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Revision 0

Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit)

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management
Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

United States Department of Energy
P.O. Box 550
Richland, Washington 99352

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TERMS

ARAR	applicable or relevant and appropriate requirement
ASTM	American Society of Testing and Materials
BCG	biota concentration guide
BDAC	Biota Dose Assessment Committee
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CLUP-EIS	DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*
COC	contaminant of concern
COPC	contaminant of potential concern
CPP	CERCLA past-practice
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FS	feasibility study
H1	Hanford formation gravel-dominated facies
H2	Hanford formation sand-dominated facies
H3	Hanford formation gravel-dominated facies
HAB	Hanford Advisory Board
HI	hazard index
HQ	hazard quotient
HSRAM	DOE/RL-91-45, *Hanford Site Risk Assessment Methodology*
IAEA	International Atomic Energy Agency
Implementation Plan	DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*
K_d	distribution coefficient
MCL	maximum contaminant level
OU	operable unit
PNNL	Pacific Northwest National Laboratory
PUREX	Plutonium/Uranium Extraction (Plant)
QA/QC	quality assurance/quality control
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	Reduction/Oxidation (Facility)
RESRAD	RESidual RADioactivity
RI	remedial investigation
RLS	radionuclide logging system
ROD	record of decision
RPP	RCRA past-practice
STOMP	Subsurface Transport Over Multiple Phases

SVOC	semivolatile organic compound
TAL	target analyte list
TCL	target compound list
TCLP	toxicity characteristic leaching potential
Tri-Parties	Ecology, EPA, and DOE
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	transuranic
TSD	treatment, storage, and/or disposal
UPR	unplanned release
URP	Uranium Recovery Project
VOC	volatile organic compound
WAC	*Washington Administrative Code*
WIDS	*Waste Information Data System*
Work Plan	DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan*

METRIC CONVERSION CHART

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

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1.0 INTRODUCTION

This remedial investigation (RI) report for the 200-TW-1 Scavenged Tank Waste Group Operable Unit (OU), the 200-TW-2 Tank Waste Group OU, and the 200-PW-5 Fission-Product Rich Process Waste Group OU focuses on characterization activities associated with representative waste sites in these OUs:

- 216-B-46 Crib (200-TW-1 OU)
- 216-T-26 Crib (200-TW-1 OU)
- 216-B-5 Reverse Well (200-TW-2 OU)
- 216-B-7A Crib (200-TW-2 OU)
- 216-B-38 Trench (200-TW-2 OU)
- 216-B-57 Crib (200-PW-5 OU).

Modifications to the M-013 series of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989) milestones for past-practice waste site investigations approved in April 2002 (Tri-Party Agreement Change Number M-13-02-01) included an approach to investigate one or more OUs in a single RI/feasibility study (FS) process. This reduces the number of work plans, RI reports, and FSs needed for the 200 Areas waste sites. The revised approach allows the collection of data necessary to adequately characterize the waste sites in more than one OU and to evaluate effective remedial alternatives for groups of OUs. DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan* (hereinafter referred to as the Work Plan), was approved by the Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA) in May 2001, in fulfillment of Milestones M-013-23 and M-013-24. A single report will be prepared in fulfillment of Tri-Party Agreement Milestone M-15-41B for submittal of RI reports for these OUs. In addition, in accordance with the recently revised approach, waste sites in the 200-PW-5 Fission-Product Rich Process Waste Group OU are being included in this RI report. The 200-PW-5 OU consists of cribs, French drains, and unplanned releases (UPR) that received similar types of wastes and quantities of effluents as the 200-TW-2 OU.

The characterization and remediation of waste sites at the Hanford Site are addressed in the Tri-Party Agreement (Ecology et al. 1989). This agreement addresses the integration of cleanup programs under the *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) and *Resource Conservation and Recovery Act of 1976* (RCRA) to provide a standard approach to direct cleanup activities in a consistent manner and to ensure that applicable regulatory requirements are met. Details of this integration for the 200 Areas are presented in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (hereinafter referred to as the Implementation Plan) and in DOE/RL-2000-38.

The 200-TW-1, 200-TW-2, and 200-PW-5 OUs are located near the center of the Hanford Site in south-central Washington State (Figure 1-1). The 200-TW-1 OU consists of 35 CERCLA past-practice (CPP) waste sites and 1 associated UPR site as defined in the Implementation Plan) (DOE/RL-98-28). The 200-TW-2 OU consists of 27 RCRA past-practice (RPP) waste sites and 1 UPR site. The 200-PW-5 OU consists of seven CPP waste sites and two UPR sites. The waste sites for these three OUs are shown in Figures 1-1 through 1-5.

The 200-TW-1 waste sites received scavenged waste from the Uranium Recovery Project (URP) and the ferrocyanide processes at the 221/224-U Plant, which recovered the uranium from the metal waste streams at the B and T Plants. The scavenged waste discharges contributed perhaps the largest liquid fraction of contaminants to the ground in the 200 Areas. The 200-TW-2 waste sites received tank waste from first- and second-cycle decontamination processes associated with the bismuth-phosphate process at the B and T Plants. The tank wastes contained inorganic anions and cations as well as low levels of radionuclides. The 200-PW-5 waste sites received fission product-rich wastes generated during the fuel-rod enrichment cycle and were released when the fuel elements were decladded or dissolved in sodium hydroxide or nitric acid. The sites in this group generally received more than 20 Ci of fission products (e.g., cesium-137 or strontium-90) and contained smaller quantities of plutonium, uranium, and organic wastes than those in the plutonium, uranium, or organic-rich groups. Most of the waste streams in this group were low salt neutral/basic, although the 216-B-50 and 216-B-57 Cribs contained some inorganic compounds.

Remedial investigation activities were conducted from June to October 2001 on one representative site for the 200-TW-1 OU (216-T-26) and two representative sites for the 200-TW-2 OU (216-B-7A and 216-B-38) in accordance with DOE/RL-98-28 and DOE/RL-2000-38. These activities included installing and geophysically logging drive casings and boreholes. Data collection activities were conducted previously at the other two 200-TW-1 and 200-TW-2 representative sites (216-B-46 and 216-B-5); therefore, no additional data collection activities were conducted at these sites. The data from the 216-B-46 Crib and the 216-B-5 Reverse Well are summarized in this RI report for completeness. Data collection activities also were conducted for the 216-B-57 Crib as part of the 200-BP-1 OU RI. This crib is one of the representative waste sites for the 200-PW-5 OU. No RI activities have been conducted at the other 200-PW-5 representative waste site (216-S-9 Crib). However, the 216-S-9 Crib is considered analogous to the 216-B-38 Trench in terms of construction and contaminant inventory and is bounded by the 216-B-7A Crib. The details of this are provided in Appendix A. The 216-B-57 Crib data are summarized in this report. The data from the representative sites will support the evaluation of remedial alternatives for these three OUs in the FS.

1.1 PURPOSE

The purpose of this RI report is to present and evaluate the data generated during the RI and other characterization activities to determine if sufficient data have been collected to support risk assessment and remedial decision making, estimate risk at the representative sites based on data collected during the RI and other existing data, determine the need to proceed with an FS, and identify those constituents and site-specific considerations that need to be addressed in the FS. The RI report also provides the data to support the evaluation of alternatives in the FS with regard to meeting potential applicable or relevant and appropriate requirements (ARAR), risk reduction, and potential significant data gaps, if any.

1.2 SUPPORTING DOCUMENTS AND REMEDIAL INVESTIGATION BASIS

Supporting documents that provided the basis for the RI and this RI report are as follows.

- DOE/RL-96-81, *Waste Site Grouping for the 200 Areas Soil Investigations* – provides the final prioritized waste site groups, identifies representative sites for worst-case and typical conditions for each waste group, and provides preliminary conceptual contaminant distribution models for the waste groups.
- DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* – outlines a strategy to streamline the characterization and remediation of waste sites in the 200 Areas, including CPP sites, RPP sites, and RCRA treatment, storage, and/or disposal (TSD) units; outlines the framework for implementing assessment activities and evaluating remedial alternatives in the 200 Areas to ensure consistency in documentation, level of characterization, and decision making; establishes a regulatory framework to integrate the requirements of RCRA and CERCLA into one standard approach for cleanup activities in the 200 Areas; and lists potential ARARs, identifies preliminary remedial action objectives (RAO), and presents a discussion of potentially feasible remedial technologies that may be used in the 200 Areas.
- DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan* – provides direction for characterizing chemical, radiological, and physical conditions in soils at the four selected waste sites in the 200-TW-1 and 200-TW-2 OUs, and identifies preliminary RAOs that are likely to be considered for remediation of the OU.
- BHI-01356, *Remedial Investigation Data Quality Objectives Summary Report for the 200-TW-1 Scavenged Waste Group and the 200-TW-2 Tank Waste Group Operable Units* – presents existing information, develops a strategy for data collection and quality, and includes an evaluation of the existing information. Based on this evaluation, data at the 216-B-5 Reverse Well and the 216-B-46 Crib were determined to be sufficient to support the RI/FS process; therefore, no additional data collection activities were identified for these sites.
- BHI-01606, *200-TW-1 Operable Unit Borehole Summary Report*, and BHI-01607, *Borehole Summary Report for Boreholes C3103 and C3104, and Drive Casing C3340, C3341, C3342, C3343, and C3344, in the 216-B-38 Trench and 216-B-7A Crib, 200-TW-2 Tank Waste Group Operable Unit* – describe the data collection activities conducted in 2001 and present the data from geophysical logging of the newly drilled boreholes and drive casings (these data also are summarized in Chapter 2.0 of this RI report).
- RHO-ST-37, *216-B-5 Reverse Well Characterization Study* – provides data on the nature and extent of contaminants at the waste site.
- DOE/RL-92-70, *Phase I Remedial Investigation Report for 200-BP-1 Operable Unit* – provides data on the 216-B-46 Crib and other analogous waste sites for the 200-TW-1 OU and on the 216-B-57 Crib waste site in 200-PW-5.

