1.4.10.1.1.15.2.	200-TP-2	19
	1.4.10.1.1.15.3.	200-TP-3	14
	1.4.10.1.1.15.4.	200-TP-4	31
	1.4.10.1.1.16.2	200-UP-2	58
	1.4.10.1.1.17.2	200-ZP-2	34
	1.4.10.1.1.18.1	200-IU-1	6
	1.4.10.1.1.18.2.	200-IU-2	5
	1.4.10.1.1.18.3.	200-IU-3	7
	1.4.10.1.1.18.5	200-IU-5	10
	1.4.10.1.1.18.6.	200-IU6	3
	1.4.10.1.1.19.1.	200-SS-1	16
	1.4.10.1.1.19.2	200-SS-2	8
	200 AREA TOTAL:		552
300 AREA			
	1.4.10.1.1.22.1	300-FF-1	15
	1.4.10.1.1.22.2	300-FF-2	84
	300 AREA TOTAL		99

Not all of these waste sites were estimated using MCACES™ in the BL95 for the following reasons:

1. Not all of the waste sites within the 100-BC and 100-DR subprojects required cleanup actions (excavation and removal) as determined by the FFSs. MCACES™ estimates were only created for those waste sites requiring cleanup action.

2. Based upon the remedial investigation and recommended cleanup actions for both 100-BC and 100-DR, the 100-FR and 100-KR subprojects were estimated on a prorated basis to 100-DR. As FFS information becomes available for these subprojects, individual waste site estimates will be created using MCACES™.

3. The capping of sites in the 100 Area was estimated using spreadsheets in conjunction with a modeling program named RACER (Remedial Actions Cost Engineering and Requirements System, program version 2.0).

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MCACES™ Model Assumptions Page 4 of 9

RD/RA Baseline Cost Estimates
Notes, Qualifications & Assumptions
BL94 vs. BL95 Comparison
March 1995

2.0 COST ESTIMATE DEVELOPMENT

2.1 COST ESTIMATE BREAKDOWN STRUCTURE

MCACES™ Gold allows up to six levels of titling hierarchy to organize cost estimate details. The cost estimate breakdown structure was developed from the U.S. Army Corps of Engineers HTRW WBS and modified for remediation work at Hanford. The following is an example of the breakdown structure used:

Level 0:	*1.4.10.1.1.5.1.2.4 100-BC-1 Trench 116-B-1*
Level 1:	*08. - Solids Collection & Containment*
Level 2:	*08.01 - Excavation*
Level 3:	*08.01.03 - Excavate Contaminated Soil*
Level 4:	*08/01/03/01 - Excavate/Load Contaminated Soil*
Level 5:	*Cost Details*
Level 6:	*not used and available*

2.2 CONTRACTOR MARKUPS

Contractor markups were included in the ERC all-in labor rates used to price each waste site (crib, trench, french drain, and etc.). These markups, applied to labor only, and did not recover indirect costs related to nonlabor such as material and equipment costs. An additional 10% markup adjustment was applied to contractor labor costs to estimate labor related contractor overhead and profit. A 40% markup (adjustment) was applied to the remaining contractor non labor costs (other direct costs), to estimate the remaining contractor overhead and profit (10%), and the remaining ERC distributable costs (30%). Fifteen percent was added to the final direct cost estimate for Construction Management and Project Management during remediation.

2.3 SALES TAX

A 7.8% Washington State sales tax was applied to all materials.

2.4 CONTINGENCY

A contingency analysis was performed for each model type in the BL94 update. This analysis takes a number of risk factors for each major activity and applies a relative weight and a probability range for each risk factor. Subsequent score ratios for each activity are multiplied by

an anticipated "normal maximum contingency." Sixty percent was the assumed normal maximum contingency for the planning stage of remediation design.

Based upon the FY94 analysis, an overall composite rate of 34% was applied to all RAs activities. This rate was applied to the BL95 estimates.

2.5 PRICE LEVEL

The pricing level used for the BL95 baseline update are in the MCACES™ database as listed:

Labor - ERC All-in Labor Rate "BHIFY95LR - Hanford All-In Labor Rates"
Material - "BHI_93EE, Eq Rates EP-1110-1-8, Aug. 1993"

2.7 ESCALATION

Escalation based on guidelines is applied at the subproject level after tasks are scheduled. Escalation is not applied in the MCACES™ models.

2.8 LABOR RATES

An All-in Labor Rate database was created for applicable classifications to be used on the Hanford ERC Project. The rates reflect the 5-year planning rates for FY95. The database includes the correct labor categories and organizational codes, reflecting BHI's direct distributable and general indirect cost.

2.9 EQUIPMENT

Equipment pricing data is based on an extract from the latest USACE equipment price book (EP 1110-8, Aug. 93) which is the basis for the MCACES™ Version 5.30 equipment rate database. The rates are equivalent to an ownership rate, and include depreciation, maintenance, fuel, and repairs. These rates were judged adequate for present day costs.

2.10 CREWS

A specific MCACES™ crew database was not used in the BL95 revision, as the labor & equipment line items were already in the models. These were updated as applicable.

Appendix E - Attachment E-2
MCACES™ Model Assumptions Page 6 of 9

RD/RA Baseline Cost Estimates
Notes, Qualifications & Assumptions
BL94 vs. BL95 Comparison
March 1995

2.11 LIST OF MODELS

The following estimating models were developed based on type of waste site and remediation approach:

1. burial ground
2. french drain
3. trench
4. septic tank
5. belowground structure
6. reactor area piping

In the BL95 update, six of the MCACES™ models were updated and used.

2.12 SUMMARY OF MODEL PARAMETERS

Major cost drivers or "parameters" form the basis for each model. They are as follows:

A. For the 100 & 300 AREA EXCAVATION MODELS:

1. Length, width, and depth of waste site in linear feet (lf)
2. Noncontaminated, contaminated, and demolition waste in bank cubic feet (bcf)

B. For the 200 AREA IN-SITU CONTAINMENT MODEL:

1. Site area or combined area in square feet, (square feet) sf

3.0 NOTES AND ASSUMPTIONS

3.1 100 & 300 AREA EXCAVATION MODELS

1. Baseline technology is excavation, stock piling or hauling to the ERDF.

2. Sampling, real-time monitoring of the excavation as it proceeds, backfill, and site restoration.

3. All contaminated material was assumed to be low level waste.

Appendix E - Attachment E-2
MCACES™ Model Assumptions Page 7 of 9

RD/RA Baseline Cost Estimates
Notes, Qualifications & Assumptions
BL94 vs. BL95 Comparison
March 1995

4. Samples were taken every 400 square feet for each excavation lift, and every 100 square feet at the bottom of the excavation for site clearance.

5. Ninety percent of all samples will be analyzed onsite; 10% of samples, the QA/QC samples, will be analyzed offsite.

6. Material will be loaded into 20 cubic yard (cy) containers. Containers will be filled to 17cy due to load restrictions on the total combined weight of the tractor, trailer, and filled container on the highways (40 tons).

7. A unit rate for the total cost of shipping contaminated media to the ERDF was estimated using an MCACES™ model. A shipping unit rate cost per yard was calculated and given to the ERDF Subproject for inclusion there, and shipping costs were backed out of the individual waste site estimates.

8. No burial ground disposal fees are included in the estimates or planned by ERDF.

9. For work to be performed by a fixed price contractor, appropriate markups were added via subproject spreadsheets after MCACES ™had been run. These markups will be included in the MCACES™ models for the FY96 baseline update.

10. Estimates include a QA/Safety and Health Physics (HP) oversight by the ERC team.

11. Key ER Program planning quantities are included under a title level within each estimate.

12. Excavation quantities were provided by the ERC project teams. Estimates include mobilization and setup for each waste site; demobilization is not included.

3.2 **200 AREA - MCACES™** barrier models were not used for the BL95 update. Detailed spreadsheet estimates were created for each operable unit in the 200 Area. Plans include update of the MCACES Barrier Models for the FY96 baseline update.

MCACES™ MODEL DETAILS

The MCACES™ models for excavation take 11 input quantities and calculate 27 additional quantities which are used to price all resources required to mobilize, sample, excavate, and restore each waste site. These estimates are grouped on spreadsheets into operable units for each subproject, and contingencies and other costs are applied (subproject road upgrades and instrumentation acquisition). Depending on schedule parameters, escalation rates are applied. MCACES™ models produce total base cost, and if requested, total base cost plus contingency.

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MCACES™ Model Assumptions Page 8 of 9

RD/RA Baseline Cost Estimates
Notes, Qualifications & Assumptions
BL94 vs. BL95 Comparison
March 1995

In the FY96 baseline update, MCACES™ will estimate all costs but escalation which depends on scheduling.

The basic input parameters include the following:

1. Noncontaminated Soil Volume in bcf

2. Contaminated Soil in bcf

3. Demolition Waste in bcf

4. Top Excavation Length in lf

5. Top Excavation Width in lf

6. Bottom Area in sf

7. Number of Groundwater Protection Samples (Small sites <10,000 sf - 3 ea.; Medium sites 10,000 >100,000 st - 21 ea.; and Large sites >100,000 - 60 ea.)

8. Transition Zone Soil percentage

9. Hauling distance for Borrow in miles

10. Hauling distance for demolition waste in miles

11. Hauling distance for contaminated soil in miles

Input parameters 9, 10, & 11 were added into models to calculate the unit cost per yard to haul waste to the ERDF, and to replace the waste volume with borrow. Once the unit rates were calculated, these parameters were taken out of the excavation models to avoid duplication. These costs for hauling to ERDF were included in the ERDF Subproject, and the cost for borrow was added to each waste site on a summary spreadsheet. The FY96 baseline update will include borrow cost in the waste site excavation models.

The models also include fixed values which are used to calculate and/or convert additional quantities, and to calculate unique resource requirements (labor and equipment types and hours for each waste site) based upon unique input values. These fixed values are as follows:

1. Soil swell factor - 115%
2. Demolition waste swell factor - 160%

Appendix E - Attachment E-2
MCACES™ Model Assumptions Page 9 of 9

RD/RA Baseline Cost Estimates
Notes, Qualifications & Assumptions
BL94 vs. BL95 Comparison
March 1995

3. Non contaminated soil excavation rate - 1,800 yards/day
4. Transition soil excavation rate - 480 yards/day
5. Contaminated soil excavation rate - 1,200 yards/day
6. Demolition waste excavation rate - 96 yards/day
7. Standard conversion factors - e.g., 27 cuft/yard, 3 ft/yard, etc.
8. Sample analysis cost for on-site mobile lab - $400.00/Sample
9. Sample analysis cost for off-site laboratory - $4,210.00/Sample

With these inputs, MCACES™ determines how much of each resource is needed for each step in the model. These resource quantities are then priced according to the rate tables provided with MCACES™. The subcontractor markups on the labor and material, and the Owner markups were applied to the waste site MCACES™ costs on a spreadsheet to produce a total base cost estimate for individual waste site remedial actions. These markups will be calculated in MCACES™ for the FY96 baseline update. The MCACES™ models will estimate all costs with the exception of escalation for the FY96 baseline.

APPENDIX F

RESIDUAL RADIOACTIVITY MODEL INPUT PARAMETERS

CONTENTS

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F2.0 MODIFIED CRCIA RANGER/INDUSTRIAL SCENARIO F-16
F2.1 COMPARISON OF THE MODIFIED CRCIA RANGER/INDUSTRIAL SCENARIO TO THE CRCIA RANGER SCENARIO F-16
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ABBREVIATIONS AND ACRONYMS

CFR	*Code of Federal Regulations*
CMS	Corrective Measures Study
COPC	contaminant of potential concern
CRCIA	Columbia River Comprehensive Impact Assessment
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
MCL	maximum contaminant level
MTCA	*Model Toxics Control Act*
NRC	U.S. Nuclear Regulatory Commission
OU	operable unit
PRG	preliminary remediation goal
RAWP	Remedial Action Work Plan
RDR	Remedial Design Report
RESRAD	RESidual RADioactivity
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
Sr-90	strontium-90
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*

F1.0 DOSE ASSESSMENT MODELING

The RESidual RADioactivity (RESRAD) model has been used as the dose assessment model for generating preliminary remediation goals (PRG) for radionuclide contaminants in soil in the 100 Area of the Hanford Site. The U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology), and the U.S. Department of Energy (DOE), Richland Operations Office (RL) agreed to use RESRAD in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), (DOE-RL, 1996a) to calculate concentrations of individual radionuclides in soil that correspond to guidelines for dose rate due to external exposure. These guidelines also protect the groundwater and the Columbia River. The RESRAD model was developed by Argonne National Laboratory (ANL 1993) to implement DOE guidelines for residual radioactive material in soil. The model was evaluated by the EPA for use in performing dose assessments to support the U.S. Nuclear Regulatory Commission (NRC) and EPA proposed radionuclide soil cleanup standard of 15 mrem/yr above background (40 *Code of Federal Regulations* [CFR] Part 196) (EPA 1994).

In order to use the RESRAD model, appropriate input parameters must be available. Although default values are provided by the model, site-specific input parameters should be obtained for representative results. The site-specific and default input parameters used in this evaluation are presented in Table F1-1.

F1.1 DIRECT EXPOSURE

The RESRAD model was used to calculate concentrations of individual radionuclide contaminants of potential concern (COPCs) in soil. These concentrations correspond to a dose rate of 15 mrem/yr through the exposure routes for the rural-residential and modified Columbia River Comprehensive Impact Assessment (CRCIA) ranger/industrial scenarios as discussed in Sections 3.3.1.2 and 3.3.1.3.

Exposure routes include ingestion and inhalation as well as external radiation exposure from radionuclides. Protection will be achieved by reducing concentrations of, or limiting exposure pathways to, contaminants in the upper 4.6 m (15 ft) of soil for the rural-residential exposure scenario and the upper 3.0 m (10 ft) of soil for the modified CRCIA ranger/industrial exposure scenario. The levels of reduction will ensure that the total dose does not exceed the draft radionuclide soil cleanup standard of 15 mrem/yr above Hanford Site background for 1,000 years following remediation proposed by the NRC and the EPA. The 1,000-year requirement ensures that the proposed standard accounts for decay of radionuclides to daughter products that are more highly radioactive. The PRGs presented in Tables 3-1 and 3-2 of this Treatment, Storage, and Disposal Corrective Measures Study (TSD CMS) are applicable at the time of remediation. These are goals of remediation and are not intended to represent concentrations to be achieved by remedial action at a particular site. Remedial actions may be guided by measurement bases other than concentration.

F1.2 PROTECTION OF GROUNDWATER AND THE COLUMBIA RIVER

After remediation, residual radioactive and nonradioactive contaminants remaining in soil must be at such levels that concentrations of contaminants migrating through the soil column to the unconfined aquifer, and eventually the Columbia River, do not exceed PRGs considered protective of groundwater and the river. These residual contaminant concentrations must be equal to or less than 100 times the groundwater cleanup level established in accordance with the Model Toxics Control Act (MTCA) Method B (*Washington Administrative Code* [WAC] 173-340-720) unless it can be demonstrated that a higher soil concentration is protective of groundwater at the site (WAC 173-303-740[3][a][ii][A]).

The unit gradient model (DOE-RL 1996b) was used to demonstrate that some residual soil contaminants will not reach the unconfined aquifer within 1,000 years (the calculation was confirmed by RESRAD). Therefore, a PRG for residual soil contamination protective of groundwater has not been provided for these contaminants. The travel-time calculations are presented in Appendix G.

F1.3 CALCULATION METHODOLOGY

A primary goal of the interim remedial record of decision (ROD) for the 100 Area (EPA 1995) is to achieve cleanup levels that would not restrict the future use of the land in the 100 Area. For the RESRAD model, using the exposure scenario described in Section 3.3.1.2 of the 100-NR-1 TSD CMS, unrestricted future use of the land is represented by an individual resident in a rural-residential setting. The exposure pathways considered in estimating doses from radionuclides in soil are external gamma exposure; inhalation; soil ingestion, and ingestion of crops, meat, milk, and aquatic foods. Excluding the drinking water and radon gas exposure pathways, the selected exposure pathways are consistent with the recommendations provided by the RESRAD User's Manual (ANL 1993).

Groundwater underlying the 100-N Area would not be used as a potable water supply or for irrigation until after remediation of groundwater has been completed. Protection of groundwater is intended to achieve maximum contaminant levels (MCL) for groundwater consistent with National Primary Drinking Water Regulations, which are based upon limiting radioactive dose in drinking water to 4 mrem/yr. Exposure to radon gas is not an exposure pathway in the rural-residential scenario because radon is not a COPC in the 100-N Area. External exposure would be the dominant exposure pathway for radionuclide COPCs in the 100 Area with the exception of strontium-90 (Sr-90). Ingestion is the dominant exposure pathway for Sr-90 and is included in the rural-residential scenario, which addresses cleanup of Sr-90 in soil.

Both modified CRCIA ranger/industrial and rural-residential scenarios were evaluated to show the potential range of exposures for future use in the 100-N Area. The modified CRCIA ranger/industrial scenario includes the external gamma exposure, inhalation, and soil ingestion pathways only. It does not include ingestion of food grown on the site. If the food ingestion pathway were to be included in the modified CRCIA ranger/industrial scenario, the resulting

PRGs (specifically the PRG for Sr-90) would be essentially of the same order of magnitude as those resulting from the rural-residential pathway evaluations. Thus, to keep the PRGs calculated from both scenarios distinct, food ingestion is not part of the modified CRCIA ranger/industrial scenario (see Section 3.3.1.3).

F1.3.1 Direct Exposure

The parameters of the exposure pathways described in Section F1.1, above, were used with the RESRAD model to calculate concentrations of individual radionuclides in soil corresponding to a 15 mrem/yr dose for the rural-residential and modified CRCIA ranger/industrial scenarios. The calculations performed apply to both 116-N-1 (1301-N) and 116-N-3 (1325-N). Values of all parameters used in the RESRAD calculations are presented in Table F1-1.

The PRGs for direct exposure were determined by using the RESRAD model as described in this Section. The appropriate parameters were entered into the RESRAD data menu, a concentration in soil for each radionuclide was assigned, and appropriate times for calculations were selected. (While the assigned concentrations are not critical to the run of the calculations, radionuclide concentrations of 1,000 pCi/g are suggested. For the calculation run, default times of 1, 3, 10, 30, 100, 300, and 1,000 years were used.)

After the software was run, the RESRAD summary report was accessed by creating a WordPerfect document in LinePrinter format with right and left margins of 0.25 inch and inserting the document "summary.rep" from the file c:\winres in RESRAD version 5.62 or the file c:\res561 in RESRAD version 5.61. The values provided in the RESRAD summary report under "Single Radionuclide Soil Guidelines," in the table headed "Summed Dose/Source Ratios and Single Radionuclide Soil Guidelines" were examined. The minimum concentration, in the column headed by G(I, min), is the concentration of each radionuclide in soil corresponding to a 15 mrem/yr dose. It is also the preliminary remediation goal for surface exposure for each radionuclide in the defined scenario. The text output of each RESRAD run was saved as a WordPerfect document to record the input parameters and output as a project document.

F1.3.1.1 Calculation of PRGs for Direct Exposure in the Modified CRCIA Ranger/Industrial Scenario using RESRAD. The RESRAD model input requirements of "indoor time fraction" and "outdoor time fraction" in Table F1-1, RESRAD Category R017, account for the fractions of time an individual spends indoors and outdoors. External gamma exposure, inhalation rate, and soil ingestion rate are a function of these time fractions. The 100-N Area modified CRCIA ranger/industrial scenario assumes an individual is on site for 9 hours per day, for 150 days per year. However, the individual is only exposed to contamination for 6 of the 9 hours. Therefore, total exposure time is 6 hours/day x 150 days/yr = 900 hours/yr divided by 24 hours/day = 37.5 days/yr. To determine a fraction of the year spent outdoors exposed to contamination, 37.5 days/yr is divided by 365 days = 0.1027 year. The RESRAD model uses this outdoors time fraction to calculate the contribution to total dose from gamma exposure.

F1.3.1.2 Calculation of PRGs for Inhalation in the Modified CRCIA Ranger/Industrial Scenario using RESRAD. The input value for inhalation rate based upon EPA and WDOH guidance is 7300 m^3/yr for reasonable maximum exposure. If this value is input for the modified CRCIA ranger/industrial scenario the RESRAD model multiplies this inhalation rate value by the 0.1027 outdoors time fraction obtaining a value which is disproportionally low. The correct volume to be entered in RESRAD must be proportionally larger to account for the actual time of exposure provided in the modified CRCIA ranger/industrial scenario. Based upon EPA guidance an inhalation rate of 2.1 m^3/hr is used (assuming moderate activity). This rate is multiplied by the number of hours in a year, 8760 hours/yr to obtain an unadjusted inhalation rate of 18,396 m^3/yr. This value for the unadjusted inhalation rate in the modified CRCIA ranger/industrial scenario entered into the RESRAD data menu (shown in Table F1-1, RESRAD Category R017). During its calculation the model multiplies the unadjusted inhalation rate by the actual exposure time (18,396 m^3/yr x 0.1027) to obtain the correct inhalation rate for exposure of 1,889 m^3/yr (equivalent to 900 hours x 2.1 m^3/yr = 1890 m^3/yr).

F1.3.1.3 Calculation of PRGs for Soil Ingestion in the Modified CRCIA Ranger/Industrial Scenario using RESRAD. Similar to the case for air inhalation rate, the soil ingestion rate must be adjusted to account for the actual time of exposure. To determine the correct rate for soil ingestion in the modified CRCIA ranger/industrial scenario, a proportionally larger initial rate per yr must be entered into RESRAD. Assume an individual potentially ingests soil for 16 hours per day (while sleeping, no soil ingestion occurs). Six hours of exposure divided by 16 hours is the fraction of the day during which an exposed individual might ingest soil. This fraction (6/16 = 0.375) is multiplied by 100 mg/day x 150 days/yr to obtain 5,625 mg/yr as the correct ingestion rate for the exposed individual in the modified CRCIA ranger/industrial scenario. Because the RESRAD model multiplies the rate which is entered by the outdoor time fraction, the entered rate must be proportionally increased. Therefore 5,625 mg/yr is divided by 0.1027 to obtain 54,771 mg/yr. This is the value entered into the RESRAD data menu (shown in Table F1-1, RESRAD Category R018). During the calculation the software multiplies the soil ingestion rate of 54,771 mg/yr by the outdoor time fraction (0.1027) to obtain the correct ingestion rate of 5,625 mg/yr (equivalent to 0.375 x 100 mg/day x 150 days/yr = 5,625 mg/yr).

F1.3.2 Protection of Groundwater and the Columbia River

Concentrations of radionuclides and nonradioactive contaminants in soil, which would be protective of the groundwater and the Columbia River, were also calculated using the RESRAD model. Site-specific information was used to evaluate contaminant migration from a source in the vadose zone to groundwater. The calculations performed apply to both 116-N-1 (1301-N) and 116-N-3 (1325-N). Since 116-N-1 is much closer to the river, the distance from 116-N-1 was used as the distance from the waste sites to the river in the dilution/attenuation factor model for transport from beneath the waste sites to the riversriver's edge. This represents the most conservative case. Values of all parameters used in the RESRAD calculations are presented in Table F1-1.

Appendices B, C, D, and E of the RDR/RAWP (DOE-RL, 1996a) present the methodology used to calculate levels of residual radioactive or heavy metal contamination that could be left in place

without impacting the groundwater. These residual contaminant concentrations, considered protective of the unconfined aquifer, must be equal to or less than 100 times the groundwater cleanup level established in accordance with WAC 173-340-720, unless it can be demonstrated that a higher soil concentration is protective of groundwater at the site (per WAC 173-303-740 [3][a][ii][A]).