- GJO-2002-322-TAR, *Hanford 200 Areas Spectral Gamma Baseline Characterization Project, 216-B-35 to 216-B-42 Trenches Waste Site Summary Report* – provides data on gamma-emitting radionuclide contamination in boreholes adjacent to the 216-B-38 Trench.

1.3 DATA EVALUATION METHODOLOGY

The data evaluation methodology used in this RI report considers applicable regulatory requirements, the data quality objective (DQO) process conducted for the Work Plan (DOE/RL-2000-38), land-use uncertainties, risk assessment methodology, other OUs, and site-specific conditions. This evaluation process ultimately supports use of the data in the FS. This RI report does not make recommendations based on the data; its purpose is to provide sufficient evaluation of different aspects of the data to support the FS development and evaluation of remedial alternatives and selection of a preferred remedy (or remedies) in the proposed plan and record of decision (ROD).

The data evaluation process was preceded by collection and validation of the data, and a data quality assessment (DQA) was performed. The data were collected under the Work Plan (DOE/RL-2000-38) based on the DQOs established for these OUs (BHI-01356). In accordance with the quality assurance/quality control (QA/QC) procedures specified in the Work Plan (DOE/RL-2000-38), at least 10 percent of all data were validated. A detailed description of the data validation effort is presented in Appendix B.

The data evaluation process consists of the following:

- Data screening for nondetected constituents
- Data screening against background constituents
- Human health risk assessment determinations for nonradiological constituents
- Evaluation of ecological risk using indicator concentrations
- Human health dose and risk evaluation for radiological constituents
- Comparison to *Washington Administrative Code* (WAC) 173-340-745, "Soil Cleanup Standards for Industrial Properties," and other human health regulatory standards
- Evaluation of impacts to groundwater through fate and transport modeling.

Details of this evaluation are provided in Chapter 5.0.

1.3.1 Initial Data Screening

The entire data set initially was screened, and nondetected constituents were eliminated from further consideration. Because of the limited number of samples, 95 percent upper confidence limits were not calculated; maximum concentrations for specific horizons were used for comparisons and evaluation. The data were compared to the 90th percentile of the background concentrations from DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Inorganics*; DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*; and Ecology Publication No. 94-115, *Natural Background Soil Metals Concentrations in Washington State*. If the maximum detected value was less than the 90th percentile background value, the constituent was eliminated as a contaminant of concern

(COC). If background data were not available for a constituent, the constituent was retained for further evaluation, as described in Sections 1.3.2 and 1.3.3.

1.3.2 Human Health Risk Evaluation

The Tri-Parties (U.S. Department of Energy [DOE], EPA, and Ecology) recently undertook the task of developing a risk framework to support risk assessments in the Central Plateau. This included a series of workshops with representatives from DOE, EPA, Ecology, the Hanford Advisory Board (HAB), the Tribal Nations, the State of Oregon, and other interested stakeholders. The workshops focused on the different programs involved in activities in the Central Plateau and the need for a consistent application of risk assessment assumptions and goals. The results of the risk framework are documented in letter HAB 132, "Exposure Scenarios Task Force on the 200 Area," in the Tri-Parties response to "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area" (Klein et al. 2002), and in *Report of the Exposure Scenarios Task Force* (HAB 2002). The following items summarize the risk framework description from the Tri-Parties' response to the HAB.

1. The Core Zone (200 Areas including B Pond [main pond] and S Ponds) will have an industrial scenario for the foreseeable future.
2. The Core Zone will be remediated and closed, allowing for "other uses" consistent with an industrial scenario (environmental industries) that will maintain active human presence in this area, which in turn will enhance the ability to maintain the institutional knowledge of waste left in place for future generations. Exposure scenarios used for this zone should include a reasonable maximum exposure to a worker/day user, to possible Native American users, and to intruders.
3. The DOE will follow the required regulatory processes for groundwater remediation (including public participation) to establish the points of compliance and RAOs. It is anticipated that groundwater contamination under the Core Zone will preclude beneficial use for the foreseeable future, which is at least the period of waste management and institutional controls (150 yr). It is assumed that the tritium and iodine-129 plumes beyond the Core Zone boundary will exceed the drinking water standards for the period of the next 150 to 300 yr (less for the tritium plume). It is expected that other groundwater contaminants will remain below, or be restored to, drinking water levels outside the Core Zone.
4. No drilling for water use or otherwise will be allowed in the Core Zone. An intruder scenario will be calculated for in assessing the risk to human health and environment.
5. Waste sites outside the Core Zone but within the Central Plateau (200 North Area, Gable Mountain Pond, B/C Crib Controlled Area) will be remediated and closed based on an evaluation of multiple land-use scenarios to optimize land use, institutional control cost, and long-term stewardship.
6. An industrial land-use scenario will set cleanup levels on the Central Plateau. Other scenarios (e.g., residential, recreational) may be used for comparison purposes to support decision making, especially for:
   - The post-institutional controls period (>150 yr)

- Sites near the core zone perimeter to analyze opportunities to "shrink the site"
- Early (precedent-setting) closure/remediation decisions.

7. This framework does not deal with the tank retrieval decision.

The risk evaluation for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs is based on these guidelines as well as EPA; DOE/RL-91-45, *Hanford Site Risk Assessment Methodology* (HSRAM); and state risk assessment guidance. Radiological constituents are addressed through a dose evaluation, as described in Section 1.3.3, which then is converted to a risk value. Hypothetical human health risks are calculated for industrial-exposure scenarios using inputs developed from other Hanford Site OUs, site-specific data, and guidance documents.

The DOE worked for several years with cooperating agencies and stakeholders to define land-use goals for the Hanford Site and develop future land-use plans (*The Future for Hanford: Uses and Cleanup, The Final Report of the Hanford Future Site Uses Working Group,* [Drummond 1992]). The cooperating agencies and stakeholders included the National Park Service, Tribal Nation, states of Washington and Oregon, local county and city governments, economic and business development interests, environmental groups, and agricultural interests. These efforts were initially reported by Drummond (1992) and culminated in DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (CLUP-EIS) and the associated "Hanford Comprehensive Land-Use Plan Environmental Impact Statement, Hanford Site, Richland, Washington; Record of Decision (ROD)" (64 FR 61615), which were issued in 1999.

Drummond (1992) identified nine general recommendations, as follows:

- Protect the Columbia River
- Deal realistically and forcefully with groundwater contamination
- Use the Central Plateau wisely for waste management
- Do no harm during cleanup or with new development
- Cleanup of areas of high future use value is important
- Clean up to the level necessary to enable the future-use option to occur
- Transport waste safely and be prepared
- Capture economic development opportunities locally
- Involve the public in future decisions about the Hanford Site.

Specific to the Central Plateau, the findings and recommendations from the Future Site Uses Working Group include the following.

- The Central Plateau is unique.
- Some type of government presence or oversight should be assumed for the foreseeable future.
- Waste from other Hanford Site locations should be concentrated in the 200 Areas.
- Waste management, storage, and disposal activities should be concentrated within the 200 Areas whenever feasible to minimize the amount of land devoted to these activities, and adverse impacts to clean areas also should be minimized.
- Wastes generated in or coming to the 200 Areas from the rest of the Site will not necessarily be permanently disposed of in the 200 Area. Off-site shipments are occurring and may continue. New technologies may be applied to waste in the future.

- Waste and contaminants within the 200 Areas should be treated and managed to prevent migration from the 200 Areas to other areas or off the Hanford Site.
- Access to the "exclusive" areas, including "exclusive buffers," will be restricted to personnel who are properly trained and monitored.

The working group identified a single cleanup scenario for the Central Plateau. This scenario assumes that future uses of the surface, subsurface, and groundwater in and immediately surrounding the 200 East and 200 West Areas will be "exclusive."

Consistent with the Future Site Uses Working Group report (Drummond 1992), the core zone (which includes the 200 East and 200 West Areas) has been designated as industrial-exclusive in the CLUP-EIS. All of the 200-TW-1, 200-TW-2, and 200-PW-5 OU waste sites are located within this core zone. The industrial exposure scenario is used to evaluate each representative site.

By Presidential proclamation, an area surrounding the Central Plateau was designated as the Hanford Reach National Monument, an area set aside by the Federal Government to be protected because of its unique and diverse ecological and cultural resources. In a memorandum dated June 9, 2000, from the President to the Secretary of Energy, the President directed the Secretary to protect these important values where practical on the Central Plateau (Clinton 2000, "Hanford Reach National Monument").

Risks from nonradiological noncarcinogens are evaluated by calculating hazard quotients (HQ) for individual constituents and a hazard index (HI) for cumulative risk. Risks from nonradiological carcinogens and radionuclides are evaluated by calculating incremental cancer risks for individual constituents and a cumulative cancer risk. Risks also are evaluated by comparison to risk-based standards, such as the WAC-173-340-745 soil cleanup levels. Radionuclides also are evaluated for dose rates through time.

1.3.3 Modeling Approach

Modeling conducted as a part of this RI report consisted of estimating dose from direct exposure to soils at 0 to 4.6 m (0 to 15 ft) below ground surface (bgs) using the RESidual RADioactivity (RESRAD) model (ANL, 1998, *RESRAD for Windows)*. The direct exposure modeling is meant to evaluate dose in relation to direct exposure standards for the public and workers. The dose also was converted to a risk value for comparison to accepted CERCLA risk ranges. Input parameters were developed based on previous Hanford Site RESRAD modeling activities, 200 Areas-specific geologic and hydrogeologic information sources, and data collected as part of this RI report.

Protection of groundwater was evaluated for nonradiological constituents based on existing regulatory requirements (i.e., WAC-173-340-747, "Deriving Soil Concentrations for Ground Water Protection," protection of groundwater standards). Fate and transport modeling for nonradiological constituents was conducted for those constituents with no WAC 173-340-747 standard or if the standard is exceeded and additional evaluation is warranted. Protection of groundwater was evaluated for radiological constituents through fate and transport modeling using the Subsurface Transport Over Multiple Phases (STOMP) code developed by the Pacific Northwest National Laboratory (PNNL) (PNNL-11217, *STOMP Subsurface Transport Over Multiple Phases Theory Guide*).

Additional information is provided in Chapters 4.0 and 5.0.

1.3.4 Ecological Risk Evaluation

DOE/RL-2001-54, *Central Plateau Ecological Evaluation Report*, was prepared to support ecological evaluations under the RI/FS process for Central Plateau waste sites. DOE/RL-2001-54 completes a screening-level ecological risk assessment for the Central Plateau in accordance with the eight-step EPA ecological risk assessment process presented in EPA/540/R-97/006, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (see Figure 1-1 in DOE/RL-2001-54).

The document contains a compilation and evaluation of ecological sampling data that have been collected over many years from undisturbed and disturbed habitats in the Central Plateau. The document presents descriptions of the habitats in the Central Plateau, including sensitive habitats and the plants and animals that inhabit them. Potential species of concern are identified, including threatened and endangered species and new-to-science species. A detailed survey of the Central Plateau, performed in 2000 and 2001, is incorporated into DOE/RL-2001-54; it provides a current, detailed description of the ecological setting of the Central Plateau and augments the ecological information presented in this RI report.

DOE/RL-2001-54 helps answer questions about the ecological resources in the Central Plateau that it is important to preserve and protect. The document also identifies ecological data needs that can be addressed in future ecological sampling activities on the Central Plateau.

The screening-level ecological risk assessment in DOE/RL-2001-54 is meant to be a conservative evaluation of risk to ecological receptors unique to the Central Plateau from stressors; in this case, introduction of contaminants and habitat elimination. The screening-level ecological risk assessment identifies pathways for ecological receptors to be exposed to the contamination and evaluates potential risk from those exposures.

Chapter 2.0 of DOE/RL-2001-54 describes the physical and ecological setting of the Central Plateau and identifies important aspects of the ecology and the condition of the waste sites to consider during the ecological risk assessment. For instance, while most waste sites are in a disturbed habitat with little vegetation to support wildlife, the nearby shrub-steppe offers a more habitable location for wildlife and needs protection in this region because of encroachment and elimination of this habitat in other parts of eastern Washington. Individual species whose populations are limited and are designated as sensitive species also must be protected. Recent surveys of the biological diversity on the Hanford Site have identified a number of new-to-science species, and the protection status of these species has not yet been determined. More information is needed to help with this determination. Regarding the waste sites, most of the waste in the waste sites has been stabilized, thereby limiting ecological access. The decisions to stabilize and remediate waste sites must balance the potential disruption to the ecosystem both at and adjacent to the waste sites as well as from distant locations (e.g., borrow source sites).

The conceptual site model in DOE/RL-2001-54, Chapter 3.0, provides an understanding of the ecological resources and the ways that receptors may be exposed. It shows where chemicals and radionuclides from the waste sites are likely to come into contact with receptors in the environment. The exposure pathways that are expected to be complete at most waste sites include the following:

- Direct contact with, or ingestion of, soil by invertebrates (e.g., beetles, ants) and burrowing mammals
- Uptake of contaminants in soil by vegetation
- Bioaccumulation through ingestion of food items (e.g., food chain effects) consumed by wildlife that may forage at the waste sites.

DOE/RL-2001-54, Chapter 4.0, discusses the toxicity values that are available for contaminants believed to be present in the Central Plateau. Contaminants were identified from preliminary sampling data available from a subset of waste sites. These contaminants then were screened, primarily with respect to the likelihood of being present in the environment (i.e., half-life and persistence). A literature search was performed for bird and mammalian toxicity values. Toxicity values are not available for some contaminants. A risk management decision will be needed to determine how contaminants that do not have toxicity values will be handled during the risk assessment for each OU.

DOE/RL-2001-54, Chapter 5.0, presents the exposure parameters used for estimating the exposure in a quantitative manner. In a screening-level ecological risk assessment, most exposure parameters are set conservatively at 100 percent. The only organism-specific factor necessary will be body weight, and these data are available in the literature. This section further evaluated the exposure pathways and constructed a food chain exposure model for wildlife specific to the Central Plateau. The wildlife is shown in the food chain and habitat model in DOE/RL-2001-54.

DOE/RL-2001-54, Chapter 6.0, is the screening-level risk calculation for the Central Plateau. The state and the DOE provide contaminant-specific numerical values (WAC 173-340-900, "Tables," Table 749-3, "Ecological Indicator Soil Concentrations (mg/kg) for Protection of Terrestrial Plants and Animals," and biota concentration guides [BCG] from DOE/STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*) for potential risks. These are conservative numbers designed to address all possibilities without leaving potential risks out of consideration. Data are available for a subset of the Central Plateau waste sites. These maximum concentrations of contaminants detected at the waste sites were compared with the state and DOE screening-level values. For chemicals, 12 metals, pentachlorophenol, and 4-dinitrophenol were detected at a maximum concentration above the screening level. The high number of metals presenting a risk requires closer examination. Site-specific bioavailability data would be helpful for understanding whether this is a reflection of the conservative nature of the screening assessment or an actual risk to the ecosystems at the waste sites. For radionuclides, cesium-137, radium-226, radium-228, and strontium-90 were above acceptable limits in the soil samples. It is important to recognize the limitations and uncertainty associated with risks identified by screening-level assessments. The risk calculations are useful for determining relative risks between waste sites, not site-specific risk. The information should be considered carefully along with biological evidence from the waste site area to determine if a hazard exists. Data are available for hundreds of wastes sites in the Central Plateau (see DOE/RL-2001-54, Appendix C). These data include soil from the waste site, vegetation, and soil invertebrates. As each OU quantifies their risk using the exposure models available, these data will be useful in verifying the mathematical estimates.

The screening-level ecological risk assessment in DOE/RL-2001-54 leads to the problem formulation stage of a baseline ecological risk assessment. During problem formulation, the risk

managers and others consider the toxicity evaluation, conceptual model exposure pathways, and assessment endpoints to support cleanup decisions. As a result, they are then able to better define the initial risks and determine direction for the DQO process, if it is needed. The DQO will then accomplish the following.

- Establish the level of effort needed to assess ecological risk at a particular site or OU.
- Identify relevant and available data.
- Design a conceptual model of the ecological threats at a site and the measures to assess those threats.
- Select methods and models to be used in the various components of the risk assessment.
- Develop assumptions to fill data gaps for toxicity and exposure assessments based on logic and scientific principles.
- Interpret the ecological significance of observed or predicted effects.

Data collected during the RI directly support the ecological evaluation. Contaminant data from the soil sampling conducted in the RI are compared against WAC 173-340-900, Table 749-3, ecological soil indicator concentrations as the beginning step of the OU-specific screening-level evaluation of ecological risk from nonradiological constituents.