The unit gradient model (DOE-RL 1996b) was used to demonstrate that some residual soil contaminants do not reach the unconfined aquifer within 1,000 years. The calculation was confirmed using the RESRAD model as described in this section. The appropriate parameters from Table F1-1 were entered into the RESRAD data menu, suppressing all exposure pathways other than drinking water ingestion. A concentration in soil for each radionuclide was assigned. The actual value is not critical to the calculations, however a value of 10,000 pCi/g is suggested. Appropriate times for calculations were also selected. Times of 1, 3, 10, 30, 100, 300, and 1,000 years are suggested for the calculation run.

After the software was run the RESRAD report of concentration of radionuclides in different media was accessed by creating a WordPerfect document in LinePrinter format with right and left margins of 0.25 inch and inserting the document "concent.rep" from the file c:\winres in RESRAD version 5.62 or the file c:\res561 in RESRAD version 5.61. The values provided for concentrations in Well Water (groundwater) for each radionuclide in each year were inspected and all radionuclides from the original input list that have values unequal to zero were recorded. Concentrations of input radionuclides which remain at zero for the full 1,000 years do not reach groundwater. Radionuclides which have values unequal to zero at any time are projected to reach groundwater within 1,000 years.

Alternatively, the graphical output provided by RESRAD for concentration of radionuclides in well water may be examined to determine which radionuclides do and/or do not reach groundwater in 1,000 years. If the graphical output displays zero for the full 1,000 years, then the contaminant does not reach groundwater within 1,000 years.

For those residual contaminants that are determined to reach the unconfined aquifer, protection is achieved by reducing concentrations remaining in soil after remediation to less than or equal to 100 times the groundwater PRG. Unless it can be demonstrated that a higher soil concentration is protective of groundwater, the 100 times groundwater PRG standard may still apply to those residual nonradionuclide contaminants that do not reach the unconfined aquifer (WAC 173-340-740). One hundred times the groundwater PRG was implemented because PRGs generated by the RESRAD model were much less (i.e., RESRAD estimated lower residual soil contaminant concentrations than those resulting from 100 times groundwater PRGs).

Following are additional contaminant transport steps needed to calculate PRGs for residual soil contamination to achieve protection of the Columbia River beyond the migration of contaminants through the soil column and their subsequent leaching into the unconfined aquifer: (1) the transportation from beneath the waste site to the river's edge (of contaminants leached to the unconfined aquifer), and (2) the discharge of these contaminants from the groundwater to the river.

The model that addresses these two steps is the dilution/attenuation factor model, summarized in Appendix D of the RDR/RAWP (DOE-RL 1996a). This model accounts for the time required for a contaminant to travel to the river through the unconfined aquifer underlying a site, for radionuclide decay occurring during that time, and for a 1:1 dilution factor applied to contaminant concentrations measured in near-river wells. The dilution factor accounts for the difference in concentration between the near-river well and the riverbank-groundwater/river interface. This 1:1 dilution factor is based on precedence established in the ROD for the 100-HR-3 and 100-KR-4 groundwater operable units (OU) (EPA 1996).

For consistency, the same methodology applied to residual soil contamination to ensure protection of the groundwater (i.e., 100 times the groundwater PRG) was also applied to ensure protection of the Columbia River. Protection of the Columbia River is achieved by reducing concentrations remaining in soil after remediation to concentrations less than or equal to 100 times the dilution/attenuation factor PRG. Only those residual contaminants shown by the RESRAD model to reach the unconfined aquifer have PRGs.

Table F1-1. RESRAD Input Parameters for Calculating PRGs for Radionuclides in Soil Under the Rural-Residential and Modified CRCIA Ranger/Industrial Scenarios. (Page 1 of 9)

RESRAD Category	Parameter	Units	RESRAD Default Value	Selected Value		Rationale	Citation
				Rural-Residential	MCRIS		
Exposure Pathways	Pathways which may be selected for exposure scenario: External Gamma, Inhalation, Plant / Meat / Milk Ingestion, Aquatic Foods, Drinking Water, Soil Ingestion, Radon	NA	All pathways active	External Gamma Inhalation Plant Ingestion Meat Ingestion Milk Ingestion Soil Ingestion (Drinking Water for GW protection only)	External Gamma Inhalation Soil Ingestion (Drinking Water for GW protection only)	Presented in Section 3.3.1 of the TSD CMS	
R011 - Contaminated Zone (CZ)	Area of CZ	m^2	10,000	4,855	4,855	Area of 1301-N crib & trench	BHI-00368[a]
	Thickness of CZ	meters	2	4.6 (Exposure) 7.6 (GW Protection)	3.0 (Exposure) 8.4 (GW Protection)	Consistent with the 100 Area RDR/RAWP and N-Area decisions.	DOE/RL-96-17[c] DOE/RL-96-11[b]
	Length Parallel to Aquifer Flow	meters	100	425	425	Length of 1301-N parallel to aquifer flow	DOE/RL-96-11[b]
	Radiation Dose Limit	mrem/yr	30	15 (Exposure) 4 (GW Protection)	15 (Exposure) 4 (GW Protection)	Proposed federal standard for soils	40 CFR Part 196[j]
	Elapsed Time of Waste Placement	years	0	0	0	Default	
R013 - Cover and CZ Hydrological Data	Cover Depth	meters	0	0.0 (Exposure) 4.6 (GW Protection)	0.0 (Exposure) 3.0 (GW Protection)	Standards apply to surface contamination	
	Density of Cover Material	g/cm^3	1.5	NA (Exposure) 2.0 (GW Protection)	NA (Exposure) 2.0 (GW Protection)	N-Area specific data	DOE/RL-96-11[b]
	Cover Erosion Rate	m/yr	0.001	NA (Exposure) 0.001 (GW Protection)	NA (Exposure) 0.001 (GW Protection)	Default	
	Density of CZ	g/cm^3	1.5	2.0	2.0	N-Area specific data	DOE/RL-96-11[b]
	CZ Erosion Rate	m/yr	0.001	0.001	0.001	Default	

Table F1-1. RESRAD Input Parameters for Calculating PRGs for Radionuclides in Soil Under the Rural-Residential and Modified CRCIA Ranger/Industrial Scenarios. (Page 2 of 9)

RESRAD Category	Parameter	Units	RESRAD Default Value	Selected Value		Rationale	Citation
				Rural-Residential	MCRIS		
	CZ Total Porosity		0.4	0.3	0.3	N-Area specific data	DOE/RL-96-11 [b]
R013 - Cover and CZ Hydrological Data (cont.)	CZ Effective Porosity		0.2	0.25	0.25	WDOH Draft Hanford Guidance for Radiological Cleanup	
	CZ Hydraulic Conductivity	m/yr	10	250	250	N-Area specific data	DOE/RL-96-11 [b]
	CZ b Parameter		5.3	4.05	4.05	Consistent with N-Area soil profile	RESRAD manual; ANL, 1993 [d]
	Humidity in Air	g/cm^3	8	8	8	Default	
	Evapotranspiration Coefficient		0.5	0.91	0.91	EPA Region 10 guidance	
	Precipitation	m/yr	1	0.16	0.16	Based on 16 cm (6.3 in) average annual rainfall	DOE/RL-90-07 [e]
	Irrigation Rate	m/yr	2	0.76	0	EPA Region 10 guidance	
	Irrigation Mode		Overhead	Overhead	Not used	Consistent with local practice	
	Runoff Coefficient		0.2	0.2	0.2	Default	
	Watershed Area for Nearby Stream or Pond	m^2	1,000,000	1,000,000	1,000,000	Default	
	Accuracy for Water/Soil Computations		0.001	0.001	0.001	Default	
R014 - Saturated Zone (SZ) Hydrological Data	Density of SZ	g/cm^3	1.5	2.0	2.0	N-Area specific data	DOE/RL-96-11 [b]
	SZ Total Porosity		0.4	0.3	0.3	N-Area specific data	DOE/RL-96-11 [b]
	SZ Effective Porosity		0.2	0.25	0.25	WDOH Draft Hanford Guidance for Radiological Cleanup	

Table F1-1. RESRAD Input Parameters for Calculating PRGs for Radionuclides in Soil Under the Rural-Residential and Modified CRCIA Ranger/Industrial Scenarios. (Page 3 of 9)

RESRAD Category	Parameter	Units	RESRAD Default Value	Selected Value		Rationale	Citation
				Rural-Residential	MCRIS		
R014 - Saturated Zone (SZ) Hydrological Data (cont.)	SZ Hydraulic Conductivity	m/yr	10	5,530	5,530	N-Area specific data	DOE/RL-95-100 [f] DOE/RL-95-83 [g] DOE/RL-93-37 [h]
	SZ Hydraulic Gradient		0.02	0.00125	0.00125	Based on GW velocity = 27.8 m/yr, porosity = 0.25, hydraulic conductivity = 5530 m/yr	1994 RCRA annual report DOE/RL-94-136 [i]
	SZ b Parameter		5.3	4.05	4.05	Consistent with N-Area soil profile	RESRAD manual; ANL, 1993 [d]
	Water Table Drop Rate	m/yr	0.001	0	0	N-Area specific data	DOE/RL-96-11 [b]
	Well Pump Intake Depth below water table	m	10	NA (Exposure) 4.6 (GW Protection)	NA (Exposure) 4.6 (GW Protection)	Typical RCRA well screen length	
	Nondispersion or Mass- Balance		ND	ND	ND	Default	
	Well Pumping Rate	m^3/yr	250	NA (Exposure) 250 (GW Protection)	NA (Exposure) 250 (GW Protection)	Default	
R015 - Uncontaminated and Unsaturated Strata Hydrological Data	Number of Unsaturated Strata		1	1 (Exposure; GW) 0 (Cont. to GW)	NA (Exposure) 1 (GW Protection)	Scenario dependent	
	Thickness	m	4	15.2 (Exposure) 7.6 (GW Protection) 0 (Cont. To GW)	NA (Exposure) 8.4 (GW Protection) 0 (Cont. To GW)	Scenario dependent	DOE/RL-96-11 [b]
	Soil Density	g/cm^3	1.5	2.0	2.0	N-Area specific data	DOE/RL-96-11 [b]
	Total Porosity		0.4	0.3	0.3	N-Area specific data	DOE/RL-96-11 [b]
	Effective Porosity		0.2	0.25	0.25	WDOH Draft Hanford Guidance for Radiological Cleanup	

Table F1-1. RESRAD Input Parameters for Calculating PRGs for Radionuclides in Soil Under the Rural-Residential and Modified CRCIA Ranger/Industrial Scenarios. (Page 4 of 9)

RESRAD Category	Parameter	Units	RESRAD Default Value	Selected Value		Rationale	Citation
				Rural-Residential	MCRIS		
	Soil-specific b Parameter		5.3	4.05	4.05	Consistent with site soil profile	RESRAD manual; ANL, 1993 [d]
R015 - Uncontaminated and Unsaturated Strata Hydrological Data (cont.)	Hydraulic Conductivity	m/yr	10	250	250	N-Area specific data	DOE/RL-96-11 [b]
R016 - Distribution Coefficients and Leach Rates for Individual Radionuclides	Distribution Coefficient (Kd) of Cover, Uncontaminated Zone, and Saturated Zone	NA	Am-241: 20 Co-60:1000 Cs-137:1000 Eu-154: -1 Eu-155: -1 H-3: 0 Pu-239:2000 Pu-240:2000 Sr-90: 30 Tc-99 : 0 Th-228:6E04 Th-232:6E04 U-233/234:50 U-238: 50	Am-241: 200 Co-60: 50 Cs-137: 50 Eu-154: 200 Eu-155: 200 H-3: 0 Pu-239: 200 Pu-240: 200 Sr-90: 15 Tc-99: 0 Th-228: 200 Th-232: 200 U-233/234: 2 U-238: 2	Am-241: 200 Co-60: 50 Cs-137: 50 Eu-154: 200 Eu-155: 200 H-3: 0 Pu-239: 200 Pu-240: 200 Sr-90: 15 Tc-99: 0 Th-228: 200 Th-232: 200 U-233/234: 2 U-238: 2	Contaminant, N-Area, and Hanford specific data	DOE/RL-96-17 [c]
	Saturated Leach Rate		0	0	0	Default	
	Saturated Solubility		0	0	0	Default	

Table F1-1. RESRAD Input Parameters for Calculating PRGs for Radionuclides in Soil Under the Rural-Residential and Modified CRCIA Ranger/Industrial Scenarios. (Page 5 of 9)

RESRAD Category	Parameter	Units	RESRAD Default Value	Selected Value		Rationale	Citation
				Rural-Residential	MCRIS		
R017 - Inhalation and External Gamma	Inhalation Rate	m^3/yr	8,400	7,300	18,396	WDOH Draft Hanford Guidance for Radiological Cleanup	
	Mass Loading for Inhalation	g/m^3	0.0002	0.0002	0.0002	Default	
	Dilution Length for Airborne Dust	m	3	3	3	Default	
	Exposure Duration	yr	30	30	30	Default	
	Inhalation Shielding Factor		0.4	0.4	0.4	Default	
R017 - Inhalation and External Gamma (cont.)	External Gamma Shielding Factor		0.7	0.8	0.8	WDOH Draft Hanford Guidance for Radiological Cleanup	
	Indoor Time Factor		0.5	0.6	0	WDOH Draft Hanford Guidance for Radiological Cleanup	
	Outdoor Time Factor		0.25	0.2	0.1027	0.2 = WDOH guidance 0.1027 = 150 d/yr x 6 hr/d / 24 hr/d / 365 d/yr	Draft Hanford Guidance for Radiological Cleanup
	Shape Factor		1	1	1	Default	
R018 - Ingestion Pathway Data, Dietary Parameters	Fruits, Vegetables, and Grain Consumption	kg/yr	160	122.5	Not used	EPA guidance	
	Leafy Vegetable Consumption	kg/yr	14	13.3	Not used	EPA guidance	
	Milk Consumption	L/yr	92	100	Not used	WDOH Draft Hanford Guidance for Radiological Cleanup	
	Meat and Poultry Consumption	kg/yr	63	126	Not used	EPA guidance	

Table F1-1. RESRAD Input Parameters for Calculating PRGs for Radionuclides in Soil Under the Rural-Residential and Modified CRCIA Ranger/Industrial Scenarios. (Page 6 of 9)

RESRAD Category	Parameter	Units	RESRAD Default Value	Selected Value		Rationale	Citation
				Rural-Residential	MCRIS		
	Fish Consumption	kg/yr	5.4	Not used	Not used	Fish are not grown in contaminated water	
	Other Seafood Consumption	kg/yr	0.9	Not used	Not used	Fish are not grown in contaminated water	
	Soil Ingestion	g/yr	36.5	43.8	54.771	EPA guidance	
	Drinking Water Intake	L/yr	510	730	Not used	EPA guidance	
	Drinking Water Contamination Fraction		1	0 (Exposure) 1 (GW Protection)	Not used (Exposure) 1 (GW Protection)	Contaminated groundwater will not be used for any purpose	
R018 - Ingestion Pathway Data, Dietary Parameters (cont.)	Household Water Contamination Fraction		1	Not used	Not used	Contaminated groundwater will not be used for any purpose	
	Livestock Water Contamination Fraction		1	0	Not used	Contaminated groundwater will not be used for any purpose	
	Irrigation Water Contamination Fraction		1	0	Not used	Contaminated groundwater will not be used for any purpose	
	Aquatic Food Contamination Fraction		0.5	Not used	Not used	Fish are not grown in contaminated water	
	Plant Food Contamination Fraction		-1	-1	Not used	Default	
	Meat Contamination Fraction		-1	-1	Not used	Default	
	Milk Contamination Fraction		-1	-1	Not used	Default	

Table F1-1. RESRAD Input Parameters for Calculating PRGs for Radionuclides in Soil Under the Rural-Residential and Modified CRCIA Ranger/Industrial Scenarios. (Page 7 of 9)

RESRAD Category	Parameter	Units	RESRAD Default Value	Selected Value		Rationale	Citation
				Rural-Residential	MCRIS		
R019 - Ingestion Pathway Data, Nondietary	Livestock Fodder Intake for Meat	kg/d	68	68	Not used	Default	
	Livestock Fodder Intake for Milk	kg/d	55	55	Not used	Default	
	Livestock Water Intake for Meat	L/d	50	50	Not used	Default	
	Livestock Water Intake for Milk	L/d	160	160	Not used	Default	
	Livestock Intake of Soil	kg/d	0.5	0.5	Not used	Default	
R019 - Ingestion Pathway Data, Nondietary (cont.)	Mass Loading for Foliar Deposition	g/m^3	0.0001	0.0001	Not used	Default	
	Depth of Soil Mixing Layer	m	0.15	0.15	0.15	Default	
	Depth of Roots	m	0.9	0.9	Not used	Default	
	Groundwater Fractional Usage - Drinking Water		1	0 (Exposure) 1 (GW Protection)	Not used (Exposure) 1 (GW Protection)	Contaminated groundwater will not be used for any purpose	
	Groundwater Fractional Usage - Household Usage		1	0 (Exposure) 1 (GW Protection)	Not used (Exposure) 1 (GW Protection)	Contaminated groundwater will not be used for any purpose	
	Groundwater Fractional Usage - Livestock Water		1	0	Not used	Contaminated groundwater will not be used for any purpose	
	Groundwater Usage - Irrigation		1	0	Not used	Contaminated groundwater will not be used for any purpose	

Table F1-1. RESRAD Input Parameters for Calculating PRGs for Radionuclides in Soil Under the Rural-Residential and Modified CRCIA Ranger/Industrial Scenarios. (Page 8 of 9)

RESRAD Category	Parameter	Units	RESRAD Default Value	Selected Value		Rationale	Citation
				Rural-Residential	MCRIS		
R021 - Radon	Cover Material Thickness	m		Not used	Not used	Radon is not a COPC	
	Cover Material Density	g/m^3		Not used	Not used	Radon is not a COPC	
	Cover Material Total Porosity		0.4	Not used	Not used	Radon is not a COPC	
	Cover Material Volumetric Water Content		0.05	Not used	Not used	Radon is not a COPC	
	Cover Material Effective Radon Diffusion Coefficient	m/sec	0.000002	Not used	Not used	Radon is not a COPC	
R021 - Radon (cont.)	Building Foundation Thickness		0.15	Not used	Not used	Radon is not a COPC	
	Building Foundation Density	g/m^3	2.4	Not used	Not used	Radon is not a COPC	
	Building Foundation Total Porosity		0.1	Not used	Not used	Radon is not a COPC	
	Building Foundation Volumetric Water Content		0.03	Not used	Not used	Radon is not a COPC	
	Building Foundation Effective Radon Diffusion Coefficient	m/sec	0.0000003	Not used	Not used	Radon is not a COPC	

Table F1-1. RESRAD Input Parameters for Calculating PRGs for Radionuclides in Soil Under the Rural-Residential and Modified CRCIA Ranger/Industrial Scenarios. (Page 9 of 9)

RESRAD Category	Parameter	Units	RESRAD Default Value	Selected Value		Rationale	Citation
				Rural-Residential	MCRIS		
	CZ Radon Diffusion Coefficient	m/sec	0.000002	Not used	Not used	Radon is not a COPC	
	Radon Vertical Dimension of Mixing	m	2	Not used	Not used	Radon is not a COPC	
	Average Annual Wind Speed	m/sec	2	Not used	Not used	Radon is not a COPC	
	Building Air Exchange Rate	1/hr	0.5	Not used	Not used	Radon is not a COPC	
	Building Room Height	m	2.5	Not used	Not used	Radon is not a COPC	
	Building Indoor Area Factor		0	Not used	Not used	Radon is not a COPC	
R021 - Radon (cont.)	Foundation Depth Below Ground Surface	m	1	Not used	Not used	Radon is not a COPC	
	Radon Emanation Coefficient - Rn-222		0.25	Not used	Not used	Radon is not a COPC	
	Radon Emanation Coefficient - Rn-220		0.15	Not used	Not used	Radon is not a COPC	

MCRIS = Modified CRCIA Ranger/Industrial Scenario

References:
[a] BHI-00368: *Data Quality Objectives Workshop Results for 1301-N and 1325-N Characterization*, Rev. 0, 1996.
[b] DOE/RL-96-11: *1301-N and 1325-N Liquid Waste Disposal Facilities Limited Field Investigation Report*, Draft A, July 1996.
[c] DOE/RL-96-17: *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Rev. 0, June 1996.
[d] ANL, 1993, *Manual for Implementing Residual Radioactive Materials Guidelines Using RESRAD*, Version 5.0, ANL/EAD/LD-2, Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois.
[e] DOE/RL-90-07: *Remedial Investigation/Feasibility Study Work Plan for the 100-BC-1 Operable Unit, Hanford Site, Richland, Washington*, July 1992.
[f] DOE/RL-95-100: *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit*, Draft A, 1996.
[g] DOE/RL-95-83: *Pilot Scale Treatability Test Summary for the 100-HR-3 Operable Unit*, Rev. 0, 1996.
[h] DOE/RL-93-37: *Limited Field Investigation Report for the 100-BC-5 Operable Unit*, Rev. 0, 1993.
[i] DOE/RL-94-136: *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1994*, Rev. 0, 1995.
[j] 40 CFR Part 196: *Notice of Proposed Rulemaking for Radiation Site Cleanup Regulations*, Code of Federal Regulations, 1994.

F2.0 MODIFIED CRCIA RANGER/INDUSTRIAL SCENARIO

F2.1 COMPARISON OF THE MODIFIED CRCIA RANGER/INDUSTRIAL SCENARIO TO THE CRCIA RANGER SCENARIO

In June 1996, the modified CRCIA ranger/industrial scenario presented in this CMS was based on the CRCIA ranger scenario presented in the draft *Human Scenarios for the Screening Assessment, Columbia River Comprehensive Impact Assessment*. Since then, the CRCIA, including some assumptions and inputs, was revised in the *Screening Assessment and Requirements for a Comprehensive Assessment* (DOE-RL 1997). The only relevant change between the original CRCIA ranger scenario and the scenario presented in the revised CRCIA document is a change in the shielding factor for external dose from 0.8 to 1.0. This appendix and the associated calculations were revised to reflect this change. This change to the CRCIA ranger scenario did not alter any decisions made concerning the modified CRCIA ranger/industrial scenario used in this CMS.

The modified CRCIA ranger/industrial scenario in the CMS differs from the CRCIA scenario (Table F2-1) for the following reasons:

F2.1.1 Difference in Specifications

1. External Radiation Exposure - The CRCIA scenario divides external gamma exposure into three parts: soil, sediments, and surface water external radiation exposure. The RESRAD model does not separate these external gamma exposures. Therefore professional judgement was used to follow EPA guidance (and RESRAD) and use a shield factor of 0.8 to make a comparable calculation. The second decision assessed the portion of the nine-hour day that the ranger would be exposed. Considering the size of the site, the travel time within the 100 Area, and the limited portion of the site that would subject the ranger to exposure, a six-hour period was selected. Therefore, the total exposure time used in the CMS modified CRCIA ranger/industrial scenario external gamma calculation was 6 hours, as opposed to the 9 hours used in the CRCIA calculation. See Note 1 for the calculations.

2. Soil Dermal Contact - The CRCIA scenario provides a calculation for soil dermal contact, the RESRAD model has no provision for considering soil dermal contact. Since the value calculated for CRCIA was very small, it was considered insignificant. See Note 2 for the calculation.