The international community has been involved for more than 20 years in evaluating the effects of ionizing radiation on plants and animals. The International Atomic Energy Agency (IAEA) issued a study in 1992, IAEA Technical Report Series No. 332, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*, endorsing the 1977 and 1990 International Commission on Radiological Protection reports *Recommendations of the International Commission on Radiological Protection* (ICRP Publication 26 and ICRP Publication 60, respectively) and stating that chronic radiation dose rates below 0.1 rad/d will not harm plant and animal populations and that radiation standards for human protection also will protect populations of nonhuman biota. The report implies that dose limits of 0.1 rad/d for animals and 1 rad/d for plants will protect populations, but additional evaluation of effects may be needed if sensitive species are present.

Effects of Ionizing Radiation on Terrestrial Plants and Animals: A Workshop Report (ORNL/TM-13141) presents information from a Doe-sponsored workshop held in 1995. The workshop was attended by 12 experts in radioecology and ecological risk assessment. The goal of the workshop was to evaluate the adequacy of current approaches to radiological protection, as exemplified by the IAEA report. The attendees reviewed DOE's perspective and responsibilities, rationales underlying the IAEA conclusions, and a summary of ecological data from the former Soviet Union. The consensus of the workshop participants was that the 0.1 rad/d limit for animals and the 1 rad/d limit for plants recommended by the IAEA are adequately supported by the available scientific information. However, they concluded that guidance on implementing the limits is needed and that the existing data support application of the recommended limits for populations of terrestrial and aquatic organisms to representative rather than maximally exposed individuals.

In response to the workshop findings, DOE produced DOE/STD-1153-2002, which provides a graded approach to ecological risk assessment for radionuclides and screening level BCGs. For radiological constituents, no promulgated screening or cleanup levels are available. The BCGs

from DOE/STD-1153-2002 are used in this evaluation of radiological constituents. Additional details are provided in Chapter 5.0.

1.3.5 Analogous Site Approach

The representative waste sites evaluated in this RI report were identified as being representative of sites within their respective OUs in DOE/RL-98-28; therefore, data collected from these sites and the resulting contaminant distribution models are anticipated to be representative of the remaining (or analogous) waste sites within the OUs. Confirmatory investigations of limited scope, rather than full characterization efforts, can be performed at the analogous waste sites, thereby optimizing investigations in support of RI/FS decision making.

This analogous approach was enhanced in June 2002 with Tri-Party Agreement change packages M-15-02-01 and M-13-02-01, which consolidated the 200-PW-5 OU into the 200-TW-1 and 200-TW-2 Work Plan (DOE/RL-2000-38). This change added the two representative sites and seven analogous waste sites from the 200-PW-5 OU into DOE/RL-2000-38. One of the 200-PW-5 representative sites, the 216-B-57 Crib, previously was investigated. To ensure that the analogous waste sites would be aligned with the proper representative sites, each of the consolidated OU waste sites was evaluated against the 200-TW-1, 200-TW-2, and 200-PW-5 OU representative sites based on the waste site type, historical use, contaminant inventory, effluent volume discharged, and available site data. Based on this evaluation, some of the consolidated OU waste sites aligned well with the contaminant distribution models developed for the 200-TW-1, 200-TW-2, and 200-PW-5 OU representative waste sites; however, some sites did not align well with these models. The waste sites that did not align with an appropriate representative site in the 200-TW-1, 200-TW-2, or 200-PW-5 OUs then were evaluated against and aligned with contaminant distribution models (for sites that have already been characterized) or conceptual contaminant distribution models (for sites that are at the work plan stage) developed for representative sites in other OUs (see Appendix A). Based on the consolidation of the work plans and other RI/FS activities, the analogous waste site approach has been broadened to use information from representative sites within any of the 200 Area OUs, as appropriate.

The analogous sites will be evaluated through the analogous site approach during the FS. Figure 1-2 shows the process for evaluating the analogous sites against the representative sites for the RI/FS process out through the confirmatory and design sampling processes and for applying risk assessment results from the representative sites to the analogous sites. Important considerations in determining the appropriate representative site for an analogous waste site include the following:

- Waste site configuration and construction (e.g., pond, trench, surface structure)
- Volume of effluent received in relation to the available pore volume for the waste site
- Types and amounts of contaminants received; contaminant inventory
- Method of discharge and purpose of waste site
- Expected distribution of contamination based on method of discharge and purpose of waste site
- Geological setting

- Neighboring waste sites, structures, or utilities
- Potential for hydrologic and contaminant impacts to groundwater.

The available information from each waste site will be evaluated in the FS against information from the representative sites. In cases where characterization data are available from an analogous waste site, the data will be evaluated for sufficiency to support a site-specific evaluation of risk. If the data are sufficient, a risk estimate for the analogous site will be calculated and then will be used to support the evaluation and selection of the appropriate remedial action for that waste site. If the data from a particular waste site are insufficient to support a risk estimate, the available data and information will be used to support the comparison and assignment to an appropriate representative site. In most cases, little or no characterization data are available from the analogous sites. In these instances, existing information from the *Waste Information Data System* (WIDS) database, discharge information, and general process information will be used to make assignments. In the case of 200-TW-1 and 200-TW-2, sufficient data exist for many of the analogous waste sites to calculate site-specific risks and to evaluate site-specific remedial actions. This will be conducted as part of the FS.

The characterization data from representative sites are intended to provide sufficient information for selection of remedies for the waste group. However, site-specific data also may be needed to verify that the selected remedial alternative is appropriate. Following the decision in the ROD, additional sampling will be conducted as needed to confirm the selected remedy for the analogous waste sites and to collect data to support remedial design. Following remedial action, an additional data collection activity will be conducted as needed to verify achievement of cleanup goals.

The risk analysis and data from the representative sites are used to support the risk evaluation and remedial decisions for those analogous sites without data to support a site-specific risk estimate. The use of the risk assessment from the representative sites presents some risk management decisions for the decision makers. If an analogous site is well represented by the representative site (i.e., the evaluation criteria of waste stream, size and construction, geology, waste inventory, and effluent volume received are similar or equal to the representative site), then the decision to apply the representative site risk and preferred alternative pose minimal risk and minimal consequences for an incorrect decision. Similarly, if the representative site bounds the contamination problem at an analogous site, the application of the representative site risk and remedial action pose minimal consequences from a human health and ecological risk standpoint, but may impact costs significantly through the potential application of an unnecessary remedy. In this situation, no or limited confirmatory sampling may be needed to confirm the nature of the contamination, the risk, and the appropriate remedial action. Design data may be needed depending on the preferred alternative.

If an analogous site is not bound by the representative site because contamination may be greater at that analogous site, then application of the representative site risk estimate and preferred alternative poses the greatest decision risk and resulting consequences. In this case, mandatory confirmatory sampling would be conducted to ensure selection of the appropriate alternative, based on a better understanding of the nature and risk of the analogous site. This last scenario is unlikely for most sites because the analogous site approach tends to target the worst-case waste sites and the worst contamination locations in those sites in an effort to bound all the contamination circumstances associated with a waste group.

Based on the results of the RI and previous characterization efforts at these OUs, the preliminary conceptual contaminant distribution models and the conceptual exposure model were revised to reflect the current understanding of the representative waste sites (details are provided in Section 3.2). Revised models were developed for cribs and trenches, which are the main two types of waste sites within these three OUs. The models will be used in the FS to support the evaluation of remedial alternatives and the selection of a preferred alternative (or alternatives if site conditions warrant different actions).

A proposed plan and ROD will be written, identifying the proposed remedy (or remedies) for all waste sites in the OUs. The ROD will include criteria for any post-ROD confirmation sampling and analysis needed to verify that all remaining (or analogous) sites in the OU meet the conceptual model for the waste group. If a waste site fails to meet the contaminant distribution model and the selected remedy is not appropriate, the site will be removed from the OU and reassigned to another OU; however, this is not expected to be a common occurrence. The analogous site approach focuses on the typical and worst-case sites as representative sites; therefore, data from the representative sites should bound the analogous sites. In addition, the ability to use data and information from representative sites outside the OU helps reduce the potential to reassign waste sites between OUs. A separate DQO process will be conducted to identify data needs and quality requirements to support the confirmatory sampling design. A permit modification also will be prepared to incorporate the corrective action of the RPP sites into the Hanford Site RCRA Permit (WA7890008967, *Hanford Facility RCRA Permit*).

1.4 BACKGROUND

This section briefly describes the waste site construction, history, and waste generating processes. The waste sites are described in more detail in DOE/RL-2000-38.

1.4.1 216-B-46 Crib

The 216-B-46 Crib is an inactive liquid waste disposal site that received effluent from the U Plant via the 241-BY Tank between September and December 1955. The crib is constructed of four large-diameter vertical concrete pipes, set below grade in a square pattern with the centers spaced 4.6 m (15 ft) apart in a 9- by 9- by 4.6 m (30- by 30- by 15-ft) deep excavation (DOE/RL-88-30, *Hanford Site Waste Management Units Report*). The crib was fed by a central pipe that branched into a chevron pattern that in turn fed each vertical pipe. The vertical pipes are 1.2 m (4 ft) in diameter and 1.2 m (4 ft) long, placed 2 m (7 ft) below grade and set on a 1.5 m (5 ft) thick bed of gravel (PNL-6456, *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford*).

The crib received approximately 6,700,000 L (1,800,000 gal) of uranium recovery process bismuth/phosphate waste that also had been scavenged (fission products removed through precipitation). Inorganic compounds in the liquids disposed to the crib included ferrocyanide, nitrate, phosphate, sodium, and sulfate-based compounds. Radionuclides sent to the crib include cesium-137, strontium-90, ruthenium-106, and plutonium and uranium isotopes (RHO-CD-673, *200 Areas Waste Sites Handbook*; WIDS; WHC-EP-0141-2, *Westinghouse Hanford Company Effluent Discharges and Solid Waste Management Report for Calendar Year 1989, 200/600 Area*). The crib also contains organic constituents such as mono-, di-, and tributyl phosphates. The site was interim stabilized with 0.6 m (2 ft) of clean soil in 1991.

1.4.2 216-T-26 Crib

The 216-T-26 Crib is an inactive liquid waste disposal site that received T Plant and U Plant effluents from August 1955 to November 1956. The 216-T-26 Crib is the northernmost crib of the 216-T-26, 216-T-27, and 216-T-28 Crib series. This crib has the same basic construction as the 216-B-46 Crib. A 36 cm (14 in.) steel inlet pipe reduces to a 25 cm (10 in.) pipe located approximately 3 m (9 ft) below grade. The smaller section of pipe branches into four 20 cm (8 in.) steel pipes that feed the large-diameter vertical concrete pipes, which are approximately 1.2 m (4 ft) long and 1.2 m (4 ft) in diameter. The piping lies within in a 9 by 9 by 4.6 m (30- by 30- by 15-ft)-deep excavation. The base of the crib was placed at 4.6 m (15 ft) bgs, and the excavation was filled with approximately 2.4 m (8 ft) of gravel followed by approximately 2.4 m (8 ft) of earthen backfill.

The 216-T-26 Crib received approximately 12,000,000 L (3,200,000 gal) of liquid waste that originated at the T Plant as metal waste and first-cycle waste that had been recovered through the URP and scavenged at the U Plant. The waste was transferred back to the TY Tank Farm to allow the sludge to settle; the liquid effluent then was discharged to the crib (WHC-SD-EN-TI-014, *Hydrogeologic Model of the 200 West Groundwater Aggregate Area*; PNL-6456). Waste disposed of at this unit includes ferrocyanide complexes, fluoride, nitrate, nitrite, phosphate, sodium, sodium aluminate, sodium hydroxide, sodium silicate, sulfate, cesium-137, ruthenium-106, strontium-90, plutonium, and uranium.

The crib was deactivated in 1956 by decommissioning the line leading to the 216-T-26 and 216-T-28 Cribs between the TY Tank Farm and the roadway. In 1975, stabilization activities performed for the 216-T-26, 216-T-27, and 216-T-28 Cribs included scraping off the top 15 cm (6 in.) of soil and replacing the excavated material with clean fill to the original grade (WIDS). This unit was surface stabilized again in May 1990 (WIDS).

1.4.3 216-B-5 Reverse Well

The 216-B-5 Reverse Well is an inactive injection well. The well was drilled to a depth of 92 m (302 ft) and perforated from 74 to 92 m (243 to 302 ft) in 1944. Effluent and contaminants were disposed of to the well from 1945 to 1947. The waste stream was routed to the 216-B-7A and 216-B-7B Cribs in 1947. Therefore, the types of contaminants expected in the subsurface are similar in nature to those detected during characterization of the 216-B-7A and 216-B-7B Cribs.

Waste streams discharged to the well contain americium-241, cesium-137, plutonium-239/240, strontium-90, and nitrate. The well received approximately 31,100,000 L (8,100,000 gal) of effluent. The waste stream was injected directly into the aquifer.

1.4.4 216-B-7A Crib

The 216-B-7A Crib is an inactive crib that received effluent between 1946 and 1967. When the crib was active, it was connected to the 216-B-7B Crib by an 8 cm (3 in.) steel inlet pipe about 6 m (20 ft) to the northwest. The cribs received effluent simultaneously.

The 216-B-7A Crib is a 4 by 4 by 1.2 m (12-by 12 by 4-ft) hollow (i.e., not gravel-filled) wooden structure made of 15 by 15 cm (6- by 6-in.) timbers. The crib was placed in a 4.2 by 4.2 by 4.2 m (14- by 14- by 14-ft) deep excavation. Contaminated soil from UPR-200-E-144, as well as clean soil, was placed over the site; thus the depth to the bottom of the crib has varied

since construction. Data gathered during the RI and from available drawings indicate that the bottom of the crib is about 7 to 7.6 m (23 to 25 ft) bgs. The crib also has a history of subsidence.

Waste streams discharged to the crib contained cesium-137, ruthenium-106, strontium-90, uranium isotopes, plutonium isotopes, and americium-241 (potentially at transuranic [TRU] levels). An estimated 21,800,000 L (5,750,000 gal) are estimated to have reached the 216-B-7A Crib or roughly half the total volume discharged to both the 216-B-7A and 216-B-7B Cribs.

1.4.5 216-B-38 Trench

The 216-B-38 Trench was active in 1954 and received 1,430,000 L (380,000 gal) of effluent. The ditch was open, unlined, 77 m (250 ft) long, 3 m (10 ft) wide, and 3 m (10 ft) deep. However, data collected during the RI suggest that the bottom of the trench is about 4.3 m (14 ft) bgs. In October 1982, the trench was backfilled and stabilized with 0.6 m (2 ft) of clean top soil. Waste streams discharged to the crib contained fluoride, nitrate, nitrite, phosphate, sodium aluminate, sodium hydroxide, sodium silicate, sulfate-based compounds, cesium-137, strontium-90, ruthenium-106, uranium, and plutonium.

Figure 1-1. Location of the Hanford Site and the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Unit Waste Sites.

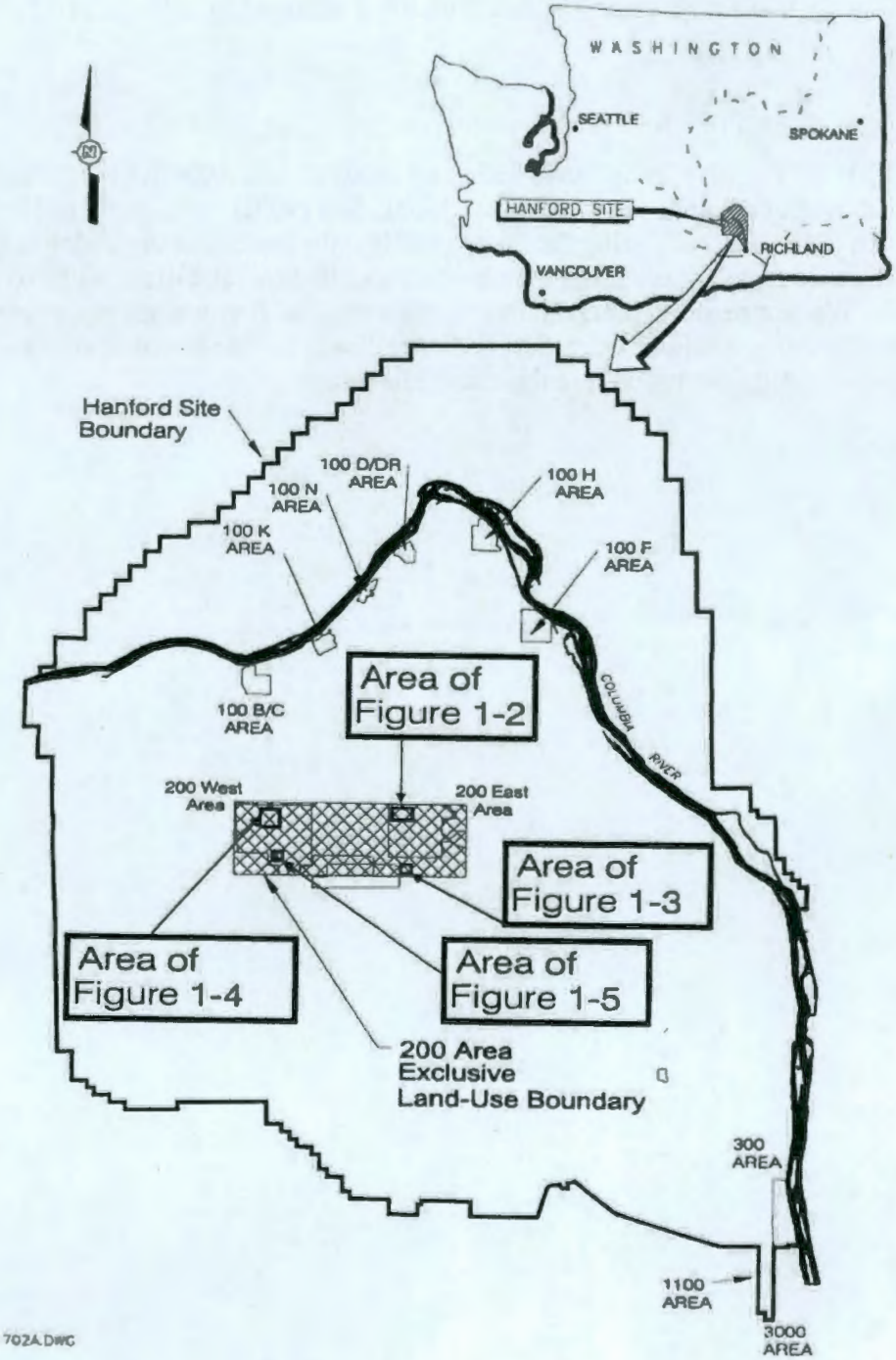


Figure 1-2. Location of 200-TW-1, 200-TW-2, and 200-PW-5 Operable Unit Waste Sites in the 200 East Area.