F2.1.2 Conflicting U.S. Environmental Protection Agency Guidance

1. Soil Ingestion - EPA guidance recommends the use a value of 100 mg/d total soil ingestion. The CRCIA scenario combines two sources of soil ingestion (soil and sediment) which totals more than the EPA guidance. A judgement was made to follow EPA guidance. This judgement resulted in a smaller exposure estimate for soil ingestion

in the CMS modified CRCIA ranger/industrial scenario than in the CRCIA case. The impact of this difference would change the PRGs slightly, but not enough to alter any decisions. See Note 3 for the calculation.

2. Air Inhalation - EPA guidance recommends using an inhalation rate of 20 m^3/d, and 2.1 m^3/hr for moderate activity. CRCIA proposes to use 10 m^3/d. A judgement was made to follow EPA guidance. Using the EPA value, the air inhalation value for the modified CRCIA ranger/industrial scenario was greater than that from the CRCIA scenario. An additional judgement was made to use the RESRAD default value for an ambient air mass loading value of 200 $\mu g/m^3$ in the CMS modified CRCIA ranger/industrial scenario as opposed to the 50 $\mu g/m^3$ value proposed for the CRCIA scenario. The Washington Department of Health now recommends a value of 100 $\mu g/m^3$, which is currently being used in the 100 Area Remedial Design Report/Remedial Action Work Plan (DOE-RL 1996b). The result of these decisions is a greater air inhalation intake for the CMS modified CRCIA ranger/industrial scenario than for the CRCIA scenario. See Note 4 for the calculation.

F2.2 CALCULATION NOTES

1. External Gamma

Per HSRAM (Appendix D),

Exposure = C x ET x RF x EF x ED x CF

where:

Exposure = lifetime external exposure to radionuclide (pCi-yr)
C = concentration of radionuclide in media
ET = exposure time (shield factor) (hr/d)
RF = dose reduction factor (unitless)
EF = exposure frequency (d/yr)
ED = exposure duration (yr)
CF = conversion factor (1.14E-04 yr/hr; 24 hr/d x 365 d/yr = 8760 hr/yr; 1 yr/8760 hr = 1.14E-04 yr/hr)

CRCIA

soil external radiation exposure

Exposure = 3 hr/d x 1.0 x 150 d/yr x 30 yr x 1.14E-04 yr/hr = 1.539 yr

sediment external radiation exposure

Exposure = 3 hr/d x 0.2 x 150 d/yr x 30 yr x 1.14E-04 yr/hr = 0.3078 yr

surface water external radiation exposure (assumes radiation emitted from contamination in the water)

Exposure = 3 hr/d x 0.5 x 150 d/yr x 30 yr x 1.14E-04 yr/hr = 0.7695 yr

Total exposure time to external gamma = **2.6163 yr**

CMS/RESRAD (does not separate sources of external gamma; assumes surface water is contaminated at such low levels, if at all, as to be insignificant)

Exposure = 6 hr/d x 0.8 x 150 d/yr x 30 yr x 1.14E-04 yr/hr = **2.4624 yr**

2. Dermal Contact

Per HSRAM (Appendix D),

$$DAD = \frac{C \times ABS \times AF \times CF \times [(SA \times EF \times ED)/BW]}{AT}$$

where:

DAD	= dermally absorbed dose (mg/kg-d)
C	= contaminant soil concentration (mg/kg)
ABS	= absorption factor (unitless)
AF	= adherence factor (mg/cm^2-day)
CF	= conversion factor (1E-06 kg/mg)
SA	= surface area exposed (cm^2)
EF	= exposure frequency (d/yr)
ED	= exposure duration (yr)
BW	= body weight (kg)
AT	= averaging time (yr x 365 d/yr)

CRCIA

soil

$$DAD = \frac{0.2\ mg/cm^2\text{-day} \times 1E\text{-}06\ kg/mg \times [(5000\ cm^2 \times 150\ d/yr \times 30\ yr)/70\ kg]}{(70\ yr \times 365\ d/yr)}$$

$$= 0.0642857/25550\ d = 2.5E\text{-}06\ (mg/kg)(d)^{-1}$$

sediment

As above, DAD = 2.5E-06 (mg/kg)(d)$^{-1}$

Total DAD = 5E-06 (mg/kg)(d)$^{-1}$; very small contribution to dose

CMS/RESRAD

Not evaluated because dermal contact provides a very small contribution to dose.

3. Soil Ingestion

Per HSRAM (Appendix D),

Intake = C x IR x ED x EF x CF

Amount of soil ingestion = IR x ED x EF x CF

where:

Intake = lifetime intake (pCi)
C = concentration of radionuclide in soil (pCi/g)
IR = ingestion rate (mg/d)
ED = exposure duration (yr)
EF = exposure frequency (d/yr)
CF = conversion factor (1E-03 g/mg)

CRCIA

Soil

Amount of soil ingestion = 100 mg/d x 30 yr x 150 d/yr x 0.001 g/mg = 450 g

Sediment

Amount of soil ingestion = 100 mg/d x 150 d/yr x 30 yr x 0.001 g/mg = 450 g

Total Amount of soil ingestion = 900 g; using two sources of soil ingestion and double the daily ingestion rate (100 mg/d x 2) is inconsistent with EPA guidance of 100 mg/d total soil ingestion.

CMS/RESRAD

Amount of soil ingestion = 37.5 mg/d x 150 d/yr x 30 yr x 0.001 g/mg = **168.75 g**

4. Inhalation (Fugitive Dust)

Intake = C x IR x MLV x EF x ED x CF

where:

Intake = lifetime intake (pCi)
C = radionuclide concentration in soil (pCi/g)

IR = inhalation rate (m^3/d)
MLV = ambient air mass loading value ($\mu g/m^3$)
EF = exposure frequency (d/yr)
ED = exposure duration (yr)
CF = conversion factor (1E-06 g/ug)

CRCIA (assumes IR of 10 m^3/d even though the individual is on site for 9 hours; EPA guidance is 20 m^3/d)

Intake = pCi/g x 10 m^3/d x 50 $\mu g/m^3$ x 150 d/yr x 30 yr x 1E-06 g/ug

= 2.25 pCi

CMS/RESRAD

Intake = pCi/g x 2.1 m^3/hr x 200 $\mu g/m^3$ x 900 hr/yr x 30 yr x 1E-06 g/ug

= 11.34 pCi

Table F2-1. Comparison of Radiation Exposure Assumptions for Modified CRCIA Ranger/Industrial, CRCIA Ranger, and HSRAM Industrial Scenarios.

ITEM	MODIFIED CRCIA RANGER/INDUSTRIAL SCENARIO	CRCIA RANGER SCENARIO	HSRAM INDUSTRIAL SCENARIO** (BASED ON MTCA C)
External Radiation Exposure	• Exposure = 2.4624 yr • Single input - RESRAD does not allow multiple inputs • Shield factor - used EPA guidance and most conservative CRCIA value (0.8 hr/day) • Daily exposure = 6 hrs (reflects the exposure time during a 9-hr period)	• Exposure = 2.3085 yr • Three inputs: Soil, sediments, water • Three shield factors 0.8 hr/day, 0.2 hr/day, and 0.5 hr/day • Daily exposure = 9 hrs, sum of three inputs	• Exposure = 2.1 yr • Shield factor = 0.8 • Daily exposure = 8 hrs
Soil Dermal Contact	• No provision to include dermally absorbed dose in RESRAD. Since CRCIA value is very small, this difference was considered acceptable	• Dermally absorbed dose = 2.5E-06 mg/kg (d^{-1})	• Dermally absorbed dose = 1.6E-06 mg/kg (d^{-1})
Soil Ingestion	• Lifetime intake = 168.75 g • EPA guidance which limits total soil ingesting to 100 mg/day was followed. PRGs differ slightly from CRCIA, but not enough to change the evaluation or the conclusions	• Lifetime intake = 900 g • Sums up soil ingestion from two sources (soil and sediments) and exceeds EPA guidance	• Lifetime intake 150 g • Soil ingestion rate = 50 mg/day
Air Inhalation	• Lifetime intake = 11.34 g • EPA guidance inhalation rate = 2.1 m^3/hr for moderate activity was followed • Ambient air mass loading = 200 $\mu g/m^3$. The Washington Department of Health guidance now recommends 100 $\mu g/m^3$	• Lifetime intake = 2.25 g • Inhalation rate = 10 m^3/d • Ambient air mass loading = 50 $\mu g/m^3$	• Lifetime intake = 10 g (assuming a 100 $\mu g/m^3$ ambient air mass loading rate) • Inhalation rate = 20 m^3/d • Ambient air mass loading not specified
Exposure Time	• 6 hrs/day • 150 days/yr • 30 yrs	• 9 hrs/day • 150 days/yr • 30 yrs	• 8 hrs/day • 250 days/yr air • 146 days/yr soil • 20 yrs

* Human Scenarios for the Screening Assessment (DOE-RL 1996a) ** Hanford Site Risk Assessment Methodology (DOE-RL 1995c)

F3.0 REFERENCES

ANL, 1993, *Manual for Implementing Residual Radioactive Materials Guidelines Using RESRAD*, Version 5.0, ANL/EAD/LD-2, Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois.

DOE-RL, 1996a, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1996b, *1301-N and 1325-N Liquid Waste Disposal Facilities Limited Field Investigation Report*, DOE/RL-96-11, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1994, *Technical Report Supporting the Development of Standards for the Cleanup of Radioactively Contaminated Sites*, September 1994, U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, Washington, D.C.

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EPA, 1996, *Record of Decision of the U.S. DOE Hanford 100 Area; 100-HR-3, and 100-KR-4 Operable Units, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Richland, Washington.

WAC 173-303, 1993, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

WAC 173-340, 1992, "Model Toxics Control Act Cleanup Regulation," *Washington Administrative Code*, as amended.

40 CFR 196, 1994, "Notice of Proposed Rulemaking for Radiation Site Cleanup Regulations," *Code of Federal Regulations*, as amended.

APPENDIX G

CONTAMINANTS OF CONCERN ASSESSMENT PROCESS

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ABBREVIATIONS AND ACRONYMS

CMS	Corrective Measures Study
COC	contaminant of concern
COPC	contaminant of potential concern
LFI	limited field investigation
PRG	preliminary remediation goal
TSD	treatment, storage, and disposal

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G1.0 CONTAMINANTS OF CONCERN ASSESSMENT PROCESS

Comparing soil data to preliminary remediation goals (PEGS) for the contaminants of potential concern (COPCS) at 116-N-1 and 116-N-3 is an essential step in developing contaminants of concern (COCs). The steps involved in this process are described below. The COPCs are listed in Tables 2-16 and 2-17 of this Treatment, Storage, and Disposal Corrective Measures Study (TSD CMS) and the PRGs in Table 3-6. Figure 2-31 in the TSD CMS illustrates the COC development process.

G1.1 DATA SELECTION

The first step in this process was to assemble all relevant soil data from the following four sources associated with the 116-N-1 (1301-N) and 116-N-3 (1325-N) units. These sources were presented in Appendix A of the *1301-N and 1325-N Liquid Waste Disposal Facilities Limited Field Investigation Report* (DOE-RL 1996).

- The historical sediment samples from the 116-N-1 Trench (sample locations TS-01 to TS-09) and the 116-N-3 Crib (sample locations CS-01 to CS-12)
- The samples collected from the boreholes drilled within 116-N-1 and 116-N-3 (199-N-107A, 199-N-108A, and 199-N-109A)
- The samples collected from the pump-and-treat wells (199-N-103A, 199-104A, 199-N-105A, and 199-N-106A)
- The samples collected from the boreholes near 116-N-1 and 116-N-3 (199-N-75, 199-N-76, 199-N-80, RW #1, RW #2, and RW #3).

The actual sample numbers used from these four sources are shown in Table G-1. The concentrations associated with these samples (Appendix A of the 1301-N and 1325-N Limited Field Investigation [LFI] report) are those reported at the time the sampling occurred and were not decayed. Because radioactive contaminants decay over time, it was essential to determine what the concentrations will be at the time of remediation. Therefore, all data were decayed to the year 2010. The decayed concentrations were then compared to PRGs. Samples from the ground surface to the water table were used because the remedial action objectives include protecting humans and animals from exposure to contaminants near the surface. The remedial action objectives also protect the groundwater and the Columbia River, which may be impacted by contaminants deep in the vadose zone.

Table G-1. Samples Used for Evaluation of Preliminary Remediation Goals. (Page 1 of 3)

Surface Soil								Subsurface Soil							
MCRIS (0-10 ft)				Rural Residential (0-15 ft)				Protection of Groundwater and River - MCRIS (>10 ft)				Protection of Groundwater and River - Rural Residential (>15 ft)			
Location	Sample ID	Elevation (ft. above mean sea level)	Depth (ft below ground surface)	Location	Sample ID	Elevation (ft. above mean sea level)	Depth (ft below ground surface)	Location	Sample ID	Elevation (ft above mean sea level)	Depth (ft below ground surface)	Location	Sample ID	Elevation (ft. above mean sea level)	Depth (ft below ground surface)
116-N-1				116-N-1				116-N-1				116-N-1			
199-N-107A	B0GGC3	N/A	N/A	199-N-107A	B0GGC3	N/A	N/A	199-N-107A	B0GL91	432-430	28-30	199-N-107A	B0GL91	432-430	28-30
	B0GL88	451-449	9-11		B0GL88	451-449	9-11		B0GL92 (Dup)	432-430	28-30		B0GL92 (Dup)	432-430	28-30
	B0GL89	449-447	11-13		B0GL89	449-447	11-13		B0GL95	403-401	57-59		B0GL95	403-401	57-59
	B0GLF4	451-449	9-11		B0GLF4	451-449	9-11		B0GLF7	437	23		B0GLF7	437	23
	B0GLF5	449-447	11-13		B0GLF5	449-447	11-13		B0GLF6	432-430	28-30		B0GLF6	432-430	28-30
									B0GLF8 (Dup)	432-430	28-30		B0GLF8 (Dup)	432-430	28-30
									B0GLF9	420	40		B0GLF9	420	40
									B0GLG0	410	50		B0GLG0	410	50
									B0GLG1	403-401	57-59		B0GLG1	403-401	57-59
									B0H1V6	391	69		B0H1V6	391	69
199-N-108A	N/A	N/A	N/A	199-N-108A	B0GL71	443-441	14.5-16.5	199-N-108A	B0GL73	434-432	23-25	199-N-108A	B0GL81	415-413	42-44
									B0GL75 (Dup)	434-432	23-25		B0GL86	395-393.5	62-63.5
									B0GL81	415-413	42-44		B0GLD7	424.5	32.5
									B0GL86	395-393.5	62-63.5		B0GLD8	415-413	42-44
									B0GLD3	434-432	23-25		B0GLD9	410	47
									B0GLD4 (Dup)	434-432	23-25		B0GLF0	405	52
									B0GLD6	429	28		B0GLF1	397.5	59.5
									B0GLD7	424.5	32.5		B0GLF2	395-393.5	62-63.5
									B0GLD8	415-413	42-44		B0GLF3	388	69
									B0GLD9	410	47				
									B0GLF0	405	52				
									B0GLF1	397.5	59.5				
									B0GLF2	395-393.5	62-63.5				
									B0GLF3	388	69				
116-N-1	N/A	N/A	N/A	116-N-1	N/A	N/A	N/A	116-N-1	TS-01	~439	N/A	116-N-1	TS-01	~439	N/A
									TS-02				TS-02		
									TS-03				TS-03		
									TS-04				TS-04		
									TS-05				TS-05		
									TS-06				TS-06		
									TS-07				TS-07		
									TS-08				TS-08		
									TS-09				TS-09		
116-N-3				116-N-3				116-N-3				116-N-3			
199-N-109A	N/A	N/A	N/A	199-N-109A	N/A	N/A	N/A	199-N-109A	B0GL97	442.5-440.5	8-10	199-N-109A	B0GL97	442.5-440.5	8-10
									B0GL99	440.5-438.5	10-12		B0GL99	440.5-438.5	10-12
									B0H1V7	442.5-440.5	8-10		B0H1V7	442.5-440.5	8-10
									B0H1V8	440.5-438.5	10-12		B0H1V8	440.5-438.5	10-12
									B0GLB1	433.5-431.5	17-19		B0GLB1	433.5-431.5	17-19
									B0H1V9	433.5-431.5	17-19		B0H1V9	433.5-431.5	17-19
									B0GLB3	426.5-424.5	24-26		B0GLB3	426.5-424.5	24-26
									B0GLB4 (Dup)	426.5-424.5	24-26		B0GLB4 (Dup)	426.5-424.5	24-26
									B0GLB6	411.5-409.5	39-41		B0GLB6	411.5-409.5	39-41
									B0GLC0	391.5-389	59-61.5		B0GLC0	391.5-389	59-61.5
									B0H1W1	426.5-424.5	24-26		B0H1W1	426.5-424.5	24-26
									B0H1W2 (Dup)	426.5-424.5	24-26		B0H1W2 (Dup)	426.5-424.5	24-26
									B0H1W3	420.5	30		B0H1W3	420.5	30
									B0H1W4	411.5-409.5	39-41		B0H1W4	411.5-409.5	39-41
									B0H1W5	400.5	50		B0H1W5	400.5	50
									B0H5N9	391.5-389	59-61.5		B0H5N9	391.5-389	59-61.5

Table G-1. Samples Used for Evaluation of Preliminary Remediation Goals. (Page 2 of 3)

Surface Soil								Subsurface Soil							
MCRIS (0-10 ft)				Rural Residential (0-15 ft)				Protection of Groundwater and River - MCRIS (>10 ft)				Protection of Groundwater and River - Rural Residential (>15 ft)			
Location	Sample ID	Elevation (ft. above mean sea level)	Depth (ft below ground surface)	Location	Sample ID	Elevation (ft. above mean sea level)	Depth (ft below ground surface)	Location	Sample ID	Elevation (ft. above mean sea level)	Depth (ft below ground surface)	Location	Sample ID	Elevation (ft. above mean sea level)	Depth (ft below ground surface)
116-N-3 (cont'd)				116-N-3 (cont'd)				116-N-3 (cont'd)				116-N-3 (cont'd)			
116-N-3	N/A	N/A	N/A	116-N-3	N/A	N/A	N/A	116-N-3	CS-01	~441	N/A	116-N-3	CS-01	~441	N/A
									CS-02				CS-02		
									CS-03				CS-03		
									CS-04				CS-04		
									CS-05				CS-05		
									CS-07				CS-07		
									CS-08				CS-08		
									CS-09				CS-09		
									CS-10				CS-10		
									CS-11				CS-11		
Outside 116-N-1/116-N-3				Outside 116-N-1/116-N-3				Outside 116-N-1/116-N-3				Outside 116-N-1/116-N-3			
199-N-75	B06837		2-3	199-N-75	B06837		2-3	199-N-75	B06843		56-58	199-N-75	B06843		56-58
	B06838		5-6		B06838		5-6		B06845		68-70		B06845		68-70
	B06839		9		B06839		9								
199-N-76	B06835		2-3	199-N-76	B06835		2-3	199-N-76	B06840		24-25	199-N-76	B06840		24-25
	B06836		5-6		B06836		5-6		B06841		24-25		B06841		24-25
									B06842		55-57		B06842		55-57
									B06844		64.5-66.5		B06844		64.5-66.5
199-N-80	N/A	N/A	N/A	199-N-80	N/A	N/A	N/A	199-N-80	B06M60		45-47	199-N-80	B06M60		45-47
									B06M61		45-47		B06M61		45-47
									B06M37		50-52		B06M37		50-52
									B06M62		50-52		B06M62		50-52
199-N-103A	N/A	N/A	N/A	199-N-103A	N/A	N/A	N/A	199-N-103A	B0DRK7		29-32	199-N-103A	B0DRK7		29-32
									103A/56.5		55-56.5		103A/56.5		55-56.5
									103A/57		55-56.5		103A/57		55-56.5
									B0DRK8		59-60.5		B0DRK8		59-60.5
									103A/62		60-61.5		103A/62		60-61.5
									B0DRK9		65-67		B0DRK9		65-67
									103A/67		65-67		103A/67		65-67
									103A/67 (Dup)		65-67		103A/67 (Dup)		65-67
									103A/67		65-67		103A/67		65-67
									103A/-72		70-72		103A/-72		70-72
199-N-104A	104A-10		10	199-N-104A	104A-10		10	199-N-104A	104A-20		20	199-N-104A	104A-20		20
									104A-30		30		104A-30		30
									B0DRL1		31-33		B0DRL1		31-33
									104A-40		40		104A-40		40
									104A-50		50		104A-50		50
									104A-58-60		58-60		104A-58-60		58-60
									104A-60		60		104A-60		60
									104A-65		65		104A-65		65
									104A/63-65		63-65		104A/63-65		63-65
									104A-70		70		104A-70		70
									104A/68-70		68-70		104A/68-70		68-70

Table G-1. Samples Used for Evaluation of Preliminary Remediation Goals. (Page 3 of 3)

Surface Soil								Subsurface Soil							
MCRIS (0-10 ft)				Rural Residential (0-15 ft)				Protection of Groundwater and River - MCRIS (>10 ft)				Protection of Groundwater and River - Rural Residential (>15 ft)			
Location	Sample ID	Elevation (ft above mean sea level)	Depth (ft below ground surface)	Location	Sample ID	Elevation (ft above mean sea level)	Depth (ft below ground surface)	Location	Sample ID	Elevation (ft above mean sea level)	Depth (ft below ground surface)	Location	Sample ID	Elevation (ft above mean sea level)	Depth (ft below ground surface)
Outside 116-N-1/116-N-3 (cont'd)				Outside 116-N-1/116-N-3 (cont'd)				Outside 116-N-1/116-N-3 (cont'd)				Outside 116-N-1/116-N-3 (cont'd)			
199-N-105A	105A-10		10	199-N-105A	105A-10		10	199-N-105A	105A-15		15	199-N-105A	105A-20		20
					105A-15		15		105A-20		20		105A-25		25
									105A-25		25		105A-30		30
									105A-30		30		B0DRL6		34-36
									B0DRL6		34-36		105A-35		35
									105A-35		35		105A-40		40
									105A-40		40		105A-45		45
									105A-45		45		105A-50		50
									105A-50		50		105A-51		51-52
									105A-51		51-52		105A-51 (Dup)		51-52
									105A-51 (Dup)		51-52		B0DRL7		51-53
									B0DRL7		51-53		105A/51-53		51-53
									105A/51-53		51-53		105A-56		56
									105A-56		56		105A/54-56		54-56
									105A/54-56		54-56		105A-55		59.5-61.5
									105A-55		59.5-61.5		105A/61.5		59.5-61.5
									105A/61.5		59.5-61.5		105A-60		60
									105A-60		60		105A-65		65
									105A-65		65		105A/67		65-67
									105A/67		65-67				
199-N-106A	N/A	N/A	N/A	199-N-106A	106A-15		15	199-N-106A	106A-15		15	199-N-106A	106A-25		25
									106A-25		25		106A-35		35
									106A-35		35		106A-45		45
									106A-45		45		106A-55		55
									106A-55		55		106A-65		65
									106A-65		65		B0GGB6		73-75
									B0GGB6		73-75		106A-75		75
									106A-75		75		B0GGB7		83/85
									B0GGB7		83/85		106A-85		85
									106A-85		85				
RW #1	RW #1		5	RW #1	RW #1		5	RW #1	RW #1		15	RW #1	RW #1		20
			10				10				20				25
							15				25				30
											30				35
											35				40
											40				45
											45				50
											50				
RW #2	RW #2		5	RW #2	RW #2		5	RW #2	RW #2		15	RW #2	RW #2		20
			10				10				20				25
							15				25				30
											30				35
											35				40
											40				45
											45				50
											50				
RW #3	RW #3		5	RW #3	RW #3		5	RW #3	RW #3		15	RW #3	RW #3		20
			10				10				20				25
							15				25				30
											30				35
											35				40
											40				50
											50				

G1.2 COMPARISON OF DATA TO PRELIMINARY REMEDIATION GOALS FOR SURFACE EXPOSURE

After the data were selected and decayed for surface soil, the next step was to compare the data to the direct surface exposure PRGs. Tables G-2 through G-5 show the following data:

- The COPC concentration decayed to the year 2010
- The comparison to the surface exposure PRGs identified for rural-residential and modified Columbia River Comprehensive Impact Assessment (CRCIA) ranger/industrial exposure scenarios.