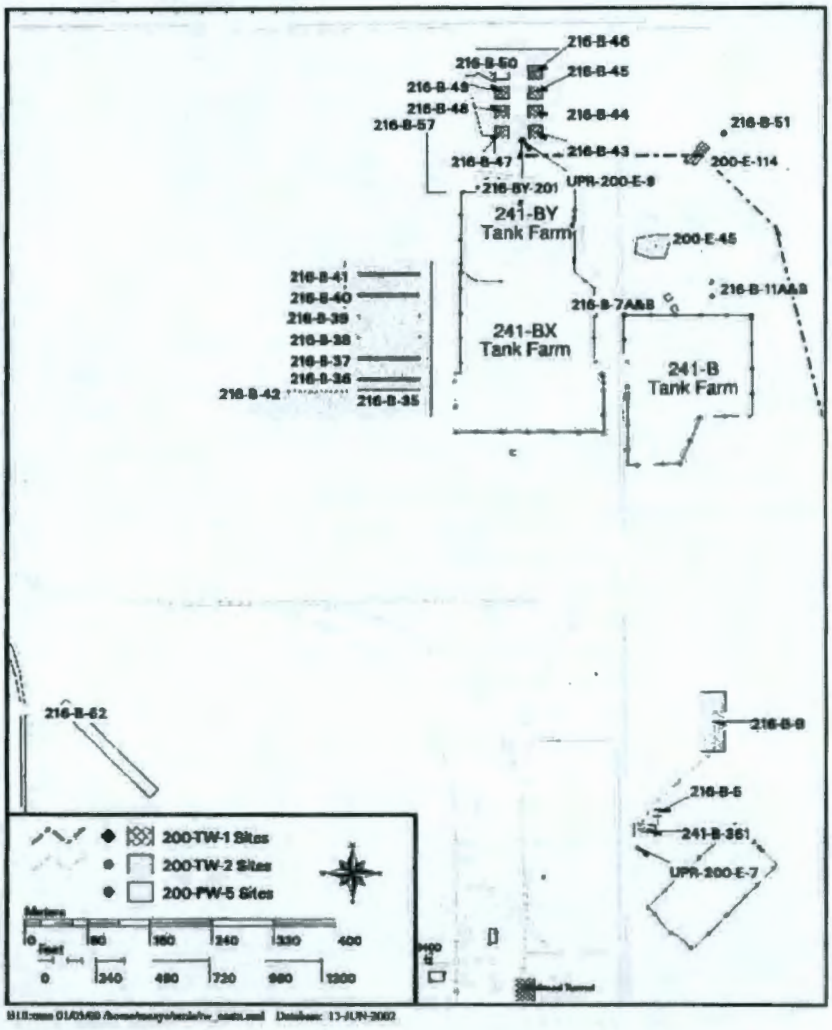


Figure 1-3. Location of the 200-TW-1 Operable Unit Waste Sites South of the 200 East Area.

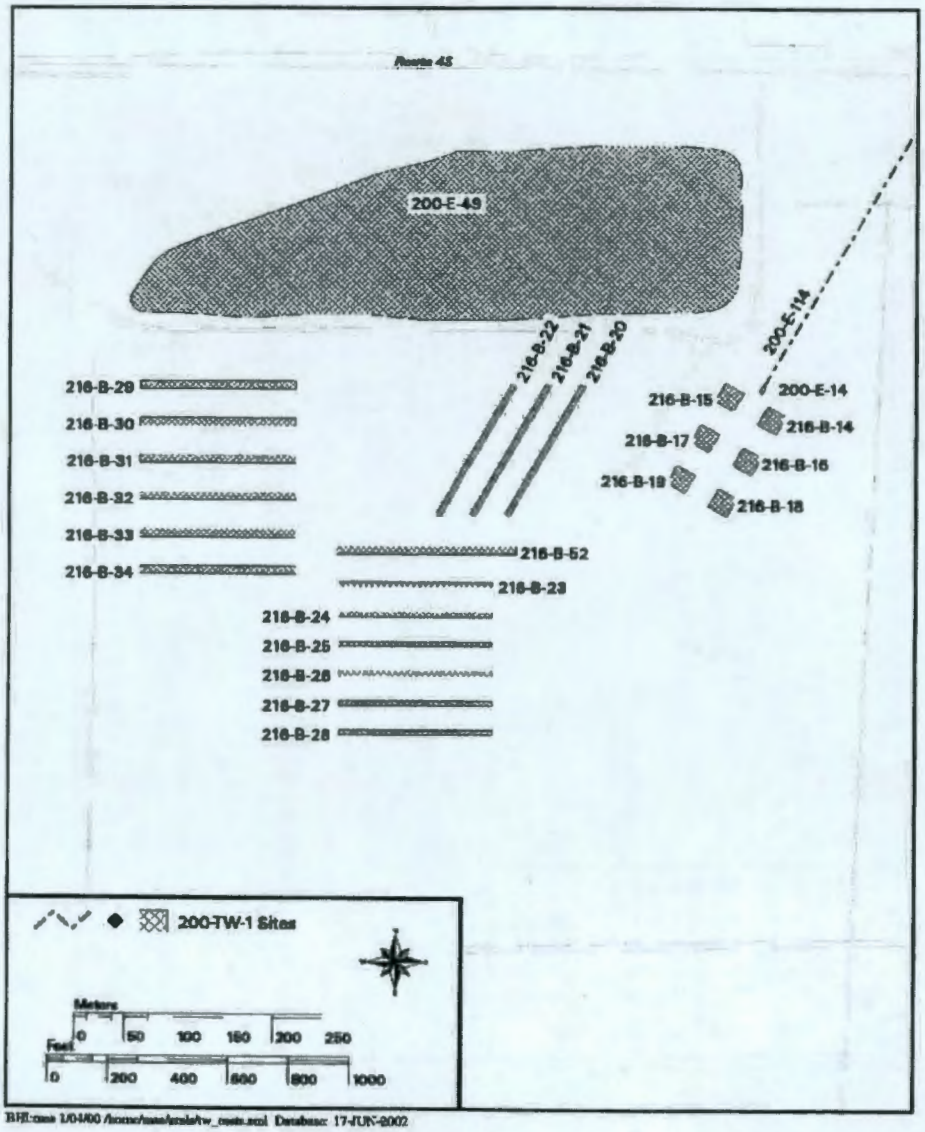


Figure 1-4. Location of the 200-TW-1 and 200-TW-2 Operable Unit Waste Sites in the 200 West Area.

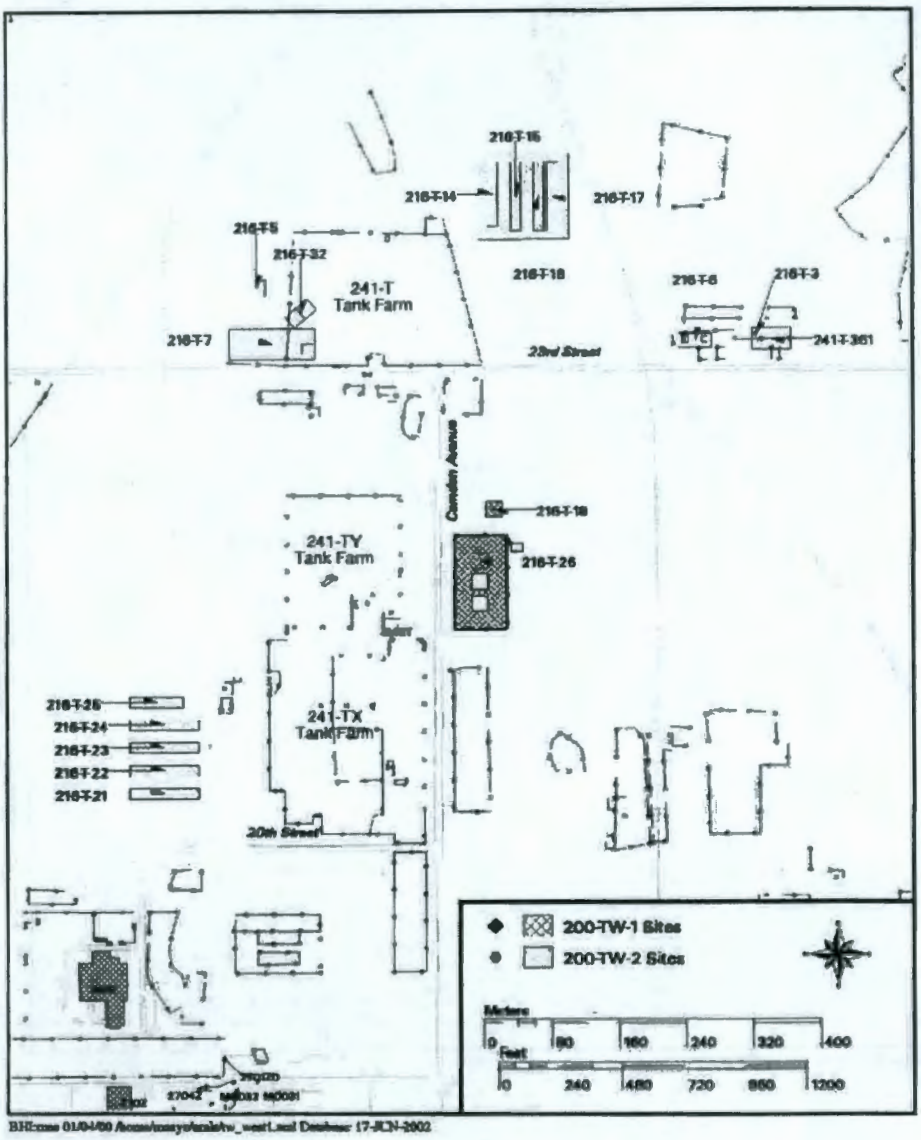
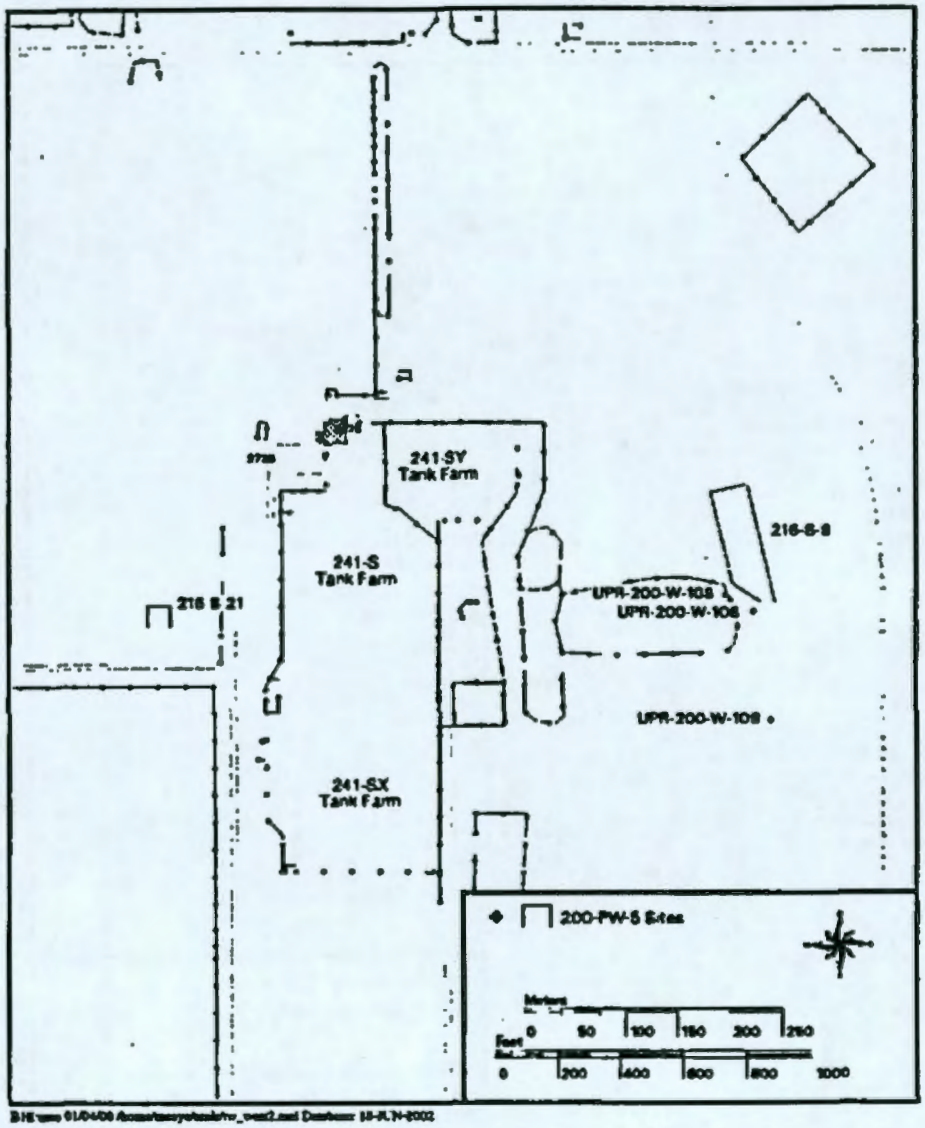


Figure 1-5. Location of the 200-PW-5 Operable Unit Waste Sites in the 200 West Area.



2.0 INVESTIGATION APPROACH AND ACTIVITIES

This chapter summarizes the data collection activities performed during the 200-TW-1 and 200-TW-2 RI. These activities are described in detail in BHI-01606 and BHI-01607. The RI was conducted in accordance with the Work Plan (DOE/RL-2000-38). Data were collected to characterize the nature and vertical extent of chemical and radiological contamination and the physical conditions in the vadose zone underlying the historical boundaries of three representative sites: the 216-T-26 Crib, the 216-B-7A Crib, and the 216-B-38 Trench. In addition, radionuclide logging system (RLS) data were collected to assess the lateral extent of gamma-emitting radionuclide contamination in and adjacent to waste sites. The scope of the RI included drilling (cable tool and direct push), conducting surface and borehole geophysical surveys, and sampling and analysis of soil.

This RI report also summarizes previous characterization efforts for the 216-B-46 Crib, 216-B-5 Reverse Well, and 216-B-57 Crib. The 216-B-46 and 216-B-57 Cribs were characterized in 1991 and 1992 according to DOE/RL-88-32, *Remedial Investigation/Feasibility Study Work Plan for the 200-BP-1 Operable Unit, Hanford Site, Richland, Washington.* DOE/RL-92-70 summarizes the data collection efforts and results, which are provided here by reference. The scope of the 200-BP-1 RI efforts included drilling, conducting borehole geophysical surveys, and sampling and analysis of soils. Characterization of the 216-B-5 Reverse Well is documented in RHO-ST-37. The scope of this effort included drilling, borehole geophysical surveys, and sampling and analysis of soil. Table 2-1 provides an overview of the data collection activities performed at the representative sites in this RI report. Other than RLS logging, no additional characterization efforts were performed at these sites under the 200-TW-1 and 200-TW-2 RI, because the existing data are considered sufficient for making remedial decisions.

Section 2.1 describes data collection activities applicable to the 200-TW-1 and 200-TW-2 RI at the 216-T-26 Crib, 216-B-7A Crib, and 216-B-38 Trench as guided by the Work Plan (DOE/RL-2000-38). Sections 2.2, 2.3, and 2.4, respectively, briefly describe data collection efforts presented in existing reports (mainly DOE/RL-92-70 and RHO-ST-37) applicable to the 216-B-46 Crib, 216-B-5 Reverse Well, and 216-B-57 Crib.

2.1 200-TW-1 AND 200-TW-2 OPERABLE UNIT REMEDIAL INVESTIGATION DRILLING

Three boreholes (C3102, C3103, and C3104) were drilled and sampled during the 200-TW-1 and 200-TW-2 RI. Boreholes were drilled through the 216-T-26 Crib and 216-B-38 Trench from the ground surface to the water table at depths of approximately 69 m (226 ft) and 80 m (263 ft), respectively. Drilling at the 216-B-7A Crib terminated within a significantly thick silt horizon at a depth of 68 m (222.5 ft), approximately 7 m (23 ft) above the surface of the water table. Boreholes were drilled to better define stratigraphy and to assess the nature and vertical extent of chemical and radiological contamination, as well as the physical properties of the soil beneath these waste sites.

Boreholes were drilled using a cable-tool drill rig. The diesel hammer drill rig also was used to augment drilling and sampling at the 216-B-7A Crib. The boreholes were advanced to total depth using drive barrels and split-spoon samplers. Split-spoon samplers were used as the primary sampling device for collecting chemical, radiological, and physical property samples;

however, the drive barrel occasionally was used to collect moisture samples. The three boreholes were decommissioned with bentonite and cement after reaching total depth, in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells."