Concentrations exceeding PRGs are in bold text and highlighted. Summaries of these comparisons are in Tables 4-2 through 4-5 of this TSD CMS.

G1.3 COMPARISON OF SUBSURFACE SOIL DATA TO PRELIMINARY REMEDIATION GOALS FOR PROTECTION OF GROUNDWATER AND THE COLUMBIA RIVER

The third step in the process was to evaluate the potential for individual contaminants to reach groundwater and the Columbia River. This evaluation included the following steps:

- Determine travel time for COPCs to reach groundwater
- Compare COPC concentrations to PRGs, if the COPCs reach groundwater in 1,000 years.

This information was used in Sections 4.2 and 4.3 of the TSD CMS to determine if the COPCs are a threat to groundwater and/or Columbia River.

G1.3.1 Determination of Travel Time

Basis for the Calculations. For the tabulations in this appendix, it was assumed that contaminants migrate through the vadose zone at rates dependent on the local moisture content and recharge rate, and on their interactions with the recharge water. As the recharge rate increases, the contaminant migration becomes more rapid due to the higher pore water velocity. The chemical property K_d is an indication of the interactions between the contaminants dissolved in water and the soil matrix.

Tabulation of Data. The potential migration of contaminants in the crib and trench sediments to groundwater, evaluated in the 1301-N and 1325-N LFI report, was determined not to present a threat to groundwater. Therefore, this evaluation has not been repeated in this appendix.

The tabulation of the 116-N-1 and 116-N-3 borehole data is presented in Table G-6. The development of this information is discussed below.

Table G-2. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Surface Soils (0-10 ft) at 116-N-1.

Location:	199-N-107A					
Sample ID:	B0GL88	B0GL89	B0GGC3*	B0GLF4	B0GLF5	
Laboratory:	Quanterra	Quanterra	222-S	222-S	222-S	
Elevation (ft. above mean sea level):	451-449	449-447	N/A	451-449	449-447	Surface Exposure - MCRIS PRG
Depth (ft below ground surface):	9-11	11-13	N/A	9-11	11-13	
Date:	11/29/95	11/30/95	8/25/95	11/29/95	11/30/95	
Radionuclides (pCi/g)						
Cesium-137	**11,430**	**9,043**	**73,345**	**8,753**	**10,924**	46.5
Cobalt-60	**21,780**	**18,869**	**8,522**	**16,766**	**20,690**	9.7
Europium-154	**326**	**266**	**3,809**	**339**	**452**	20.5
Europium-155	**28.9**	**19.7**	**554**	**50**	**42**	843
Plutonium-239/240	**1,581**	**3,155**	**12,681**	NR	**638**	85.5
Strontium-90	**6,810**	**14,035**	**65,536**	**2,315**	**8,976**	3,885
Thorium-232	ND	ND	NR	NR	NR	6.6
Tritium	NR	NR	NR	NR	NR	16,110
Uranium-233/234	NR	NR	NR	NR	NR	199
Uranium-238	ND	ND	NR	NR	NR	262
Inorganics (mg/kg)						
Cadmium	**0.46 B**	**0.73**	NR	NR	NR	4,542
Chromium	**45.7 J**	**57.7 J**	NR	NR	NR	22,711
Lead	**6.3 J**	**21.9 J**	NR	NR	NR	250
Mercury	NR	NR	NR	NR	NR	1,363
Nitrate	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
B - Result value was less than the Required Detection Limit (RDL), but was greater than or equal to the IDL.
J - Estimated value
ND - Not detected
NR - Not requested
N/A - Not available
Shaded areas represent exceedences of PRGs
Bold areas represent detected values

Table G-3. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Surface Soils (0-10 ft) Outside 116-N-1/116-N-3. (Page 1 of 2)

Location:	199-N-75			199-N-76		199-N-104A	199-N-105A	
Sample ID:	B06837	B06838	B06839	B06835	B06836	104A-10	105A-10	
Laboratory:								Surface
Depth (ft below ground surface):	2-3	5-6	9	2-3	5-6	10	10	Exposure - MCRIS PRG
Date:	4/14/92	4/14/92	4/14/92	4/13/92	4/13/92	2/16/95	3/16/95	
Radionuclides (pCi/g)								
Cesium-137	ND	ND	ND	ND	ND	ND	ND	46.5
Cobalt-60	ND	ND	ND	ND	ND	ND	ND	9.7
Europium-154	NR	NR	NR	NR	NR	ND	ND	20.5
Europium-155	NR	NR	NR	NR	NR	ND	ND	843
Plutonium-239/240	NR	NR	NR	NR	NR	ND	ND	86
Strontium-90	ND	ND	ND	ND	ND	ND	**1.0**	3,885
Thorium-228	**0.55**	**0.7**	**0.67**	**0.62**	**0.41**	NR	NR	13.6
Thorium-232	**0.42**	**0.52**	**0.72**	**0.69**	**0.43**	**0.55**	**0.56**	6.6
Tritium	NR	NR	NR	NR	NR	NR	NR	16,110
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	199
Uranium-238	**0.55**	**0.50**	**0.73**	**0.53**	**0.46**	ND	ND	262
Inorganics (mg/kg)								
Cadmium	**0.43**	**0.61**	**0.49**	**0.48**	**0.52**	NR	NR	4,542
Chromium	**8.5**	**8.7**	**7.6**	**8.2**	**8.3**	NR	NR	22,711
Lead	**5.1**	**4.2**	**4.2**	**4.5**	**3.4**	NR	NR	250
Mercury	ND	ND	ND	ND	**0.11**	NR	NR	1,363
Nitrate	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
ND - Not detected
NR - Not requested
N/A - Not available
Bold areas represent detected values

Table G-3. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Surface Soils (0-10 ft) Outside 116-N-1/116-N-3. (Page 2 of 2)

Location:							
Sample ID:	RW #1	RW #1	RW #2	RW #2	RW #3	RW #3	Surface Exposure - MCRIS PRG
Laboratory:							
Depth (ft below ground surface):	5	10	5	10	5	10	
Date:	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	
Radionuclides (pCi/g)							
Cesium-137	**0.35**	**0.40**	**0.01**	**0.01**	**0.01**	**0.02**	46.5
Cobalt-60	**0.02**	**0.02**	**0.002**	**0.002**	**0.001**	**0.001**	9.7
Europium-154	NR	NR	NR	NR	NR	NR	20.5
Europium-155	NR	NR	NR	NR	NR	NR	843
Plutonium-239/240	NR	NR	NR	NR	NR	NR	86
Strontium-90	NR	NR	NR	NR	NR	NR	3,885
Thorium-228	NR	NR	NR	NR	NR	NR	13.6
Thorium-232	NR	NR	NR	NR	NR	NR	6.6
Tritium	NR	NR	NR	NR	NR	NR	16,110
Uranium-233/234	NR	NR	NR	NR	NR	NR	199
Uranium-238	NR	NR	NR	NR	NR	NR	262
Inorganics (mg/kg)							
Cadmium	NR	NR	NR	NR	NR	NR	4,542
Chromium	NR	NR	NR	NR	NR	NR	22,711
Lead	NR	NR	NR	NR	NR	NR	250
Mercury	NR	NR	NR	NR	NR	NR	1,363
Nitrate	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
ND - Not detected
NR - Not requested
N/A - Not available
Bold areas represent detected values

Table G-4. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Surface Soils (0-15 ft) at 116-N-1.

Location:	199-N-107A					199-N-108A	
Sample ID:	B0GL88	B0GL89	B0GGC3*	B0GLF4	B0GLF5	B0GL71	
Laboratory:	Quanterra	Quanterra	222-S	222-S	222-S	Quanterra	
Elevation (ft. above mean sea level):	451-449	449-447	N/A	451-449	449-447	443-441	Surface Exposure - Rural-Residential PRG
Depth (ft below ground surface):	9-11	11-13	N/A	9-11	11-13	14.5-16.5	
Date:	11/29/95	11/30/95	8/25/95	11/29/95	11/30/95	11/9/95	
Radionuclides (pCi/g)							
Cesium-137	11,430	9,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.1
Cobalt-60	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.4
Europium-152	326	263	[illegible]	335	452	**2.68**	3.1
Europium-155	**28.9**	**19.7**	[illegible]	**50**	**42**	**0.33**	127
Plutonium-239/240	1,588	3,335	12,681	NR	688	**12.6**	23.5
Strontium-90	6,810	14,035	65,336	2,315	8,976	546	3.7
Thorium-232	ND	ND	NR	NR	NR	ND	0.94
Tritium	NR	NR	NR	NR	NR	NR	241
Uranium-233/234	ND	ND	NR	NR	NR	ND	101
Uranium-238	ND	ND	NR	NR	NR	**1.74**	69
Inorganics (mg/kg)							
Cadmium	**0.46 B**	**0.73**	NR	NR	NR	ND	80
Chromium	**45.7 J**	**57.7 J**	NR	NR	NR	**22.2 J**	400
Lead	**6.3 J**	**21.9 J**	NR	NR	NR	**0.57 J**	250
Mercury	NR	NR	NR	NR	NR	NR	24
Nitrate	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
J - Estimated value
ND - Not detected
NR - Not requested
N/A - Not available
Shaded areas represent exceedences of PRGs
Bold areas represent detected values

Table G-5. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Surface Soils (0-15 ft) Outside 116-N-1/116-N-3. (Page 1 of 2)

Location:	199-N-75			199-N-76		199-N-104A	199-N-105A		199-N-106A	
Sample ID:	B06837	B06838	B06839	B06835	B06836	104A-10	105A-10	105A-15	106A-15	Surface Exposure - Rural-Residential PRG
Laboratory:										
Depth (ft below ground surface):						10	10	15	15	
Date:	4/14/92	4/14/92	4/14/92	4/13/92	4/13/92	2/16/95	3/16/95	3/16/95	8/10/95	
Radionuclides (pCi/g)										
Cesium-137	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.1
Cobalt-60	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.4
Europium-154	NR	NR	NR	NR	NR	ND	ND	ND	ND	3.1
Europium-155	NR	NR	NR	NR	NR	ND	ND	ND	ND	127
Plutonium-239/240	NR	NR	NR	NR	NR	ND	ND	ND	ND	23.5
Strontium-90	ND	ND	ND	ND	ND	ND	**1.0**	**0.61**	NR	3.7
Thorium-228	**0.55**	**0.7**	**0.67**	**0.62**	**0.41**	NR	NR	NR	NR	2.2
Thorium-232	**0.42**	**0.52**	**0.72**	**0.69**	**0.43**	**0.55**	**0.56**	**0.44**	**0.58**	0.94
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	241
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	101
Uranium-238	**0.55**	**0.50**	**0.73**	**0.53**	**0.46**	ND	ND	ND	ND	69
Inorganics (mg/kg)										
Cadmium	**0.43**	**0.61**	**0.49**	**0.48**	**0.52**	NR	NR	NR	NR	80
Chromium	**8.5**	+	**7.6**	**8.2**	**8.3**	NR	NR	NR	NR	400
Lead	**5.1**	**4.2**	**4.2**	**4.5**	**3.4**	NR	NR	NR	NR	250
Mercury	ND	ND	ND	ND	**0.11**	NR	NR	NR	NR	24
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
ND - Not detected
NR - Not requested
N/A - Not available
Bold areas represent detected values

Table G-5. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Surface Soils (0-15 ft) Outside 116-N-1/116-N-3. (Page 2 of 2)

Location:										Surface Exposure - Rural-Residential PRG
Sample ID:	RW #1	RW #1	RW #1	RW #2	RW #2	RW #2	RW #3	RW #3	RW #3	
Laboratory:										
Depth (ft below ground surface)	5	10	15	5	10	15	5	10	15	
Date:	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	
Radionuclides (pCi/g)										
Cesium-137	**0.35**	**0.40**	**0.357**	**0.01**	**0.01**	**0.004**	**0.01**	**0.02**	**0.013**	6.1
Cobalt-60	**0.02**	**0.02**	**0.021**	**0.002**	**0.002**	**0.002**	**0.001**	**0.001**	**0.001**	1.4
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	3.1
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	127
Plutonium-239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR	23.5
Strontium-90	NR	NR	NR	NR	NR	NR	NR	NR	NR	3.7
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.2
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.94
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	241
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	101
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	69
Inorganics (mg/kg)										
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	80
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	400
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	250
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	24
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
ND - Not detected
NR - Not requested
N/A - Not available
Bold areas represent detected values

Table G-6. Constituent Transport and Soil Concentration at Water Table Modified CRCIA Ranger/Industrial and Rural-Residential Exposure Scenario. (Page 1 of 4)

			Rural-Residential Exposure Scenario		MCRIS Exposure Scenario	
Constituent	Elevation meters (ft) above MSL	Borehole Soil Concentration (pCi/g or mg/kg)	Travel Time to Water Table (years)	Concentration in Soil at Water Table (pCi/g or mg/kg)	Travel Time to Water Table (years)	Concentration in Soil at Water Table (pCi/g or mg/kg)
199-N-75A						
Chromium VI	137.5(451)	8.5	30	8.5	125	8.5
	136.5(448)	8.7	29	8.7	120	8.7
	135.6(445)	7.6	28	7.6	115	7.6
	120.7(396)	14.7	3.5	14.7	15	14.7
Europium-154	All	Undetected	--	--	--	--
Europium-155	All	Undetected	--	--	--	--
Thorium-232	137.5(451)	0.42	100,000	0.42	550,000	0.42
	136.5(448)	0.52	90,000	0.52	500,000	0.52
	135.6(445)	0.72	85,000	0.72	470,000	0.72
	120.7(396)	0.39	17,000	0.39	95,000	0.39
Uranium-233/234	135.6(445)	Undetected	--	--	--	--
	120.7(396)	0.62	170	0.62	1,200	0.62
Uranium-238	137.5(451)	0.53	1,000	0.53	5,700	0.53
	136.5(448)	0.5	990	0.5	5,400	0.5
	135.6(445)	0.73	900	0.73	4,900	0.73
	120.7(396)	0.47	170	0.47	990	0.47
199-N-76A						
Chromium VI	135.9(446)	8.2	28	8.2	120	8.2
	135(443)	8.3	27	8.3	115	8.3
	129.2(424)	11.3	18	11.3	69	11.3
	119.5(392)	11.4	2.1	11.4	8.5	11.4
Europium-154	All	Undetected	--	--	--	--
Europium-155	All	Undetected	--	--	--	--
Thorium-232	135.9(446)	0.69	90,000	0.69	460,000	0.69
	135(443)	0.43	87,000	0.43	420,000	0.43
	129.2(424)	Undetected	--	--	--	--
	119.5(392)	0.41	11,000	0.41	62,000	0.41
Uranium-233/234	119.5(392)	1.2	120	1.2	650	1.2
Uranium-238	135.9(446)	0.53	950	0.53	5,000	0.53
	135(443)	0.46	850	0.46	4,400	0.46
	129.2(424)	0.53	600	0.53	3,200	0.53
	119.5(392)	0.49	120	0.49	650	0.49
199-N-80						
Chromium VI	All	Undetected	--	--	--	--
Europium-154	All	Undetected	--	--	--	--
Europium-155	All	Not Requested	--	--	--	--
Thorium-232	124.3(408)	0.67	32,000	0.67	180,000	0.67
	122.8(403)	Undetected	--	--	--	--
Uranium-233/234	120.7(396)	0.33	170	0.33	950	0.33
	117.3(385)	0.36	7	0.36	15	0.36
Uranium-238	117.3(385)	0.35	7	0.35	15	0.35

Table G-6. Constituent Transport and Soil Concentration at Water Table Modified CRCIA Ranger/Industrial and Rural-Residential Exposure Scenario. (Page 2 of 4)

			Rural-Residential Exposure Scenario		MCRIS Exposure Scenario	
Constituent	Elevation meters (ft) above MSL	Borehole Soil Concentration (pCi/g or mg/kg)	Travel Time to Water Table (years)	Concentration in Soil at Water Table (pCi/g or mg/kg)	Travel Time to Water Table (years)	Concentration in Soil at Water Table (pCi/g or mg/kg)
199-N-103A						
Chromium VI	All	Not Requested	--	--	--	--
Europium-154	All	Undetected	--	--	--	--
Europium-155	128.9(423)	0.046	53,000	0	300,000	0
Thorium-232	All	Undetected	--	--	--	--
Uranium-233/234	All	Not Requested	--	--	--	--
Uranium-235	All	Not Requested			--	--
Uranium-238	128.9(423)	0.518	550	0.518	3,000	0.518
199-N-104A						
Chromium VI	All	Not Requested	--	--	--	--
Europium-154	All	Undetected	--	--	--	--
Europium-155	All	Undetected	--	--	--	--
Thorium-232	138.9(456)	0.55	Off Scale	--	Off Scale	--
	135.9(446)	0.38	90,000	0.38	500,000	0.38
	132.8(436)	0.47	80,000	0.47	425,000	0.47
	129.8(426)	0.51	60,000	0.51	325,000	0.51
	126.7(416)	0.37	42,000	0.37	230,000	0.37
	124.0(406)	0.46	29,000	0.46	175,000	0.46
	122.2(401)	0.36	20,000	0.36	120,000	0.36
	120.7(396)	0.67	15,000	0.67	80,000	0.67
	119.2(391)	0.4	7,500	0.4	41,000	0.4
Uranium-233/234	All	Not Requested	--	--	--	--
Uranium-238	118.9(390)	0.87	50	0	300	0.87
199-N-105A						
Chromium VI	All	Not Requested	--	--	--	--
Europium-152	131.6(432)	0.23	67,000	0	380,000	0
Europium-154	All	Undetected	--	--	--	--
Europium-155	All	Undetected	--	--	--	--
Thorium-232	136.2(447)	0.56	95,000	0.56	500,000	0.56
	134.7(442)	0.44	80,000	0.44	450,000	0.44
	133.2(437)	0.53	70,000	0.53	420,000	0.53
	131.6(432)	0.55	67,000	0.55	380,000	0.55
	130.1(427)	0.38	60,000	0.38	325,000	0.38
	128.6(422)	0.42	53,000	0.42	300,000	0.42
	127.1(417)	0.29	48,000	0.29	275,000	0.29
	125.5(412)	0.4	39,000	0.4	225,000	0.4
	124.0(407)	0.29	31,000	0.29	180,000	0.29
	122.5(402)	0.41	23,000	0.41	150,000	0.41
	121.0(397)	0.43	18,000	0.43	120,000	0.43
Uranium-233/234	All	Not Requested	--	--	--	--
Uranium-238	128.3(421)	0.498	580	0.498	3,300	0.498

Table G-6. Constituent Transport and Soil Concentration at Water Table Modified CRCIA Ranger/Industrial and Rural-Residential Exposure Scenario. (Page 3 of 4)

			Rural-Residential Exposure Scenario		MCRIS Exposure Scenario	
Constituent	Elevation meters (ft) above MSL	Borehole Soil Concentration (pCi/g or mg/kg)	Travel Time to Water Table (years)	Concentration in Soil at Water Table (pCi/g or mg/kg)	Travel Time to Water Table (years)	Concentration in Soil at Water Table (pCi/g or mg/kg)
199-N-106A						
Chromium VI	All	Not Requested	--	--	--	--
Europium-154	All	Undetected	--	--	--	--
Europium-155	All	Undetected	--	--	--	--
Thorium-232	134.7(442)	0.58	84,000	0.58	460,000	0.58
	131.6(432)	0.45	72,000	0.45	360,000	0.45
	128.6(422)	0.48	51,000	0.48	290,000	0.48
	125.5(412)	0.38	38,000	0.38	110,000	0.38
	122.5(402)	0.49	27,000	0.49	160,000	0.48
	119.5(392)	0.48	12,000	0.48	72,000	0.48
Uranium-233/234	All	Not Requested	--	--	--	--
Uranium-238	All	Undetected	--	--	--	--
199-N-107A						
Chromium VI	136.8(449)	45.7	31	45.7	115	45.7
	136.2(447)	57.7	29	57.7	112	57.7
	131.0(430)	12.7	24	12.7	90	12.7
	122.2(401)	12.4	6	12.4	22	12.4
Europium-154	136.8(449)	1030	90,000	0	500,000	0
	136.2(447)	1370	85,000	0	480,000	0
	133.1(437)	Undetected	--	--	--	--
Europium-155	136.8(449)	207	90,000	0	500,000	0
	136.2(447)	141	85,000	0	480,000	0
Plutonium-239/240	136.9(449)	1590	78,000	1590	380,000	0.0285
	136.2(447)	3340	74,000	3340	360,000	0.106
	131.3(431)	0.07	54,000	0.07	260,000	0
	122.2(401)	Undetected	--	--	--	--
Thorium-232	136.2(447)	Undetected	--	--	--	--
	131.0(430)	1.08	53,000	1.08	330,000	1.08
	122.2(401)	0.624	28,000	0.624	200,000	0.624
Uranium-233/234	136.2(447)	Undetected	--	--	--	--
	131.0(430)	0.48	675	0.48	3,500	0.475
	122.2(401)	0.3	130	0.3	1,400	0.299
Uranium-238	136.2(447)	Undetected	--	--	--	--
	131.0(430)	0.44	675	0.44	3,500	0.44
	122.2(401)	0.36	130	0.36	1,400	0.36
199-N-108A						
Chromium VI	134.3(440.5)	22.2	25	22.2	110	22.2
	131.6(432)	20.4	21	20.4	84	20.4
	125.8(413)	27.3	15	27.3	60	27.3
	119.9(393.5)	13	2	13	8	13
Europium-154	134.3(440.5)	8.17	80,000	0	425,000	0
	131.6(432)	0.23	70,000	0	400,000	0
	125.8(413)	Undetected	--	--	--	--
Europium-155	134.3(440.5)	2.36	80,000	0	425,000	0

Table G-6. Constituent Transport and Soil Concentration at Water Table Modified CRCIA Ranger/Industrial and Rural-Residential Exposure Scenario. (Page 4 of 4)

			Rural-Residential Exposure Scenario		MCRIS Exposure Scenario	
Constituent	Elevation meters (ft) above MSL	Borehole Soil Concentration (pCi/g or mg/kg)	Travel Time to Water Table (years)	Concentration in Soil at Water Table (pCi/g or mg/kg)	Travel Time to Water Table (years)	Concentration in Soil at Water Table (pCi/g or mg/kg)
199-N-108A (Continued)						
Plutonium-239/240	134.2(440.5)	12.6	65,000	12.6	330,000	0.001
	133.8(439)	73.7	64,000	73.7	325,000	0.0064
Thorium-232	134.3(440.5)	Undetected	--	--	--	--
	131.6(432)	1.12	70,000	1.12	400,000	1.12
	125.8(413)	0.6	40,000	0.6	230,000	0.6
	119.9(393.5)	0.82	12,000	0.82	65,000	0.82
Uranium-233/234	136.2(447)	Undetected	--	--	--	--
	125.8(413)	0.53	410	0.53	2,500	0.526
	119.9(393.5)	0.4	250	0.4	500	0.399
Uranium-238	134.3(440.5)	1.74	800	1.74	4,400	1.74
	131.6(432)	0.84	525	0.84	3,000	0.84
	125.8(413)	0.49	410	0.49	2,500	0.49
	119.9(393.5)	0.48	250	0.48	500	0.48
199-N-109A						
Chromium VI	134.4(441)	8.9	14	8.9	52	8.9
	133.8(439)	6.2	13	6.2	50	6.2
	131.6(432)	3.2	11	3.2	43	3.2
	129.5(425)	5	8	5	35	5
	124.9(410)	1.7	6	1.7	27	1.7
	118.7(389.5)	12.2	1	12.2	3	12.2
Europium-152	129.5(425)	2.05	59,000	0	330,000	0
	124.9(410)	0.21	25,000	0	200,000	0
	118.7(389.5)	Undetected	--	--	--	--
Europium-154	134.4(441)	2.86	80,000	0	425,000	0
Europium-155	134.4(441)	2.02	80,000	0	425,000	0
Plutonium-239/240	134.4(441)	24.1	70,000	24.1	360,000	0.0008
	133.8(439)	Undetected	--	--	--	--
	131.6(432)	0.15	56,000	0.15	280,000	0
Thorium-232	131.6(432)	0.62	70,000	0.62	400,000	0.62
	129.5(425)	0.5	59,000	0.5	330,000	0.5
	124.9(410)	0.68	25,000	0.68	200,000	0.68
	118.7(389.5)	0.61	2,400	0.61	20,000	0.61
Uranium-233/234	134.4(441)	1.36	800	1.36	4,750	1.34
	133.8(439)	Undetected	--	--	--	--
	131.6(432)	0.73	700	0.73	4,000	0.722
	129.5(425)	0.64	600	0.64	3,500	0.634
	124.9(410)	0.35	340	0.35	2,000	0.348
	118.7(389.5)	0.45	48	0.45	280	0.45
Uranium-238	131.6(432)	0.44	700	0.44	4,000	0.44
	129.5(425)	0.53	600	0.53	3,500	0.53
	124.9(410)	0.5	340	0.5	2,000	0.5
	118.7(389.5)	0.42	48	0.42	280	0.42

Constituent Travel Times. Calculation of travel times to groundwater began with the development of transport curves for each borehole and contaminant. The transport curves were determined by local moisture content, hydrogeology, recharge rates, and contaminant K_d values. The transport curves for 116-N-1 and 116-N-3 are provided in Figure G-1. Examination of these figures reveals that there are two curves in each graph. The curve closest to the primary y-axis represents the rural-residential exposure scenario, which has a recharge rate of 8.28 cm/yr (3.3 in./yr). The second curve represents the modified CRCIA ranger/industrial exposure scenario with a recharge rate of 1.44 cm/yr (0.6 in./yr).

The travel times to groundwater for the borehole samples were taken directly from Figure G-1. The primary y-axis in these graphs represents the elevation of the samples above groundwater. The elevation of a borehole sample is identified on the secondary y-axis. This elevation line is plotted horizontally to intersect with the transport curve. A vertical line from the intersection point to the x-axis yields the travel time to the water table for the corresponding sample elevation.

After the travel times were obtained for the rural-residential and modified CRCIA ranger/industrial exposure scenarios, they were entered into the fifth and seventh columns in Table G-6, respectively. For example, uranium-233/234 present in borehole 199-N-75A at an elevation of 121.0 m (397 ft) takes 1,200 years to travel to groundwater in a modified CRCIA ranger/industrial exposure scenario. Under both exposure scenarios, chromium, uranium-233/234, and uranium-238 were predicted to reach groundwater within 1,000 years. Furthermore, nitrate and tritium, if present in soil, were also predicted to reach groundwater within 1,000 years.

G1.3.2 Comparison of Subsurface Soil Data

After contaminants that reach groundwater had been identified and decayed, the comparison of subsurface soil data to PRGs was performed.

Tables G-7 through G-12 show the data for the COPCs decayed to the year 2010. These data were then compared to the PRGs identified for rural-residential and modified CRCIA ranger/industrial exposure scenarios (Table 3-6). Concentrations exceeding PRGs are in bold text and highlighted. Summaries of these comparisons are provided in Tables 4-2 through 4-5 of this TSD CMS.

G2.0 REFERENCES

DOE-RL, 1996, *1301-N and 1325-N Liquid Waste Disposal Facilities Limited Field Investigation Report*, DOE/RL-96-11, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Figure G-1. Travel Times to Groundwater for K_d Values of 0, 1.4, 2, 3, 15, 25, 30, 50, and 200 mL/g. (Page 1 of 7)

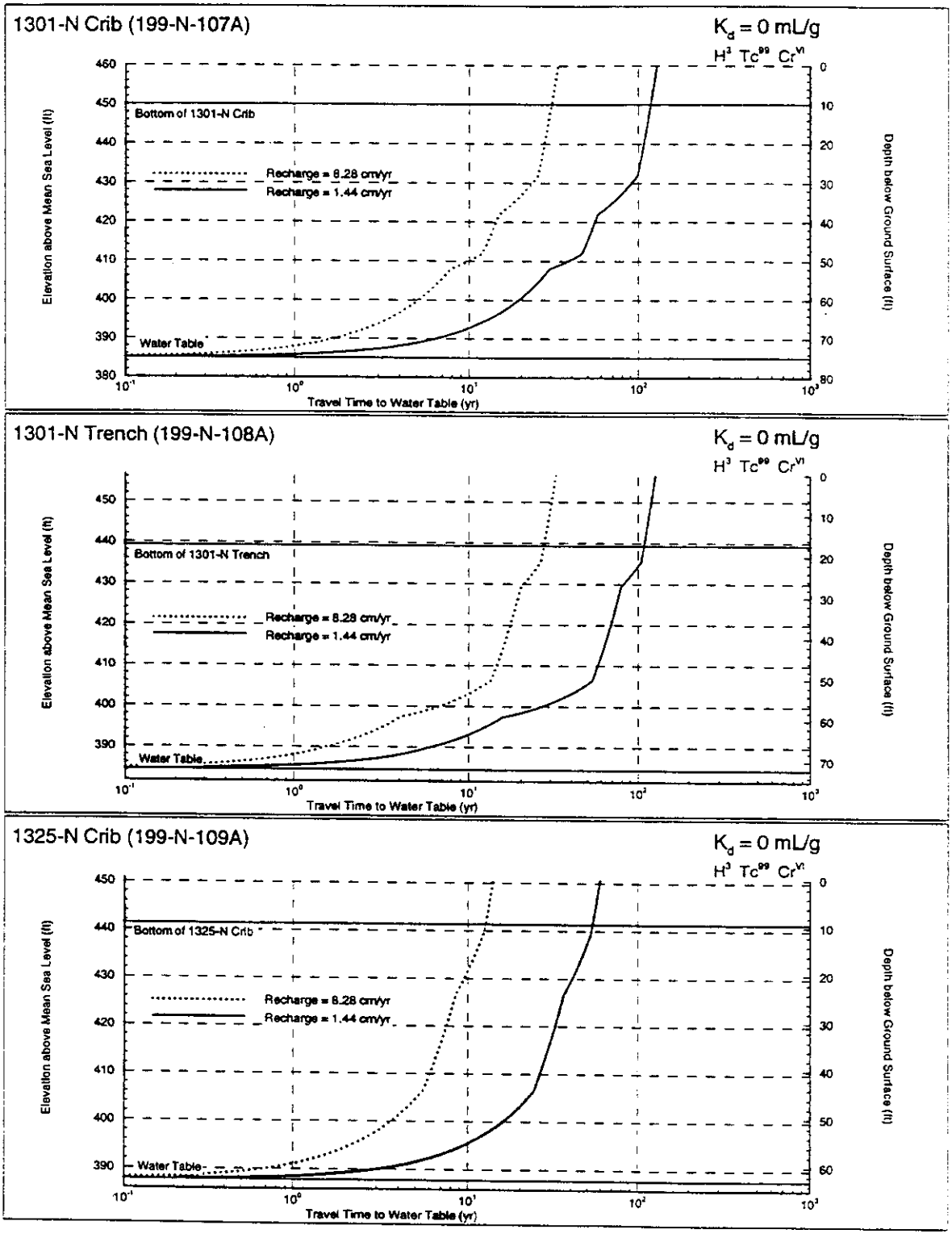

Figure G-1. Travel Times to Groundwater for K_d Values of 0, 1.4, 2, 3, 15, 25, 30, 50, and 200 mL/g. (Page 2 of 7)

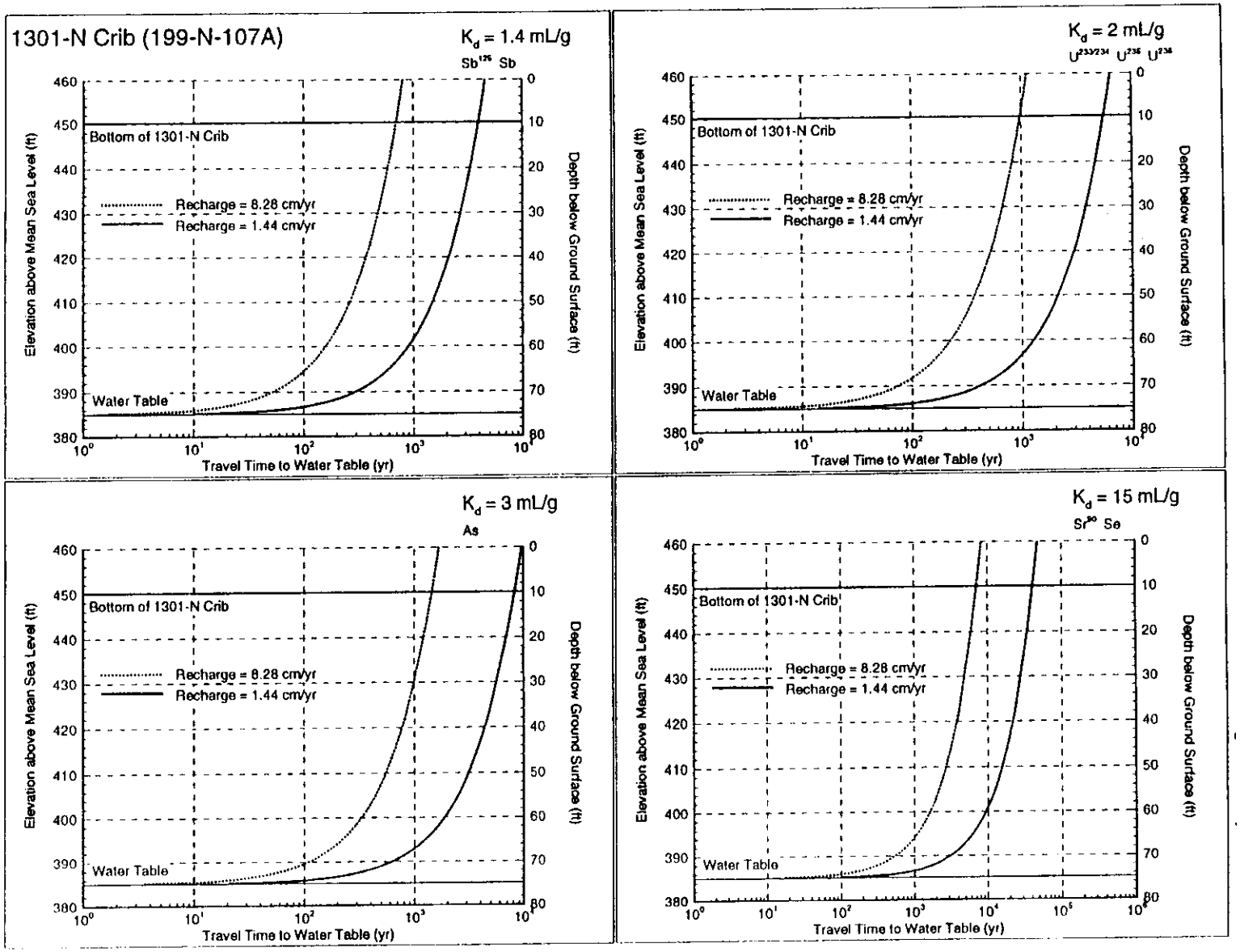

Figure G-1. Travel Times to Groundwater for K_d Values of 0, 1.4, 2, 3, 15, 25, 30, 50, and 200 mL/g. (Page 3 of 7)

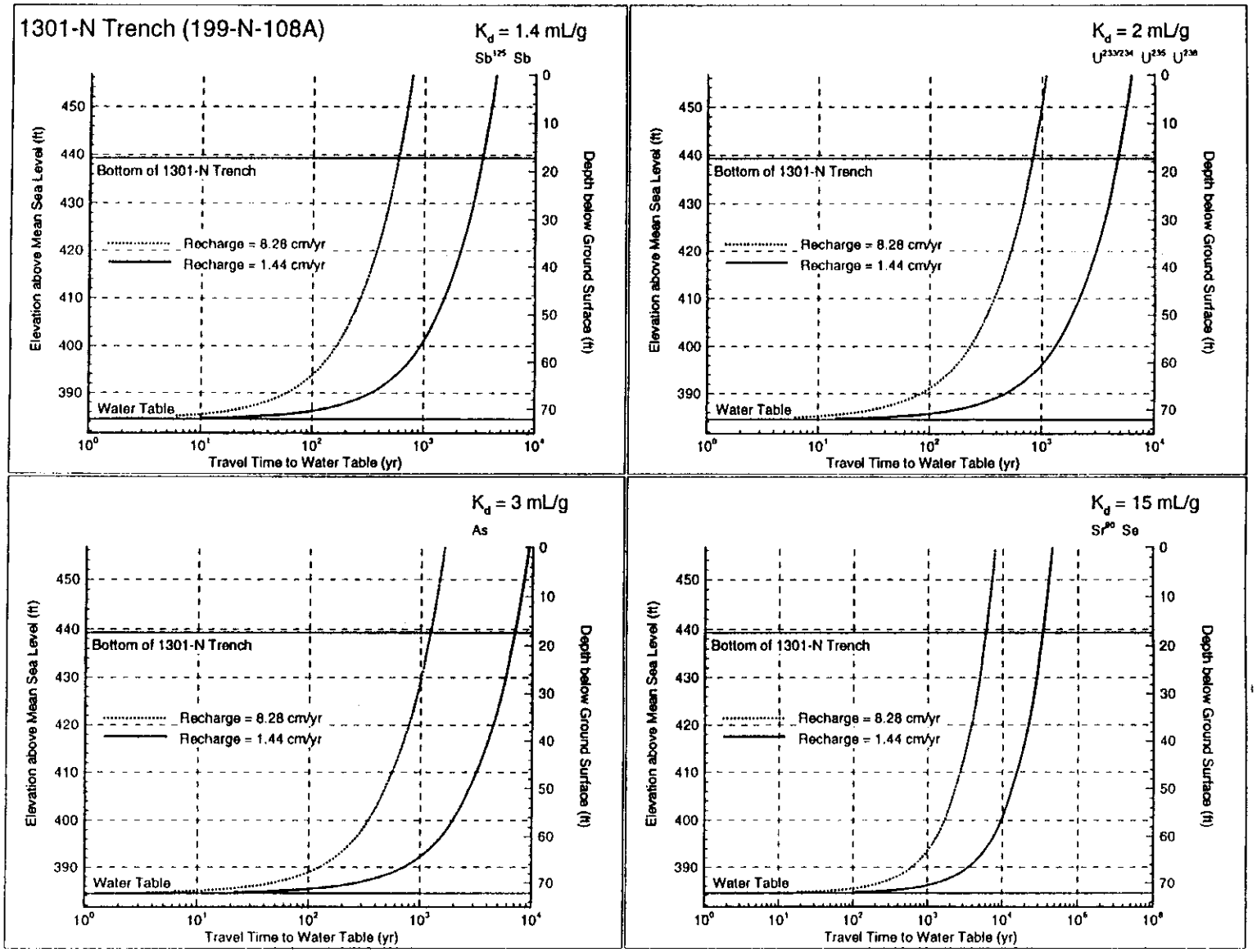

Figure G-1. Travel Times to Groundwater for K_d Values of 0, 1.4, 2, 3, 15, 25, 30, 50, and 200 mL/g. (Page 4 of 7)

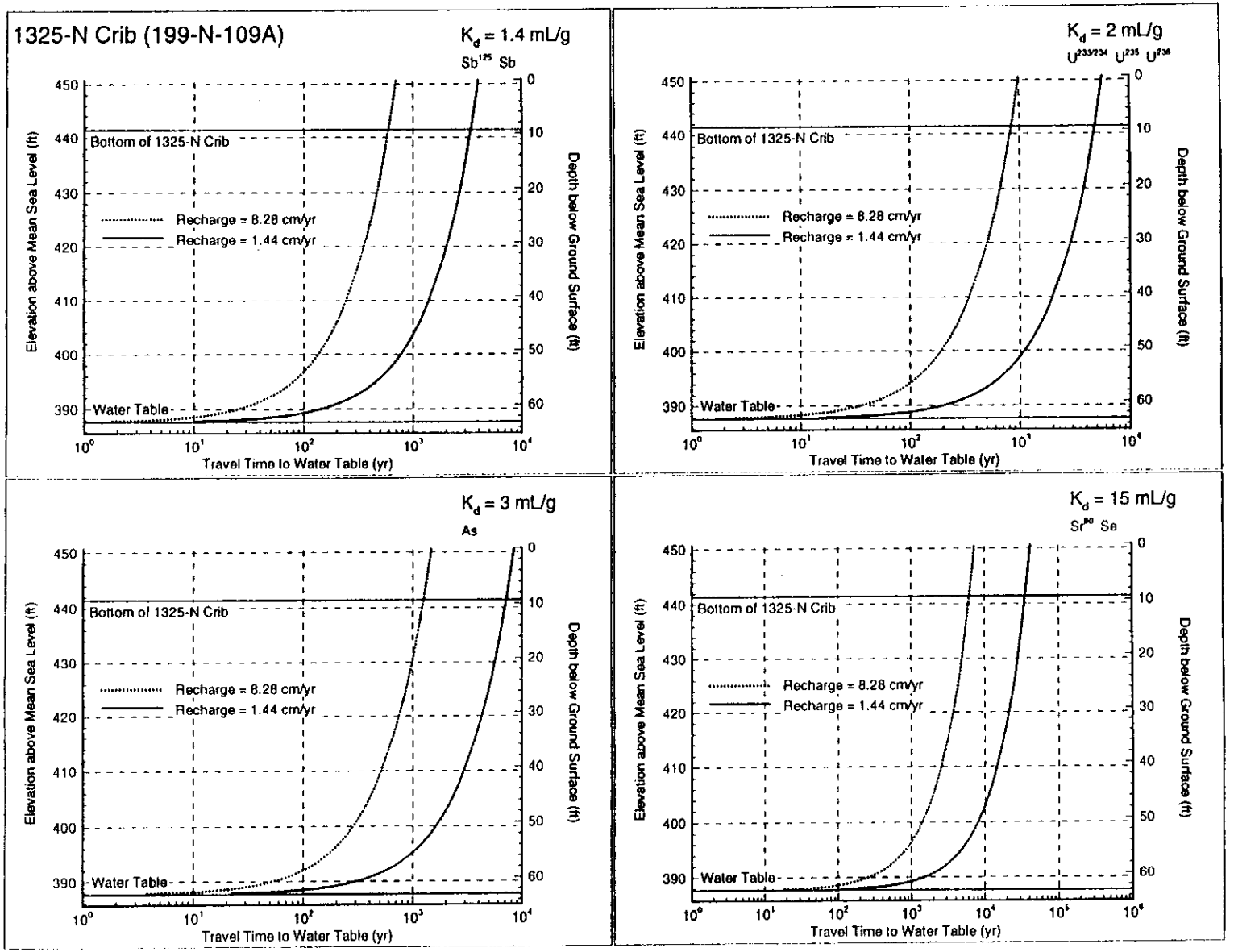

Figure G-1. Travel Times to Groundwater for K_d Values of 0, 1.4, 2, 3, 15, 25, 30, 50, and 200 mL/g. (Page 5 of 7)

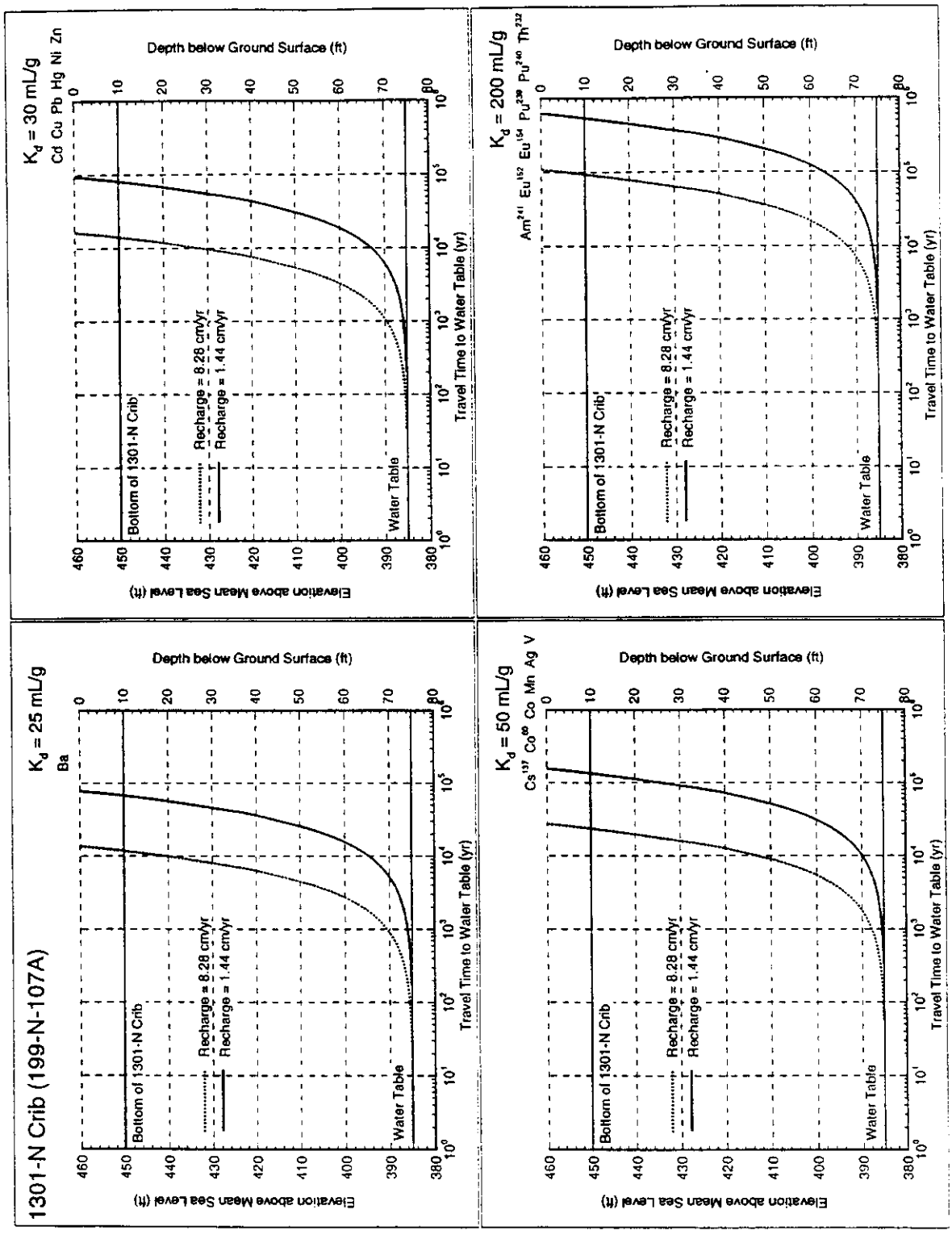

Figure G-1. Travel Times to Groundwater for K_d Values of 0, 1.4, 2, 3, 15, 25, 30, 50, and 200 mL/g. (Page 6 of 7)

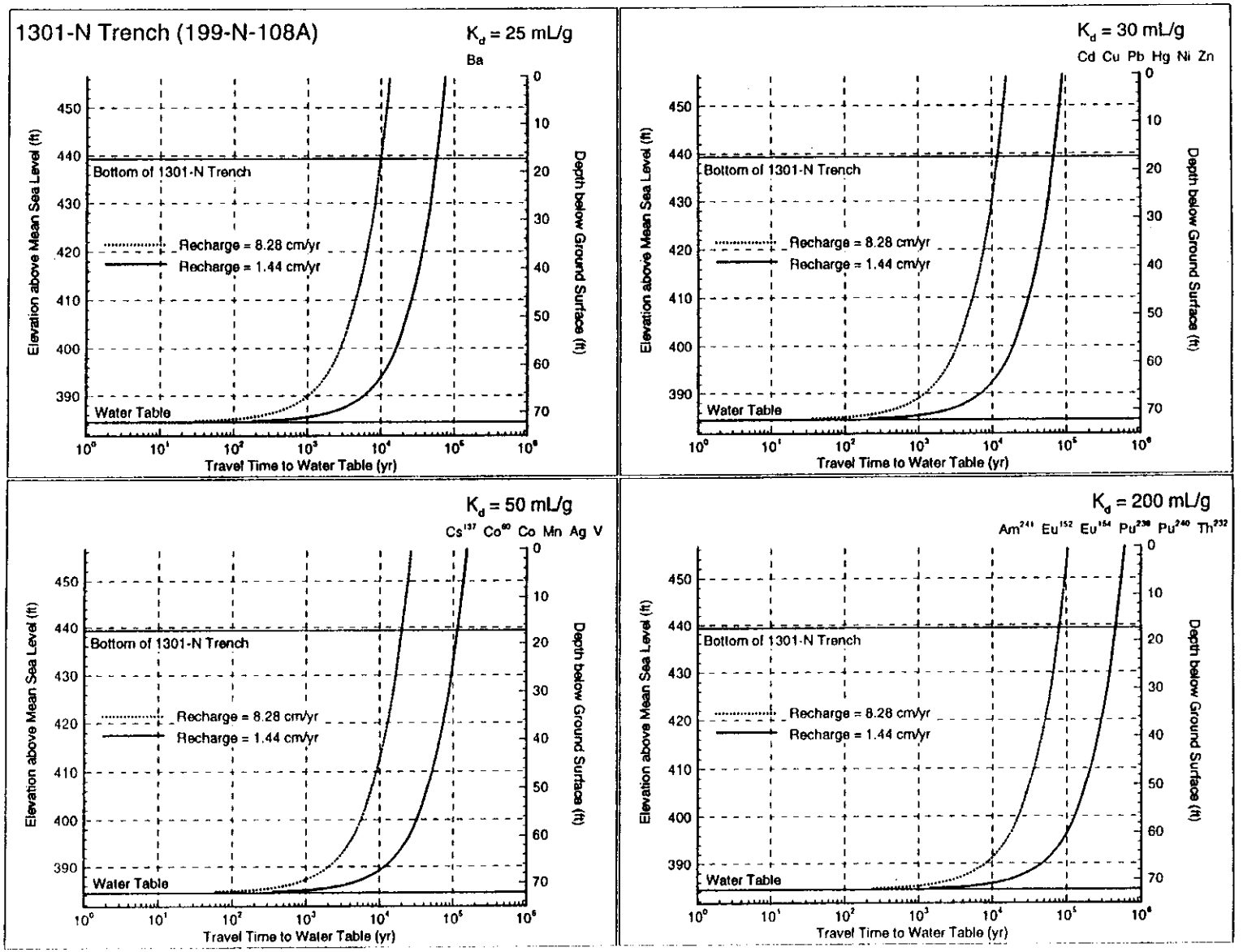

Figure G-1. Travel Times to Groundwater for K_d Values of 0, 1.4, 2, 3, 15, 25, 30, 50, and 200 mL/g. (Page 7 of 7)

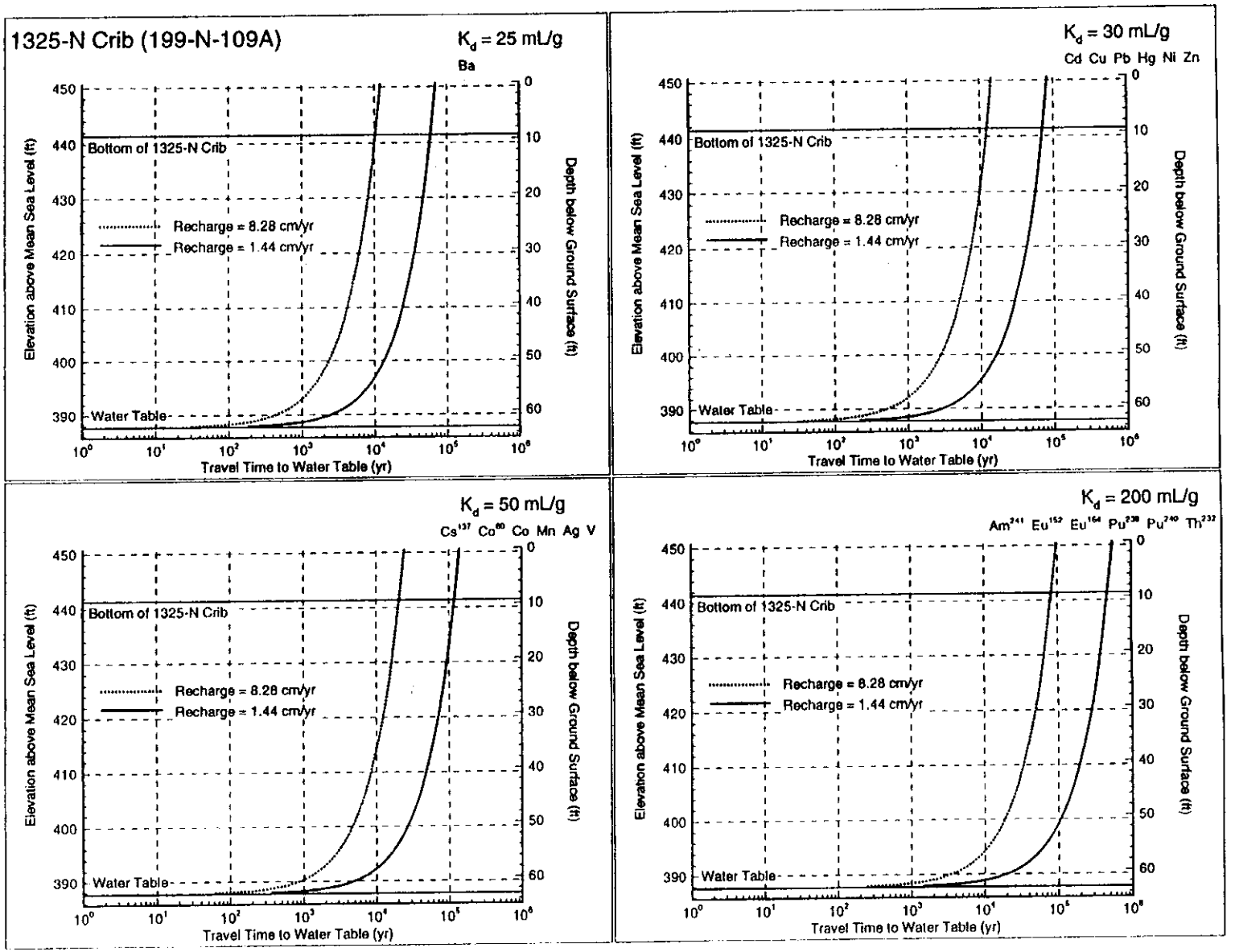

Table G-7. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) at 116-N-1. (Page 1 of 7)

Location:	199-N-107A										Protection of Groundwater and River - MCRIS PRG
Sample ID:	B0GL91	B0GL92 (Dup)	B0GL95	B0GLF7	B0GLF6	B0GLF8 (Dup)	B0GLF9	B0GLG0	B0GLG1	B0H1V6	
Laboratory:	Quanterra	Quanterra	Quanterra	222-S	222-S	222-S	222-S	222-S	222-S	222-S	
Elevation (ft. above mean sea level):	432-430	432-430	403-401	437	432-430	432-430	420	410	403-401	391	
Depth (ft below ground surface):	28-30	28-30	57-59	23	28-30	28-30	40	50	57-59	69	
Date:	12/5/95	12/5/95	12/8/95	12/5/95	12/5/95	12/5/95	12/6/95	12/6/95	12/8/95	12/8/95	
Radionuclides (pCi/g)											
Cesium-137	**1.78**	**4.35**	ND	**2,019**	**4.2**	**4.12**	ND	NR	ND	ND	
Cobalt-60	**0.78**	**0.875**	**0.203**	**3.75**	**0.914**	**0.824**	**0.189**	**0.123**	**0.181**	**0.111**	
Europium-154	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Europium-155	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Plutonium-239/240	ND	**0.07**	ND	ND	ND	ND	ND	ND	ND	ND	
Strontium-90	**1,090**	**934**	**35.6**	**834**	**1,105**	**962**	**770**	**134**	**45**	**38.9**	
Thorium-232	**1.08**	NR	**0.624**	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	**0.414**	**0.479**	**0.302**	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	**0.363**	**0.441**	**0.364**	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)											
Cadmium	**0.37 B**	**0.47 B**	**0.19**	NR	NR	NR	NR	NR	NR	NR	
Chromium	**8 J**	**12.7 J**	**12.4 J**	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	**1.3 J**	**1.2 J**	**1.5 J**	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
B - Result value was less than the Required Detection Limit (RDL), but was greater than or equal to the IDL.
J - Estimated value
ND - Not detected
NR - Not requested
N/A - Not available
Shaded areas represent exceedences of PRGs
Bold areas represent detected values
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs except chromium as noted. Therefore, being protective of groundwater is also being protective of the Columbia River.
[a] 8 - protection of groundwater, 2- protection of Columbia River

Table G-7. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) at 116-N-1. (Page 2 of 7)

Location:	199-N-108A										Protection of Groundwater and River - MCRIS PRG
Sample ID:	B0GL73	B0GL75 (Dup)	B0GL81	B0GL86	B0GLD3	B0GLD4 (Dup)	B0GLD6	B0GLD7	B0GLD8	B0GLD9	
Laboratory:	Quanterra	Quanterra	Quanterra	222-S	222-S	222-S	222-S	222-S	222-S	222-S	
Elevation (ft. above mean sea level):	434-432	434-432	415-413	395-393.5	434-432	434-432	429	424.5	415-413	410	
Depth (ft below ground surface):	23-25	23-25	42-44	62-63.5	23-25	23-25	28	32.5	42-44	47	
Date:	11/10/95	11/10/95	11/15/95	11/16/95	11/10/95	11/10/95	11/10/95	11/10/95	11/15/95	11/15/95	
Radionuclides (pCi/g)											
Cesium-137	**32**	**47.5**	ND	ND	**78**	**61.3**	**4.2**	ND	ND	ND	
Cobalt-60	**1.1**	**1.43**	**0.085**	**0.083**	**1.62**	**2.21**	**0.914**	ND	ND	ND	
Europium-154	ND	**0.076**	ND	ND	ND	ND	ND	ND	ND	ND	
Europium-155	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Plutonium-239/240	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Strontium-90	**1017 J**	**1080 J**	**41.2 J**	**102**	**1,003**	**982**	**1,105**	**84.7**	**17.5**	**3.1**	
Thorium-232	NR	**1.12**	**0.596**	**0.635**	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	ND	**1**	**0.534**	**0.398**	NR	NR	NR	NR	NR	NR	2
Uranium-238	ND	**0.842**	**0.487**	**0.48**	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)											
Cadmium	ND	ND	ND	ND	NR	NR	NR	NR	NR	NR	
Chromium	**18.5 J**	**20.4 J**	**27.3 J**	**13 J**	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	**0.69 J**	**0.76 J**	**0.21 BJ**	**0.63 J**	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

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Table G-7. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) at 116-N-1. (Page 3 of 7)

Location:	199-N-108A				116-N-1						Protection of Groundwater and River - MCRIS PRG
Sample ID:	B0GLF0	B0GLF1	B0GLF2	B0GLF3	TS-01	TS-01	TS-01	TS-01	TS-01	TS-01	
Laboratory:	222-S	222-S	222-S	222-S							
Elevation (ft. above mean sea level):	405	397.5	395-393.5	388	~439	~439	~439	~439	~439	~439	
Depth (ft below ground surface):	52	59.5	62-63.5	69							
Date:	11/15/95	11/15/95	11/16/95	11/16/95	1980	1981	1982	1983	1984	1985	
Radionuclides (pCi/g)											
Cesium-137	ND	ND	ND	ND	**137,174**	**98,738**	**499,637**	**45,123,298**	**1,746,614**	**16,712**	
Cobalt-60	ND	ND	ND	ND	**251,478**	**145,657**	**528,541**	**631,473**	**1,873,212**	**52,400**	
Europium-154	ND	ND	ND	ND	NR	NR	NR	**15,498**	NR	NR	
Europium-155	ND	ND	ND	ND	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	ND	ND	ND	ND	NR	**25,921**	**27,917**	**11,966**	NR	**25,933**	
Strontium-90	**1.0**	**170**	**17.6**	**86**	NR	**84,592**	**56,068**	**24,017**	NR	**51,670**	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)											
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

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Table G-7. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) at 116-N-1. (Page 4 of 7)

Location:	116-N-1												Protection of Groundwater and River - MCRIS PRG
Sample ID:	TS-02	TS-02	TS-02	TS-02	TS-02	TS-02	TS-03	TS-03	TS-03	TS-03	TS-03	TS-03	
Laboratory:													
Elevation (ft. above mean sea level) Depth (ft below ground surface):	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	
Date:	1980	1981	1982	1983	1984	1985	1980	1981	1982	1983	1984	1985	
Radionuclides (pCi/g)													
Cesium-137	**106,691**	**98,738**	**260,449**	**299,010**	**540,887**	**14,983**	**60,966**	**275,427**	**499,637**	**315,319**	**462,007**	**21,322**	
Cobalt-60	**170,231**	**139,036**	**679,553**	**459,253**	**777,560**	**44,338**	**162,494**	**419,314**	**855,733**	**717,583**	**1,130,996**	**64,492**	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	**9,172**	**62,814**	**12,963**	NR	**15,959**	NR	**24,924**	**169,499**	**9,972**	NR	**26,931**	
Strontium-90	NR	**383,150**	**127,428**	**24,017**	NR	**42,781**	NR	**54,736**	**163,107**	**15,141**	NR	**116,674**	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)													
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

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Table G-7. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) at 116-N-1. (Page 5 of 7)

Location:	116-N-1												Protection of Groundwater and River - MCRIS PRG
Sample ID:	TS-04	TS-04	TS-04	TS-04	TS-04	TS-04	TS-05	TS-05	TS-05	TS-05	TS-05	TS-05	
Laboratory:													
Elevation (ft. above mean sea level):	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	
Depth (ft below ground surface):													
Date:	1980	1981	1982	1983	1984	1985	1980	1981	1982	1983	1984	1985	
Radionuclides (pCi/g)													
Cesium-137	**111,771**	**171,492**	**281,710**	**206,589**	**422,568**	**16,136**	**132,094**	**254,640**	**287,026**	**391,431**	**732,451**	**31,695**	
Cobalt-60	**98,657**	**132,415**	**161,079**	**229,627**	**565,498**	**48,369**	**59,968**	**97,104**	**166,113**	**149,257**	**293,352**	**38,292**	
Europium-154	NR	NR	NR	**6,438**	NR	NR	NR	NR	NR	**9,537**	**20,256**	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	**11,963**	**2,791,741***	**7,479**	NR	**22,941**	NR	**5,483**	**658,053**	**2,991**	NR	**20,946**	
Strontium-90	NR	**17,914**	**76,457**	**13,575**	NR	**61,115**	NR	**10,450**	**56,068**	**6,788**	NR	**105,563**	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)													
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2*
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

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Table G-7. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) at 116-N-1. (Page 6 of 7)

Location:	116-N-1												Protection of Groundwater and River - MCRIS PRG
Sample ID:	TS-06	TS-06	TS-06	TS-06	TS-06	TS-06	TS-07	TS-07	TS-07	TS-07	TS-07	TS-07	
Laboratory:													
Elevation (ft. above mean sea level): Depth (ft below ground surface):	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	
Date:	1980	1981	1982	1983	1984	1985	1980	1981	1982	1983	1984	1985	
Radionuclides (pCi/g)													
Cesium-137	**106,691**	**296,214**	**265,764**	**516,471**	**422,568**	**39,187**	**121,932**	**275,427**	**531,529**	**434,923**	**552,155**	**32,271**	
Cobalt-60	**108,329**	**375,176**	**377,529**	**459,253**	**812,903**	**44,338**	**32,886**	**196,416**	**352,361**	**172,220**	**565,498**	**52,400**	
Europium-154	NR	NR	NR	**20,267**	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	**24,924**	**43,870**	**9,772**	NR	**23,938**	NR	**29,908**	**16,950**	**6,182**	NR	**13,964**	
Strontium-90	NR	**47,769**	**117,234**	**24,017**	NR	**66,671**	NR	**54,736**	**42,306**	**14,097**	NR	**66,671**	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)													
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

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Table G-7. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) at 116-N-1. (Page 7 of 7)

Location:	116-N-1												Protection of Groundwater and River - MCRIS PRG
Sample ID:	TS-08	TS-08	TS-08	TS-08	TS-08	TS-08	TS-09	TS-09	TS-09	TS-09	TS-09	TS-09	
Laboratory:													
Elevation (ft. above mean sea level):	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	
Depth (ft below ground surface):													
Date:	1980	1981	1982	1983	1984	1985	1980	1981	1982	1983	1984	1985	
Radionuclides (pCi/g)													
Cesium-137	**320,073**	**228,657**	**244,503**	**217,462**	**411,299**	**12,678**	**177,818**	**405,346**	**297,656**	**212,025**	**732,451**	**14,407**	
Cobalt-60	**147,018**	**119,174**	**113,259**	**114,813**	**565,498**	**10,480**	**83,181**	**183,174**	**108,225**	**114,813**	**530,154**	**25,797**	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	**6,580**	**15,953**	**4,587**	NR	**10,972**	NR	**19,939**	**12,962**	**4,288**	NR	**19,949**	
Strontium-90	NR	**12,440**	**35,680**	**6,788**	NR	**38,891**	NR	**22,392**	**76,457**	**4,542**	NR	**61,115**	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)													
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2*
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

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Table G-8. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) at 116-N-3. (Page 1 of 5)

Location:	199-N-109A									Protection of Groundwater and River - MCRIS PRG
Sample ID:	B0GL97	B0GL99	B0H1V7	B0H1V8	B0GLB1	B0GLB3	B0GLB4 (Dup)	B0GLB6	B0GLC0	
Laboratory:	Quanterra	Quanterra	222-S	222-S	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	
Elevation (ft. above mean sea level):	442.5-440.5	440.5-438.5	442.5-440.5	440.5-438.5	433.5-431.5	426.5-424.5	426.5-424.5	411.5-409.5	391.5-389	
Depth (ft below ground surface):	8-10	10-12	8-10	10-12	17-19	24-26	24-26	39-41	59-61.5	
Date:	12/19/95	12/20/95	12/19/95	12/20/95	12/20/95	12/22/95	12/22/95	12/27/95	12/28/95	
Radionuclides (pCi/g)										
Cesium-137	**415**	**0.38**	**269**	ND	**0.104**	**0.043**	ND	ND	ND	
Cobalt-60	**60**	**0.71**	**35.5**	**0.605**	**0.374**	**0.248**	**0.226**	**0.086**	**0.234**	
Europium-154	**0.95**	ND	ND	ND	ND	NR	NR	NR	ND	
Europium-155	**0.28**	ND	ND	ND	ND	ND	ND	ND	ND	
Plutonium-239/240	**24**	ND	NR	NR	**0.15**	ND	ND	ND	ND	
Strontium-90	**956**	**877**	**770**	**618**	**286 J**	**161 J**	**143 J**	**19.8 J**	**11.4 J**	
Thorium-228	NR	NR	NR	NR	**0.622**	**0.504**	**0.156**	**0.682**	**0.616**	
Thorium-232	NR	NR	NR	NR	**0.622**	**0.504**	**0.156**	**0.682**	**0.616**	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	**1.4**	ND	NR	NR	**0.727**	**0.642**	**0.354**	**0.348**	**0.454**	2
Uranium-238	ND	ND	NR	NR	**0.44**	**0.435**	**0.531**	**0.5**	**0.418**	2.4
Inorganics (mg/kg)										
Cadmium	ND	ND	NR	NR	ND	ND	ND	ND	ND	
Lead	**2.7**	**1.9**	NR	NR	**1.7**	**1.6**	**1.7**	**1.2**	**3.2**	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010

J - Estimated value

ND - Not detected

NR - Not requested

N/A - Not requested

Bold areas represent detected values

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Table G-8. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) at 116-N-3. (Page 2 of 5)

Location:	199-N-109A							116-N-3		
Sample ID:	B0H1V9	B0H1W1	B0H1W2 (Dup)	B0H1W3	B0H1W4	B0H1W5	B0H5N9	CS-01	CS-01	
Laboratory:	222-S	222-S	222-S	222-S	222-S	222-S	222-S			
Elevation (ft. above mean sea level):	433.5-431.5	426.5-424.5	426.5-424.5	420.5	411.5-409.5	400.5	391.5-389	~441	~441	**Protection of Groundwater and River - MCRIS PRG**
Depth (ft below ground surface):	17-19	24-26	24-26	30	39-41	50	59-61.5			
Date:	12/20/95	12/22/95	12/22/95	12/22/95	12/27/95	12/27/95	12/28/95	1985	1986	
Radionuclides (pCi/g)										
Cesium-137	ND	ND	ND	ND	ND	ND	ND	**23,395**	**104,846**	
Cobalt-60	**0.260**	**0.273**	**0.308**	**4.39**	**0.086**	**0.198**	**0.225**	**52,400**	**412,626**	
Europium-154	ND	ND	ND	ND	ND	ND	ND	NR	NR	
Europium-155	ND	ND	ND	ND	ND	ND	ND	NR	NR	
Plutonium-239/240	NR	NR	NR	NR	NR	NR	NR	**11,969**	NR	
Strontium-90	**236**	**138**	**105**	**90.6**	**1.7**	**3.3**	**12.9**	**49,189**	**5,196**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)										
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010

J - Estimated value

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Table G-8. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) at 116-N-3. (Page 3 of 5)

Location:	116-N-3										Protection of Groundwater and River - MCRIS PRG
Sample ID:	CS-01	CS-02	CS-02	CS-02	CS-03	CS-03	CS-03	CS-04	CS-04	CS-04	
Laboratory:											
Elevation (ft. above mean sea level):	~441	~441	~441	~441	~441	~441	~441	~441	~441	~441	
Depth (ft below ground surface):											
Date:	1987	1985	1986	1987	1985	1986	1987	1985	1986	1985	
Radionuclides (pCi/g)											
Cesium-137	**19,089**	**27,960**	**36,114**	NR	**27,960**	**51,258**	**10,738**	**19,972**	**49,511**	**19,972**	
Cobalt-60	**42,618**	**26,603**	**23,579**	**72,762**	**44,338**	**104,290**	**32,743**	**24,184**	**113,359**	**24,184**	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	**5,188**	**4,987**	NR	**48,884**	**12,967**	NR	**1,596**	**4,289**	NR	**4,289**	
Strontium-90	**8,194**	**14,533**	**2,227**	**23,412**	**49,748**	**2,855**	**3,453**	**15,092**	**2,855**	**15,092**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)											
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010

J - Estimated value

ND - Not detected

NR - Not requested

N/A - Not requested

Bold areas represent detected values

All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs. Therefore, being protective of groundwater is also being protective of the Columbia River.

Table G-8. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) at 116-N-3. (Page 4 of 5)

Location:	116-N-3											
Sample ID:	CS-04	CS-04	CS-05	CS-05	CS-05	CS-07	CS-07	CS-07	CS-08	CS-08	CS-08	
Laboratory:												
Elevation (ft. above mean sea level):	~441	~441	~441	~441	~441	~441	~441	~441	~441	~441	~441	
Depth (ft below ground surface):												
Date:	1986	1987	1985	1986	1987	1985	1986	1987	1985	1986	1987	Protection of Groundwater and River - MCRIS PRG
Radionuclides (pCi/g)												
Cesium-137	**49,511**	**17,299**	**7,418**	**53,588**	**17,896**	**6,277**	NR	**28,634**	**16,548**	**38,444**	**8,948**	
Cobalt-60	**113,359**	**32,743**	**7,255**	**28,113**	**35,342**	**64,492**	NR	**67,565**	**68,522**	**77,084**	**57,170**	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	**9,877**	**2,793**	NR	**8,480**	**29,923**	NR	**97,768**	**55,856**	NR	**119,716**	
Strontium-90	**2,855**	**2,517**	**8,385**	**1,941**	**5,853**	**111,794**	NR	**366,692**	**55,897**	NR	**158,033**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)												
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010

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ND - Not detected

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N/A - Not requested

Bold areas represent detected values

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Table G-8. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) at 116-N-3. (Page 5 of 5)

Location:	116-N-3									Protection of Groundwater and River - MCRIS PRG
Sample ID:	CS-09	CS-09	CS-09	CS-10	CS-10	CS-11	CS-11	CS-12	CS-12	
Laboratory:										
Elevation (ft. above mean sea level):	~441	~441	~441	~441	~441	~441	~441	~441	~441	
Depth (ft below ground surface):										
Date:	1985	1986	1987	1985	1987	1985	1987	1985	1987	
Radionuclides (pCi/g)										
Cesium-137	**2,853**	**46,598**	**10,141**	**31,955**	**12,527**	**27,390**	**7,755**	**40,514**	**7,755**	
Cobalt-60	**5,643**	**126,962**	**42,618**	**20,960**	**7,276**	**32,246**	**43,657**	**23,378**	**62,368**	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	**11,969**	NR	**8,280**	**2,294**	**1,397**	**6,882**	**19,953**	**33,913**	**38,908**	
Strontium-90	**9,502**	**5,253**	**5,853**	**7,267**	**8,194**	**6,708**	**16,974**	**3,242**	**20,486**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)										
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010

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Table G-9. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) Outside 116-N-1/116-N-3. (Page 1 of 8)

Location:	199-N-75		199-N-76				199-N-80				Protection of Groundwater and River - MCRIS PRG
Sample ID:	B06843	B06845	B06840	B06841	B06842	B06844	B06M60	B06M61	B06M37	B06M62	
Laboratory:											
Depth (ft below ground surface):	56-58	68-70	24-25	24-25	55-57	64.5-66.5	45-47	45-47	50-52	50-52	
Date:	4/23/92	4/24/92	4/16/92	4/16/92	4/22/92	4/23/92	7/22/92	7/22/92	7/1/92	7/22/92	
Radionuclides (pCi/g)											
Cesium-137	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	
Cobalt-60	**0.051**	**0.027**	ND	ND	**0.017**	**0.018**	ND	R	ND	ND	
Europium-154	ND	ND	NR	NR	NR	ND	ND	R	ND	ND	
Europium-155	NR	NR	NR	NR	NR	NR	NR	R	NR	NR	
Plutonium-239/240	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	
Strontium-90	**124**	**78**	ND	ND	**208**	ND	ND	R	**18.4**	**16**	
Thorium-228	**0.47**	**0.59**	**0.52**	**0.59**	**0.59**	**0.50**	**1.10**	R	**0.64**	**0.47**	
Thorium-232	**0.39**	**0.62**	ND	ND	**0.41**	**0.46**	**0.67**	R	ND	ND	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	**0.62**	**0.69**	NR	NR	NR	NR	R	R	R	R	2
Uranium-238	**0.47**	ND	**0.53**	**0.52**	**0.49**	**0.54**	R	R	R	R	2.4
Inorganics (mg/kg)											
Cadmium	**0.39**	**0.2**	**0.22**	**0.21**	**0.57**	**0.9**	**0.35**	**0.88**	**0.29**	**0.3**	
Chromium	**14.7**	**7.8**	**10**	**11.3**	**11.4**	**8.9**	**16.5**	**8.3**	**8.9**	**7.2**	8 and 2[a]
Lead	**2.7**	**2.3**	**7.6**	**6.9**	**3.4**	**2.9**	**8.4**	**3.8**	**3.8**	**3**	
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Nitrate	NR	NR	NR	NR	NR	NR	**16.1**	**54.6**	**2.81**	**2.58**	4,400

All radionuclide data decayed to 2010
ND - Not detected
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[a] 8 - protection of groundwater, 2- protection of Columbia River

Table G-9. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) Outside 116-N-1/116-N-3. (Page 2 of 8)

Location:	199-N-103A												
Sample ID:	B0DRK7	103A/56.5	103A/57	B0DRK8	103A/62	103A/62	B0DRK9	103A/67	103A/67 (Dup)	103A/67	103A/-72	103A/-72	Protection of Groundwater and River - MCRIS PRG
Laboratory:	Quanterra	PNNL	EAL	Quanterra	PNL	EAL	Qunaterra	PNNL	PNNL	EAL	PNNL	EAL	
Depth (ft below ground surface):	29-32	55-56.5	55-56.5	59-60.5	60-61.5	60-61.5	65-67	65-67	65-67	65-67	70-72	70-72	
Date:	1/30/95	2/1/95	2/1/95	2/2/95	2/2/95	2/2/95	2/6/95	2/3/95	2/3/95	2/3/95	2/7/95	2/7/95	
Radionuclides (pCi/g)													
Cesium-137	ND	NR	ND	**0.0013**	NR	ND	**0.0016**	NR	NR	ND	NR	ND	
Cobalt-60	ND	NR	ND	ND	NR	ND	ND	NR	NR	ND	NR	ND	
Europium-154	ND	NR	ND	ND	NR	ND	ND	NR	NR	ND	NR	ND	
Europium-155	**0.0058**	NR	ND	ND	NR	ND	ND	NR	NR	ND	NR	ND	
Plutonium-239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Strontium-90	ND	**0.39**	NR	**1.57**	**1.77**	NR	**106.6**	**84**	**83**	NR	**56**	NR	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	ND	NR	NR	ND	NR	NR	NR	ND	NR	ND	
Tritium	ND	NR	NR	**127,000**	NR	NR	**84,800**	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	**0.52**	NR	ND	NR	NR	ND	NR	NR	NR	ND	NR	ND	2.4
Inorganics (mg/kg)													
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

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Table G-9. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) Outside 116-N-1/116-N-3. (Page 3 of 8)

Location:	199-N-104A											Protection of Groundwater and River - MCRIS PRG
Sample ID:	104A-20	104A-30	B0DRL1	104A-40	104A-50	104A-58-60	104A-60	104A-65	104A/63-65	104A-70	104A/68-70	
Laboratory:												
Depth (ft below ground surface):	20	30	31-33	40	50	58-60	60	65	63-65	70	68-70	
Date:	2/16/95	2/16/95	2/22/95	2/16/95	2/16/95	2/16/95	2/16/95	2/16/95	2/16/95	2/16/95	2/16/95	
Radionuclides (pCi/g)												
Cesium-137	ND	ND	ND	ND	ND	NR	ND	ND	NR	ND	NR	
Cobalt-60	ND	ND	ND	ND	ND	NR	ND	ND	NR	ND	NR	
Europium-154	ND	ND	ND	ND	ND	NR	ND	ND	NR	ND	NR	
Europium-155	ND	ND	ND	ND	ND	NR	ND	ND	NR	ND	NR	
Plutonium-239/240	ND	ND	NR	ND	ND	NR	ND	ND	NR	ND	NR	
Strontium-90	NR	NR	ND	NR	NR	**0.34**	NR	NR	**0.43**	NR	**0.92**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	**0.38**	**0.47**	NR	**0.51**	**0.37**	NR	**0.46**	**0.36**	NR	**0.67**	NR	
Tritium	NR	NR	ND	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	ND	ND	NR	ND	ND	NR	ND	ND	NR	ND	NR	2.4
Inorganics (mg/kg)												
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2*
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

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Table G-9. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) Outside 116-N-1/116-N-3. (Page 4 of 8)

Location:	199-N-105A										Protection of Groundwater and River - MCRIS PRG
Sample ID:	105A-15	105A-20	105A-25	105A-30	105A-35	105A-40	105A-40	105A-45	105A-45	105A-50	
Laboratory:	EAL	EAL	EAL	EAL	EAL	PNNL	EAL	PNNL	EAL	EAL	
Depth (ft below ground surface):	15	20	25	30	35	40	40	45	45	50	
Date:	3/16/95	3/16/95	3/16/95	3/16/95	3/16/95	3/16/95	3/16/95	3/16/95	3/16/95	3/16/95	
Radionuclides (pCi/g)											
Cesium-137	ND	ND	ND	ND	ND	NR	ND	NR	ND	ND	
Cobalt-60	ND	ND	ND	ND	ND	NR	ND	NR	ND	ND	
Europium-154	ND	ND	ND	ND	ND	NR	ND	NR	ND	ND	
Europium-155	ND	ND	ND	ND	ND	NR	ND	NR	ND	ND	
Plutonium-239/240	ND	ND	ND	ND	ND	NR	ND	NR	ND	ND	
Strontium-90	**0.6**	**0.4**	**0.2**	**0.8**	**1.3**	**0.29**	**2.2**	**0.27**	**2.2**	**9.78**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	**0.44**	**0.53**	**0.55**	**0.38**	**0.42**	NR	**0.29**	NR	**0.40**	**0.29**	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	ND	ND	ND	ND	ND	NR	ND	NR	ND	ND	2.4
Inorganics (mg/kg)											
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

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Table G-9. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) Outside 116-N-1/116-N-3. (Page 5 of 8)

Location:	199-N-105A									Protection of Groundwater and River - MCRIS PRG
Sample ID:	105A-51	105A-51 (Dup	B0DRL7	105A-56	105A-55	105A/61.5	105A-60	105A-65	105A/67	
Laboratory:	PNNL	PNNL	Quanterra	PNNL	EAL	EAL	EAL	EAL	PNNL	
Depth (ft below ground surface):	51-52	51-52	51-53	54.5-55.5	55	59.5-61.5	60	65	65-67	
Date:	3/24/95	3/24/95	3/24/95	3/27/95	3/16/95	3/16/95	3/16/95	3/16/95	3/16/95	
Radionuclides (pCi/g)										
Cesium-137	NR	NR	ND	NR	ND	NR	ND	ND	NR	
Cobalt-60	NR	NR	ND	NR	ND	NR	ND	ND	NR	
Europium-154	NR	NR	ND	NR	ND	NR	ND	ND	NR	
Europium-155	NR	NR	ND	NR	ND	NR	ND	ND	NR	
Plutonium-239/240	NR	NR	ND	NR	ND	NR	ND	ND	NR	
Strontium-90	**301**	**352**	**496**	**95**	**42**	**104**	**30**	**35**	**64**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	**0.41**	NR	**0.43**	**0.41**	NR	
Tritium	NR	NR	**16,200**	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	ND	NR	ND	ND	NR	2.4
Inorganics (mg/kg)										
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

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Table G-9. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) Outside 116-N-1/116-N-3. (Page 6 of 8)

Location:	199-N-106A										Protection of Groundwater and River - MCRIS PRG
Sample ID:	106A-15	106A-25	106A-35	106A-45	106A-55	106A-65	B0GGB6	106A-75	B0GGB7	106A-85	
Laboratory:	EAL	EAL	EAL	EAL	EAL	EAL	Quanterra	EAL	Quanterra	EAL	
Depth (ft below ground surface):	15	25	35	45	55	65	73-75	75	83/85	85	
Date:	8/10/95	8/10/95	8/10/95	8/10/95	8/10/95	8/10/95	8/22/95	8/10/95	8/23/95	8/10/95	
Radionuclides (pCi/g)											
Cesium-137	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Cobalt-60	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Europium-154	ND	ND	ND	ND	ND	ND	**0.001**	ND	**0.001**	ND	
Europium-155	ND	ND	ND	ND	ND	ND	**0.001**	ND	**0.001**	ND	
Plutonium-239/240	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Strontium-90	NR	NR	NR	NR	ND	ND	**148**	ND	**55.6**	ND	
Thorium-228	NR	NR	NR	NR	NR	NR	**0.49**	NR	**0.37**	NR	
Thorium-232	**0.58**	**0.45**	**0.48**	**0.38**	**0.49**	**0.48**	NR	**0.59**	NR	**0.31**	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	ND	ND	ND	ND	ND	ND	NR	ND	NR	ND	2.4
Inorganics (mg/kg)											
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2*
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

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Bold areas represent detected values
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs except chromium as noted. Therefore, being protective of groundwater is also being protective of the Columbia River.
* 8 - protection of groundwater, 2- protection of Columbia River

Table G-9. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) Outside 116-N-1/116-N-3. (Page 7 of 8)

Location:													
Sample ID:	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1	RW #2	RW #2	RW #2	RW #2	Protection of Groundwater and River - MCRIS PRG
Laboratory:													
Depth (ft below ground surface):	15	20	25	30	35	40	45	50	15	20	25	30	
Date:	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	
Radionuclides (pCi/g)													
Cesium-137	**0.357**	**0.391**	**0.292**	**0.336**	**0.137**	**0.411**	**0.612**	**0.26**	**0.004**	**0.008**	**0.006**	ND	
Cobalt-60	**0.021**	**0.023**	**0.025**	**0.059**	**0.006**	**0.059**	**0.269**	**0.244**	**0.002**	**0.0004**	**0.0005**	**0.001**	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Strontium-90	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)													
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2*
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

All radionuclide data decayed to 2010
ND - Not detected
NR - Not requested
R - Rejected value
Shaded areas represent exceedences of PRGs
Bold areas represent detected values
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs except chromium as noted. Therefore, being protective of groundwater is also being protective of the Columbia River.
* 8 - protection of groundwater, 2- protection of Columbia River

Table G-9. Comprehensive Comparison of Modified CRCIA Ranger/Industrial Scenario Preliminary Remediation Goals for Subsurface Soils (>10 ft) Outside 116-N-1/116-N-3. (Page 8 of 8)

Location:												
Sample ID:	RW #2	RW #2	RW #2	RW #2	RW #3	RW #3	RW #3	RW #3	RW #3	RW #3	RW #3	Protection of Groundwater and River - MCRIS PRG
Laboratory:												
Depth (ft below ground surface):	35	40	45	50	15	20	25	30	35	40	50	
Date:	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	
Radionuclides (pCi/g)												
Cesium-137	**0.008**	**0.005**	ND	ND	**0.013**	**0.005**	ND	**0.005**	ND	ND	ND	
Cobalt-60	**0.0001**	ND	**0.001**	**0.006**	**0.001**	**0.0002**	**0.0002**	**0.0002**	**0.0002**	**0.0002**	**0.005**	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Strontium-90	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)												
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

All radionuclide data decayed to 2010
ND - Not detected
NR - Not requested
R - Rejected value
Shaded areas represent exceedences of PRGs
Bold areas represent detected values
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs except chromium as noted. Therefore, being protective of groundwater is also being protective of the Columbia River.
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Table G-10. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) at 116-N-1. (Page 1 of 7)

Location:	199-N-107A										Protection of Groundwater and River-Residential PRG
Sample ID:	B0GL91	B0GL92 (Dup)	B0GL95	B0GLF7	B0GLF6	B0GLF8 (Dup)	B0GLF9	B0GLG0	B0GLG1	B0H1V6	
Laboratory:	Quanterra	Quanterra	Quanterra	222-S	222-S	222-S	222-S	222-S	222-S	222-S	
Elevation (ft. above mean sea level):	432-430	432-430	403-401	437	432-430	432-430	420	410	403-401	391	
Depth (ft below ground surface):	28-30	28-30	57-59	23	28-30	28-30	40	50	57-59	69	
Date:	12/5/95	12/5/95	12/8/95	12/5/95	12/5/95	12/5/95	12/6/95	12/6/95	12/8/95	12/8/95	
Radionuclides (pCi/g)											
Cesium-137	**1.78**	**4.35**	ND	**2,019**	**4.2**	**4.12**	ND	NR	ND	ND	
Cobalt-60	**0.78**	**0.90**	**0.20**	**3.75**	**0.91**	**0.82**	**0.19**	**0.12**	**0.181**	**0.11**	
Europium-154	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Europium-155	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Plutonium-239/240	ND	0.07	ND	ND	ND	ND	ND	ND	ND	ND	
Strontium-90	**1,090**	**934**	**35.6**	**834**	**1,105**	**962**	**770**	**134**	**45**	**38.9**	
Thorium-232	**1.08**	NR	**0.62**	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	**0.41**	**0.48**	**0.30**	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	**0.36**	**0.44**	**0.36**	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)											
Cadmium	**0.37 B**	**0.47 B**	**0.19**	NR	NR	NR	NR	NR	NR	NR	
Chromium	**8 J**	**12.7 J**	**12.4 J**	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	**1.3 J**	**1.2 J**	**1.5 J**	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
B - Result value was less than the Required Detection Limit (RDL), but was greater than or equal to the IDL.
J - Estimated value
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N/A - Not available
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Table G-10. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) at 116-N-1. (Page 2 of 7)

Location:	199-N-108A									Protection of Groundwater and River-Residential PRG
Sample ID:	B0GL81	B0GL86	B0GLD7	B0GLD8	B0GLD9	B0GLF0	B0GLF1	B0GLF2	B0GLF3	
Laboratory:	Quanterra	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S	
Elevation (ft. above mean sea level):	415-413	395-393.5	424.5	415-413	410	405	397.5	395-393.5	388	
Depth (ft below ground surface):	42-44	62-63.5	32.5	42-44	47	52	59.5	62-63.5	69	
Date:	11/15/95	11/16/95	11/10/95	11/15/95	11/15/95	11/15/95	11/15/95	11/16/95	11/16/95	
Radionuclides (pCi/g)										
Cesium-137	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Cobalt-60	**0.09**	**0.08**	ND	ND	ND	ND	ND	ND	ND	
Europium-154	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Europium-155	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Plutonium-239/240	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Strontium-90	**41.2 J**	**102**	**84.7**	**17.5**	**3.1**	**1.0**	**170**	**17.6**	**86**	
Thorium-232	**0.60**	**0.64**	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	**0.53**	**0.40**	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	**0.49**	**0.48**	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)										
Cadmium	ND	ND	NR	NR	NR	NR	NR	NR	NR	
Chromium	**17.5 J**	**13 J**	NR	NR	NR	NR	NR	NR	NR	8 and 2*
Lead	**0.21 BJ**	**0.63 J**	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	

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Table G-10. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) at 116-N-1. (Page 3 of 7)

Location:	116-N-1										Protection of Groundwater and River-Residential PRG
Sample ID:	TS-01	TS-01	TS-01	TS-01	TS-01	TS-01	TS-02	TS-02	TS-02	TS-02	
Laboratory:											
Elevation (ft. above mean sea level):	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	
Depth (ft below ground surface):											
Date:	1980	1981	1982	1983	1984	1985	1980	1981	1982	1983	
Radionuclides (pCi/g)											
Cesium-137	**137,174**	**98,738**	**499,637**	**45,123,298**	**1,746,614**	**16,712**	**106,691**	**98,738**	**260,449**	**299,010**	
Cobalt-60	**251,478**	**145,657**	**528,541**	**631,473**	**1,873,212**	**52,400**	**170,231**	**139,036**	**679,553**	**459,253**	
Europium-154	NR	NR	NR	**15,498**	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	**25,921**	**27,917**	**11,966**	NR	**25,933**	NR	**9,172**	**62,814**	**12,963**	
Strontium-90	NR	**84,592**	**56,068**	**24,017**	NR	**51,670**	NR	**383,150**	**127,428**	**24,017**	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)											
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

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Table G-10. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) at 116-N-1. (Page 4 of 7)

Location:	116-N-1										Protection of Groundwater and River-Residential PRG
Sample ID:	TS-02	TS-02	TS-03	TS-03	TS-03	TS-03	TS-03	TS-03	TS-04	TS-04	
Laboratory:											
Elevation (ft. above mean sea level):	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	
Depth (ft below ground surface):											
Date:	1984	1985	1980	1981	1982	1983	1984	1985	1980	1981	
Radionuclides (pCi/g)											
Cesium-137	**540,887**	**14,983**	**60,966**	**275,427**	**499,637**	**315,319**	**462,007**	**21,322**	**111,771**	**171,492**	
Cobalt-60	**777,560**	**44,338**	**162,494**	**419,314**	**855,733**	**717,583**	**1,130,996**	**64,492**	**98,657**	**132,415**	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	**15,959**	NR	**24,924**	**169,499**	**9,972**	NR	**26,931**	NR	**11,963**	
Strontium-90	NR	**42,781**	NR	**54,736**	**163,107**	**15,141**	NR	**116,674**	NR	**17,914**	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)											
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

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Table G-10. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) at 116-N-1. (Page 5 of 7)

Location:	116-N-1										Protection of Groundwater and River-Residential PRG
Sample ID:	TS-04	TS-04	TS-04	TS-04	TS-05	TS-05	TS-05	TS-05	TS-05	TS-05	
Laboratory:											
Elevation (ft. above mean sea level):	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	
Depth (ft below ground surface):											
Date:	1982	1983	1984	1985	1980	1981	1982	1983	1984	1985	
Radionuclides (pCi/g)											
Cesium-137	**281,710**	**206,589**	**422,568**	**16,136**	**132,094**	**254,640**	**287,026**	**391,431**	**732,451**	**31,695**	
Cobalt-60	**161,079**	**229,627**	**565,498**	**48,369**	**59,968**	**97,104**	**166,113**	**149,257**	**293,352**	**38,292**	
Europium-154	NR	**6,438**	NR	NR	NR	NR	NR	**9,537**	**20,256**	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	**2,791,741***	**7,479**	NR	**22,941**	NR	**5,483**	**658,053**	**2,991**	NR	**20,946**	
Strontium-90	**76,457**	**13,575**	NR	**61,115**	NR	**10,450**	**56,068**	**6,788**	NR	**105,563**	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)											
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

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Table G-10. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) at 116-N-1. (Page 6 of 7)

Location:	116-N-1												Protection of Groundwater and River-Residential PRG
Sample ID:	TS-06	TS-06	TS-06	TS-06	TS-06	TS-06	TS-07	TS-07	TS-07	TS-07	TS-07	TS-07	
Laboratory:													
Elevation (ft. above mean sea level):	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	
Depth (ft below ground surface):													
Date:	1980	1981	1982	1983	1984	1985	1980	1981	1982	1983	1984	1985	
Radionuclides (pCi/g)													
Cesium-137	**106,691**	**296,214**	**265,764**	**516,471**	**422,568**	**39,187**	**121,932**	**275,427**	**531,529**	**434,923**	**552,155**	**32,271**	
Cobalt-60	**108,329**	**375,176**	**377,529**	**459,253**	**812,903**	**44,338**	**32,886**	**196,416**	**352,361**	**172,220**	**565,498**	**52,400**	
Europium-154	NR	NR	NR	**20,267**	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	**24,924**	**43,870**	**9,772**	NR	**23,938**	NR	**29,908**	**16,950**	**6,182**	NR	**13,964**	
Strontium-90	NR	**47,769**	**117,234**	**24,017**	NR	**66,671**	NR	**54,736**	**42,306**	**14,097**	NR	**66,671**	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)													
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

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Table G-10. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) at 116-N-1. (Page 7 of 7)

Location:	116-N-1												Protection of Groundwater and River-Residential PRG
Sample ID:	TS-08	TS-08	TS-08	TS-08	TS-08	TS-08	TS-09	TS-09	TS-09	TS-09	TS-09	TS-09	
Laboratory:													
Elevation (ft. above mean sea level):	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	~439	
Depth (ft below ground surface):													
Date:	1980	1981	1982	1983	1984	1985	1980	1981	1982	1983	1984	1985	
Radionuclides (pCi/g)													
Cesium-137	**320,073**	**228,657**	**244,503**	**217,462**	**411,299**	**12,678**	**177,818**	**405,346**	**297,656**	**212,025**	**732,451**	**14,407**	
Cobalt-60	**147,018**	**119,174**	**113,259**	**114,813**	**565,498**	**10,480**	**83,181**	**183,174**	**108,225**	**114,813**	**530,154**	**25,797**	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	**6,580**	**15,953**	**4,587**	NR	**10,972**	NR	**19,939**	**12,962**	**4,288**	NR	**19,949**	
Strontium-90	NR	**12,440**	**35,680**	**6,788**	NR	**38,891**	NR	**22,392**	**76,457**	**4,542**	NR	**61,115**	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)													
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

All radionuclide data decayed to 2010
B - Result value was less than the Required Detection Limit (RDL), but was greater than or equal to the IDL.
J - Estimated value
ND - Not detected
NR - Not requested
N/A - Not available
Shaded areas represent exceedences of PRGs
Bold areas represent detected values
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs except chromium as noted. Therefore, being protective of groundwater is also being protective of the Columbia River.
[a] 8 - protection of groundwater, 2- protection of Columbia River

Table G-11. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) at 116-N-3. (Page 1 of 5)

Location:	199-N-109A								Protection of Groundwater and River - Rural Residential PRGs
Sample ID:	B0GLB1	B0GLB3	B0GLB4 (Dup)	B0GLB6	B0GLC0	B0H1V9	B0H1W1	B0H1W2 (Dup)	
Laboratory:	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	222-S	222-S	222-S	
Elevation (ft. above mean sea level)	433.5-431.5	426.5-424.5	426.5-424.5	411.5-409.5	391.5-389	433.5-431.5	426.5-424.5	426.5-424.5	
Depth (ft below ground surface)	17-19	24-26	24-26	39-41	59-61.5	17-19	24-26	24-26	
Date:	12/20/95	12/22/95	12/22/95	12/27/95	12/28/95	12/20/95	12/22/95	12/22/95	
Radionuclides (pCi/g)									
Cesium-137	**0.104**	0.043	ND	ND	ND	ND	ND	ND	
Cobalt-60	**0.374**	**0.248**	**0.226**	**0.086**	**0.234**	**0.260**	**0.273**	**0.308**	
Europium-154	ND	NR	NR	NR	ND	ND	ND	ND	
Europium-155	ND	ND	ND	ND	ND	ND	ND	ND	
Plutonium-239/240	**0.15**	ND	ND	ND	ND	NR	NR	NR	
Strontium-90	**286 J**	**161 J**	**143 J**	**19.8 J**	**11.4 J**	**236**	**138**	**105**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	**0.622**	**0.504**	**0.156**	**0.682**	**0.616**	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	**0.727**	**0.642**	**0.354**	**0.348**	**0.454**	NR	NR	NR	2
Uranium-238	**0.44**	**0.435**	**0.531**	**0.5**	**0.418**	NR	NR	NR	2.4
Inorganics (mg/kg)									
Cadmium	ND	ND	ND	ND	ND	NR	NR	NR	
Lead	**1.7**	**1.6**	**1.7**	**1.2**	**3.2**	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
J - Estimated value
ND - Not detected
NR - Not requested
N/A - Not available
Bold areas represent detected values
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs. Therefore, being protective of groundwater is also being protective of the Columbia River.

Table G-11. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) at 116-N-3. (Page 2 of 5)

Location:	199-N-109A				116-N-3						
Sample ID:	B0H1W3	B0H1W4	B0H1W5	B0H5N9	CS-01	CS-01	CS-01	CS-02	CS-02	CS-02	Protection of Groundwater and River - Rural Residential PRGs
Laboratory:	222-S	222-S	222-S	222-S							
Elevation (ft. above mean sea level):	420.5	411.5-409.5	400.5	391.5-389	~441	~441	~441	~441	~441	~441	
Depth (ft below ground surface):	30	39-41	50	59-61.5							
Date:	12/22/95	12/27/95	12/27/95	12/28/95	1985	1986	1987	1985	1986	1987	
Radionuclides (pCi/g)											
Cesium-137	ND	ND	ND	ND	**23,395**	**104,846**	**19,089**	**27,960**	**36,114**	NR	
Cobalt-60	**0.439**	**0.086**	**0.198**	**0.225**	**52,400**	**412,626**	**42,618**	**26,603**	**23,579**	**72,762**	
Europium-154	ND	ND	ND	ND	NR	NR	NR	NR	NR	NR	
Europium-155	ND	ND	ND	ND	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	NR	NR	NR	**11,969**	NR	**5,188**	**4,987**	NR	**48,884**	
Strontium-90	**90.6**	**1.7**	**3.3**	**12.9**	**49,189**	**5,196**	**8,194**	**14,533**	**2,227**	**23,412**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)											
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
J - Estimated value
ND - Not detected
NR - Not requested
N/A - Not available
Bold areas represent detected values
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs. Therefore, being protective of groundwater is also being protective of the Columbia River.

Table G-11. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) at 116-N-3. (Page 3 of 5)

Location:	116-N-3									Protection of Groundwater and River - Rural Residential PRGs
Sample ID:	CS-03	CS-03	CS-03	CS-04	CS-04	CS-04	CS-05	CS-05	CS-05	
Laboratory:										
Elevation (ft. above mean sea level):	~441	~441	~441	~441	~441	~441	~441	~441	~441	
Depth (ft below ground surface):										
Date:	1985	1986	1987	1985	1986	1987	1985	1986	1987	
Radionuclides (pCi/g)										
Cesium-137	**27,960**	**51,258**	**10,738**	**19,972**	**49,511**	**17,299**	**7,418**	**53,588**	**17,896**	
Cobalt-60	**44,338**	**104,290**	**32,743**	**24,184**	**113,359**	**32,743**	**7,255**	**28,113**	**35,342**	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	**12,967**	NR	**1,596**	**4,289**	NR	**9,877**	**2,793**	NR	**8,480**	
Strontium-90	**49,748**	**2,855**	**3,453**	**15,092**	**2,855**	**2,517**	**8,385**	**1,941**	**5,853**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)										
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
J - Estimated value
ND - Not detected
NR - Not requested
N/A - Not available
Bold areas represent detected values
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs. Therefore, being protective of groundwater is also being protective of the Columbia River.

Table G-11. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) at 116-N-3. (Page 4 of 5)

Location:	116-N-3									Protection of Groundwater and River - Rural Residential PRGs
Sample ID:	CS-07	CS-07	CS-07	CS-08	CS-08	CS-08	CS-09	CS-09	CS-09	
Laboratory:										
Elevation (ft. above mean sea level):	~441	~441	~441	~441	~441	~441	~441	~441	~441	
Depth (ft below ground surface):										
Date:	1985	1986	1987	1985	1986	1987	1985	1986	1987	
Radionuclides (pCi/g)										
Cesium-137	**6,277**	NR	**28,634**	**16,548**	**38,444**	**8,948**	**2,853**	**46,598**	**10,141**	
Cobalt-60	**64,492**	NR	**67,565**	**68,522**	**77,084**	**57,170**	**5,643**	**126,962**	**42,618**	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	**29,923**	NR	**97,768**	**55,856**	NR	**119,716**	**11,969**	NR	**8,280**	
Strontium-90	**111,794**	NR	**366,692**	**55,897**	NR	**158,033**	**9,502**	**5,253**	**5,853**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)										
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
J - Estimated value
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N/A - Not available
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All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs. Therefore, being protective of groundwater is also being protective of the Columbia River.

Table G-11. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) at 116-N-3. (Page 5 of 5)

Location:	116-N-3						Protection of Groundwater and River - Rural Residential PRGs
Sample ID:	CS-10	CS-10	CS-11	CS-11	CS-12	CS-12	
Laboratory:							
Elevation (ft. above mean sea level):	~441	~441	~441	~441	~441	~441	
Depth (ft below ground surface):							
Date:	1985	1987	1985	1987	1985	1987	
Radionuclides (pCi/g)							
Cesium-137	**31,955**	**12,527**	**27,390**	**7,755**	**40,514**	**7,755**	
Cobalt-60	**20,960**	**7,276**	**32,246**	**43,657**	**23,378**	**62,368**	
Europium-154	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	**2,294**	**1,397**	**6,882**	**19,953**	**33,913**	**38,908**	
Strontium-90	**7,267**	**8,194**	**6,708**	**16,974**	**3,242**	**20,486**	
Thorium-228	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)							
Cadmium	NR	NR	NR	NR	NR	NR	
Lead	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	N/A

All radionuclide data decayed to 2010
J - Estimated value
ND - Not detected
NR - Not requested
N/A - Not available
Bold areas represent detected values
All protection of groundwater PRGs are lower than the protection of the Columbia River PRGs. Therefore, being protective of groundwater is also being protective of the Columbia River.

Table G-12. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) Outside 116-N-1/116-N-3. (Page 1 of 8)

Location:	199-N-75		199-N-76				199-N-80				Protection of Groundwater and River - Residential PRG
Sample ID:	B06843	B06845	B06840	B06841	B06842	B06844	B06M60	B06M61	B06M37	B06M62	
Laboratory:	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	
Depth (ft below ground surface):	56-58	68-70	24-25	24-25	55-57	64.5-66.5	45-47	45-47	50-52	50-52	
Date:	4/23/92	4/24/92	4/16/92	4/16/92	4/22/92	4/23/92	7/22/92	7/22/92	7/1/92	7/22/92	
Radionuclides (pCi/g)											
Cesium-137	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	
Cobalt-60	**0.051**	**0.027**	ND	ND	**0.017**	**0.018**	ND	R	ND	ND	
Europium-154	ND	ND	NR	NR	NR	ND	ND	R	ND	ND	
Europium-155	NR	NR	NR	NR	NR	NR	NR	R	NR	NR	
Plutonium-239/240	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	
Strontium-90	**124**	**78**	ND	ND	**208**	ND	ND	R	**18.4**	**16**	
Thorium-228	**0.47**	**0.59**	**0.52**	**0.59**	**0.59**	**0.50**	**1.10**	R	**0.64**	**0.47**	
Thorium-232	**0.39**	**0.62**	ND	ND	**0.41**	**0.46**	**0.67**	R	ND	ND	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	**0.62**	**0.69**	NR	NR	NR	NR	R	R	R	R	2
Uranium-238	**0.47**	ND	**0.53**	**0.52**	**0.49**	**0.54**	R	R	R	R	2.4
Inorganics (mg/kg)											
Cadmium	**0.39**	**0.2**	**0.22**	**0.21**	**0.57**	**0.9**	**0.35**	**0.88**	**0.29**	**0.3**	
Chromium	**14.7**	**7.8**	**10**	**11.3**	**11.4**	**8.9**	**16.5**	**8.3**	**8.9**	**7.2**	8 and 2[a]
Lead	**2.7**	**2.3**	**7.6**	**6.9**	**3.4**	**2.9**	**8.4**	**3.8**	**3.8**	**3**	
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Nitrate	NR	NR	NR	NR	NR	NR	**16.1**	**54.6**	**2.81**	**2.58**	4,400

All radionuclide data decayed to 2010

ND - Not detected

NR - Not requested

R - Rejected value

Shaded areas represent exceedences of PRGs

Bold areas represent detected values

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[a] 8 - protection of groundwater, 2- protection of Columbia River

Table G-12. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) Outside 116-N-1/116-N-3. (Page 2 of 8)

Location:	199-N-103A										Protection of Groundwater and River - Residential PRG
Sample ID:	B0DRK7	103A/56.5	103A/57	B0DRK8	103A/62	103A/62	B0DRK9	103A/67	103A/67 (Dup)	103A/67	
Laboratory:	Quanterra	PNNL	EAL	Quanterra	PNL	EAL	Qunaterra	PNNL	PNNL	EAL	
Depth (ft below ground surface):	29-32	55-56.5	55-56.5	59-60.5	60-61.5	60-61.5	65-67	65-67	65-67	65-67	
Date:	1/30/95	2/1/95	2/1/95	2/2/95	2/2/95	2/2/95	2/6/95	2/3/95	2/3/95	2/3/95	
Radionuclides (pCi/g)											
Cesium-137	ND	NR	ND	**0.0013**	NR	ND	**0.0016**	NR	NR	ND	
Cobalt-60	ND	NR	ND	ND	NR	ND	ND	NR	NR	ND	
Europium-154	ND	NR	ND	ND	NR	ND	ND	NR	NR	ND	
Europium-155	**0.0058**	NR	ND	ND	NR	ND	ND	NR	NR	ND	
Plutonium-239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Strontium-90	ND	**0.39**	NR	**1.57**	**1.77**	NR	**106.6**	**84**	**83**	NR	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	ND	NR	NR	ND	NR	NR	NR	ND	
Tritium	ND	NR	NR	**127,000**	NR	NR	**84,800**	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	**0.52**	NR	ND	NR	NR	ND	NR	NR	NR	ND	2.4
Inorganics (mg/kg)											
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

All radionuclide data decayed to 2010

ND - Not detected

NR - Not requested

R - Rejected value

Shaded areas represent exceedences of PRGs

Bold areas represent detected values

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[a] 8 - protection of groundwater, 2- protection of Columbia River

Table G-12. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) Outside 116-N-1/116-N-3. (Page 3 of 8)

Location:	199-N-103A		199-N-104A							Protection of Groundwater and River - Residential PRG
Sample ID:	103A/-72	103A/-72	104A-20	104A-30	B0DRL1	104A-40	104A-50	104A-58-60	104A-60	
Laboratory:	PNNL	EAL	EAL	EAL	Quanterra	EAL	EAL	PNNL	EAL	
Depth (ft below ground surface):	70-72	70-72	20	30	31-33	40	50	58-60	60	
Date:	2/7/95	2/7/95	2/16/95	2/16/95	2/22/95	2/16/95	2/16/95	2/16/95	2/16/95	
Radionuclides (pCi/g)										
Cesium-137	NR	ND	ND	ND	ND	ND	ND	NR	ND	
Cobalt-60	NR	ND	ND	ND	ND	ND	ND	NR	ND	
Europium-154	NR	ND	ND	ND	ND	ND	ND	NR	ND	
Europium-155	NR	ND	ND	ND	ND	ND	ND	NR	ND	
Plutonium-239/240	NR	NR	ND	ND	NR	ND	ND	NR	ND	
Strontium-90	**56**	NR	NR	NR	ND	NR	NR	**0.34**	NR	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	ND	**0.38**	**0.47**	NR	**0.51**	**0.37**	NR	**0.46**	
Tritium	NR	NR	NR	NR	ND	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	ND	ND	ND	NR	ND	ND	NR	ND	2.4
Inorganics (mg/kg)										
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

All radionuclide data decayed to 2010

ND - Not detected

NR - Not requested

R - Rejected value

Shaded areas represent exceedences of PRGs

Bold areas represent detected values

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Table G-12. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) Outside 116-N-1/116-N-3. (Page 4 of 8)

Location:	199-N-104A				199-N-105A						Protection of Groundwater and River - Residential PRG
Sample ID:	104A-65	104A/63-65	104A-70	104A/68-70	105A-20	105A-25	105A-30	B0DRL6	105A-35	105A-40	
Laboratory:	EAL	PNNL	EAL	PNNL	EAL	EAL	EAL	Quanterra	EAL	PNNL	
Depth (ft below ground surface):	65	63-65	70	68-70	20	25	30	34-36	35	40	
Date:	2/16/95	2/16/95	2/16/95	2/16/95	3/16/95	3/16/95	3/16/95	3/21/95	3/16/95	3/16/95	
Radionuclides (pCi/g)											
Cesium-137	ND	NR	ND	NR	ND	ND	ND	ND	ND	NR	
Cobalt-60	ND	NR	ND	NR	ND	ND	ND	ND	ND	NR	
Europium-154	ND	NR	ND	NR	ND	ND	ND	ND	ND	NR	
Europium-155	ND	NR	ND	NR	ND	ND	ND	ND	ND	NR	
Plutonium-239/240	ND	NR	ND	NR	ND	ND	ND	NR	NR	NR	
Strontium-90	NR	**0.43**	NR	**0.92**	**0.45**	**0.24**	**0.77**	ND	**1.26**	**0.29**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	**0.36**	NR	**0.67**	NR	**0.53**	**0.55**	**0.38**	NR	**0.42**	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	ND	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	ND	NR	ND	NR	ND	ND	ND	**0.50**	ND	NR	2.4
Inorganics (mg/kg)											
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

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Table G-12. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) Outside 116-N-1/116-N-3. (Page 5 of 8)

Location:	199-N-105A									Protection of Groundwater and River - Residential PRG
Sample ID:	105A-40	105A-45	105A-45	105A-50	105A-51	105A-51 (Dup)	B0DRL7	105A-56	105A-55	
Laboratory:	EAL	PNNL	EAL	EAL	PNNL	PNNL	Quanterra	PNNL	EAL	
Depth (ft below ground surface):	40	45	45	50	51-52	51-52	51-53	54.5-55.5	55	
Date:	3/16/95	3/16/95	3/16/95	3/16/95	3/24/95	3/24/95	3/24/95	3/27/95	3/16/95	
Radionuclides (pCi/g)										
Cesium-137	ND	NR	ND	ND	NR	NR	ND	NR	ND	
Cobalt-60	ND	NR	ND	ND	NR	NR	ND	NR	ND	
Europium-154	ND	NR	ND	ND	NR	NR	ND	NR	ND	
Europium-155	ND	NR	ND	ND	NR	NR	ND	NR	ND	
Plutonium-239/240	ND	NR	ND	ND	NR	NR	NR	NR	NR	
Strontium-90	**2.17**	**0.27**	**2.17**	**9.78**	**301**	**352**	**496**	**95**	**42**	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	**0.29**	NR	**0.40**	**0.29**	NR	NR	NR	NR	**0.41**	
Tritium	NR	NR	NR	NR	NR	NR	**16,200**	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	ND	NR	ND	ND	NR	NR	NR	NR	ND	2.4
Inorganics (mg/kg)										
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

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Table G-12. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) Outside 116-N-1/116-N-3. (Page 6 of 8)

Location:	199-N-105A				199-N-106A									Protection of Groundwater and River - Residential PRG
Sample ID:	105A/61.5	105A-60	105A-65	105A/67	106A-25	106A-35	106A-45	106A-55	106A-65	B0GGB6	106A-75	B0GGB7	106A-85	
Laboratory:	EAL	EAL	EAL	PNNL	EAL	EAL	EAL	EAL	EAL	Quanterra	EAL	Quanterra	EAL	
Depth (ft below ground surface):	59.5-61.5	60	65	65-67	25	35	45	55	65	73-75	75	83/85	85	
Date:	3/16/95	3/16/95	3/16/95	3/16/95	8/10/95	8/10/95	8/10/95	8/10/95	8/10/95	8/22/95	8/10/95	8/23/95	8/10/95	
Radionuclides (pCi/g)														
Cesium-137	NR	ND	ND	NR	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Cobalt-60	NR	ND	ND	NR	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Europium-154	NR	ND	ND	NR	ND	ND	ND	ND	ND	**0.001**	ND	**0.001**	ND	
Europium-155	NR	ND	ND	NR	ND	ND	ND	ND	ND	**0.001**	ND	**0.001**	ND	
Plutonium-239/240	NR	ND	ND	NR	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Strontium-90	**104**	**30**	**35**	**64**	NR	NR	NR	ND	ND	**148**	ND	**55.6**	ND	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	**0.49**	NR	**0.37**	NR	
Thorium-232	NR	**0.43**	**0.41**	NR	**0.45**	**0.48**	**0.38**	**0.49**	**0.48**	NR	**0.59**	NR	**0.31**	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	ND	ND	NR	ND	ND	ND	ND	ND	NR	ND	NR	ND	2.4
Inorganics (mg/kg)														
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

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Table G-12. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) Outside 116-N-1/116-N-3. (Page 7 of 8)

Location:												
Sample ID:	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1	RW #2	RW #2	RW #2	RW #2	Protection of Groundwater and River - Residential PRG
Laboratory:												
Depth (ft below ground surface):	20	25	30	35	40	45	50	20	25	30	35	
Date:	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	
Radionuclides (pCi/g)												
Cesium-137	**0.391**	**0.292**	**0.336**	**0.137**	**0.411**	**0.612**	**0.26**	**0.008**	**0.006**	ND	**0.008**	
Cobalt-60	**0.023**	**0.025**	**0.059**	**0.006**	**0.059**	**0.269**	**0.244**	**0.0004**	**0.0005**	**0.001**	**0.0001**	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Strontium-90	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)												
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2[a]
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

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Table G-12. Comprehensive Comparison of Rural-Residential Preliminary Remediation Goals for Subsurface Soils (>15 ft) Outside 116-N-1/116-N-3. (Page 8 of 8)

Location:										
Sample ID:	RW #2	RW #2	RW #2	RW #3	RW #3	RW #3	RW #3	RW #3	RW #3	Protection of Groundwater and River - Residential PRG
Laboratory:										
Depth (ft below ground surface)	40	45	50	20	25	30	35	40	50	
Date:	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	
Radionuclides (pCi/g)										
Cesium-137	0.005	ND	ND	0.005	ND	0.005	ND	ND	ND	
Cobalt-60	ND	0.001	0.006	0.0002	0.0002	0.0002	0.0002	0.0002	0.005	
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Plutonium-239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Strontium-90	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium-232	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	2,000
Uranium-233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	2
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.4
Inorganics (mg/kg)										
Cadmium	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Chromium	NR	NR	NR	NR	NR	NR	NR	NR	NR	8 and 2*
Lead	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Mercury	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Nitrate	NR	NR	NR	NR	NR	NR	NR	NR	NR	4,400

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