Five direct-push holes were installed at the 216-B-38 Trench using an environmental diesel hammer drill rig. The five direct-push holes were placed along the center axis of the trench and pushed to a depth of approximately 18.3 m (60 ft). The pushes were used in conjunction with the RLS to identify the area of highest gamma-emitting radionuclide contamination and the lateral extent of this contamination within the trench and to support placement of a deep vadose zone borehole. The five pushes were decommissioned with bentonite and cement after reaching total depth. Drive casing and abandonment activities were performed in accordance with WAC 173-160. Borehole and direct push boring locations near these waste sites are shown in Figures 2-1 and 2-2. Sampling and geophysical logging associated with drilling are described in Sections 2.1.1 and 2.1.2 and in the borehole summary reports (BHI-01606 and BHI-01607).

2.1.1 200-TW-1 and 200-TW-2 Operable Unit Remedial Investigation Sampling and Analysis

Soil samples collected from boreholes were screened in the field before sample collection for indications of contamination and to assist with determining discrete sample locations or depths. Samples were screened for volatile organic contamination, beta-gamma activity, and alpha activity. Radiological activity greater than two times background was used as a screening indicator of contamination. Field screening data can be found in BHI-01606 and BHI-01607.

Soil samples were collected for chemical and radiological analysis and determination of physical properties. Sample collection was guided by the sample schedule in the Work Plan (DOE/RL-2000-38), Appendix A (Tables A-4 through A-6). The sampling approach generally required a greater sample frequency near the bottom of the waste site, which is the area of highest suspected contamination. Several samples could not be collected or, in some cases, sample analysis was limited, because of poor sample recovery. Sample analyses performed for each sample at each of the three boreholes are presented in Table 2-2. Sample collection was always attempted at depths of 4.6 and 7.6 m (15 and 25 ft) bgs. Sample frequency generally was reduced to 7.6 to 15.2 m (25- to 50-ft) intervals below a depth of 7.6 m (25 ft) in boreholes and included a sample from the capillary fringe zone at the water table. Between 12 and 15 soil samples were collected beneath each representative site.

Soil samples generally were analyzed for tributyl phosphate, metals, herbicides, diesel range organic compounds, general chemistry parameters, and radionuclides. Several samples also were analyzed for volatile organic compounds (VOC) to support the dispersed carbon tetrachloride investigation for the 200-PW-1 OU. Samples were analyzed selectively for field bulk density and moisture content. Soil descriptions were made according to BHI-EE-01, *Environmental Investigations Procedures*, Procedure 7.0, "Geologic Logging," to better define stratigraphic relationships in the OUs.

The waste site bottom samples from each borehole were analyzed for an expanded list of compounds, to satisfy waste designation requirements that were identified as part of BHI-01492, *Data Quality Objectives Summary Report for 200-TW-1 and 200-TW-2 Waste Designation*. In addition, several samples were analyzed for a select list of toxicity characteristic leaching potential (TCLP) metals to assist with the waste designation.

2.1.2 200-TW-1 and 200-TW-2 Operable Unit Remedial Investigation Geophysical Logging

Borehole geophysical logging was performed in 12 boreholes and 5 direct push holes during the 200-TW-1 and 200-TW-2 RI. Spectral gamma surveys were conducted in accordance with the Work Plan (DOE/RL-2000-38) at each of the new boreholes and drive casings and at existing monitoring well/borings near the waste sites. In addition to the wells/borings identified in the Work Plan, several additional well/borings near the waste site were logged as part of the 200 Area geophysical logging program performed by MACTEC-ERS. The following summarizes the logging activities at each of the three waste sites:

- 216-T-26 Crib
  - Boreholes C3102, 299-W11-70, and 299-W11-82
- 216-B-7A Crib
  - Boreholes C3103, 299-E33-18, 299-E-33-19, 299-E33-20, 299-E33-58, 299-E33-59, 299-E33-60, and 299-E33-75
- 216-B-38 Trench
  - Boreholes C3104, 299-E33-289, and 299-E33-290
  - Direct push holes C3340, C3341, C3342, C3343, and C3344.

Neutron-neutron moisture surveys were conducted in each new borehole and in the drive casings. Logging was performed to determine the vertical and lateral extent of gamma-emitting radiological contamination and volumetric moisture content within the sediment profile. Detailed reports of logging operations are provided in BHI-01606 and BHI-01607. The reports include summaries of the calibration requirements, processing data, log plots, and results.

2.2 OTHER 200-TW-1 AND 200-TW-2 OPERABLE UNIT ACTIVITIES

2.2.1 Surface Geophysical Surveys

Surface geophysical surveys were conducted before excavation at each site using ground-penetrating radar. The surveys were performed to verify the location of waste sites and to identify potential underground hazards. Several sample locations were adjusted based on the survey findings. Surface geophysical survey reports are found in the project file and in the borehole summary reports (BHI-01606, BHI-01607).

2.2.2 Air Monitoring

Air monitoring during RI activities was conducted in accordance with the *Environmental Program ALARACT Demonstration for Drilling* (WDOH 2001) to verify that contamination did not migrate from the waste site. Existing near-facility stations (N161, N967, N973, N975, N976, and N987) were used for monitoring. Data from these stations will be included in the annual Sitewide near-field environmental monitoring report.

2.2.3 Geodetic Survey

All boreholes were geodetically surveyed in accordance with BHI-EE-01, Procedure 1.6, "Survey Requirements and Techniques." Data were recorded in NAVD88, *North American Vertical Datum of 1988* and Washington State Plane (South Zone) NAD83, *North American Datum of 1983*, with the 1991 adjustment for horizontal coordinates. Survey data are presented in the borehole summary reports (BHI-01606, BHI-01607).

2.2.4 216-B-46 Crib Characterization

Three boreholes (299-E33-299, 299-E33-310, and 299-E33-311) were drilled through the 216-B-46 Crib with a cable tool rig in 1991 and 1992. The boreholes were placed in a triangular array and drilled to depths between 9 m (29.5 ft) and 10.7 m (35 ft) bgs in the crib. The boreholes were decommissioned after drilling to total depth in accordance with WAC 173-160.

Four samples were collected from each borehole and analyzed for CERCLA target compound list (TCL) and target analyte list (TAL) constituents, major anions, bismuth, cyanide (free, complex, and total), and selected radioisotopes. Physical property samples were not collected from this site; however, the data are available from nearby waste sites (e.g., 216-B-43 Trench). Analytical results are presented in DOE/RL-92-70. The subject boreholes also were logged with the RLS and neutron moisture tools. In addition, boreholes 299-E33-4 and 299-E33-23, which are located adjacent to the waste site, were logged with the RLS and neutron moisture tool in 2001. The locations of boreholes near the crib are shown in Figure 2-1.

2.2.5 216-B-5 Reverse Well Characterization

Four boreholes (299-E28-7, 299-E28-23, 299-E28-24, and 299-E28-25) were drilled and sampled during late 1970 to determine the distribution of gamma-emitting contaminants near the 216-B-5 Reverse Well. The boreholes also were logged with the RLS in 2001. These wells are located within 19 m (62 ft) of the reverse well and are shown in Figure 2-3.

Fifteen soil samples were collected at borehole 299-E28-23 (RHO-ST-37). The samples were collected in the vadose zone from near the surface to a depth of 86.6 m (284 ft) bgs. Also, 23 saturated sediment samples were collected from the water table 86.6 m (284 ft) bgs in 1980 to a depth of 100.7 m (330.4 ft) (the top of the basalt). Soils were analyzed for americium-241, plutonium-239/240, strontium-90, and cesium-137. A similar sampling scheme was employed at boreholes 299-E28-7, 299-E28-24, and 299-E28-25. Analytical results are presented in RHO-ST-37.

2.3 200-PW-5 OPERABLE UNIT CHARACTERIZATION

Three boreholes (299-E33-304, 299-E33-305, and 299-E33-306) were drilled through the 216-B-57 Crib in 1991. The boreholes were drilled to depths between 15.2 and 71 m (50 and 233 ft) with a cable tool drill rig. The boreholes were decommissioned after drilling according to WAC 173-160.

Twenty-three samples were collected from the boreholes and analyzed for CERCLA TLC and TAL constituents, major anions, bismuth, cyanide (free, complex, and total), and radioisotopes. Several of these samples also were used in column leach test experiments. In addition,

89 physical property samples were collected continuously with a spilt-spoon sampler from borehole 299-E33-304. Samples were analyzed for bulk density, moisture content, grain size, moisture retention, saturated and unsaturated conductivity, specific gravity, calcium carbonate, and porosity. Analytical results are presented in DOE/RL-92-70. The subject boreholes were logged with the RLS and neutron moisture tool. The locations of boreholes near the crib are shown in Figure 2-1.

Figure 2-1. Borehole Location Map for the 200 East Area.

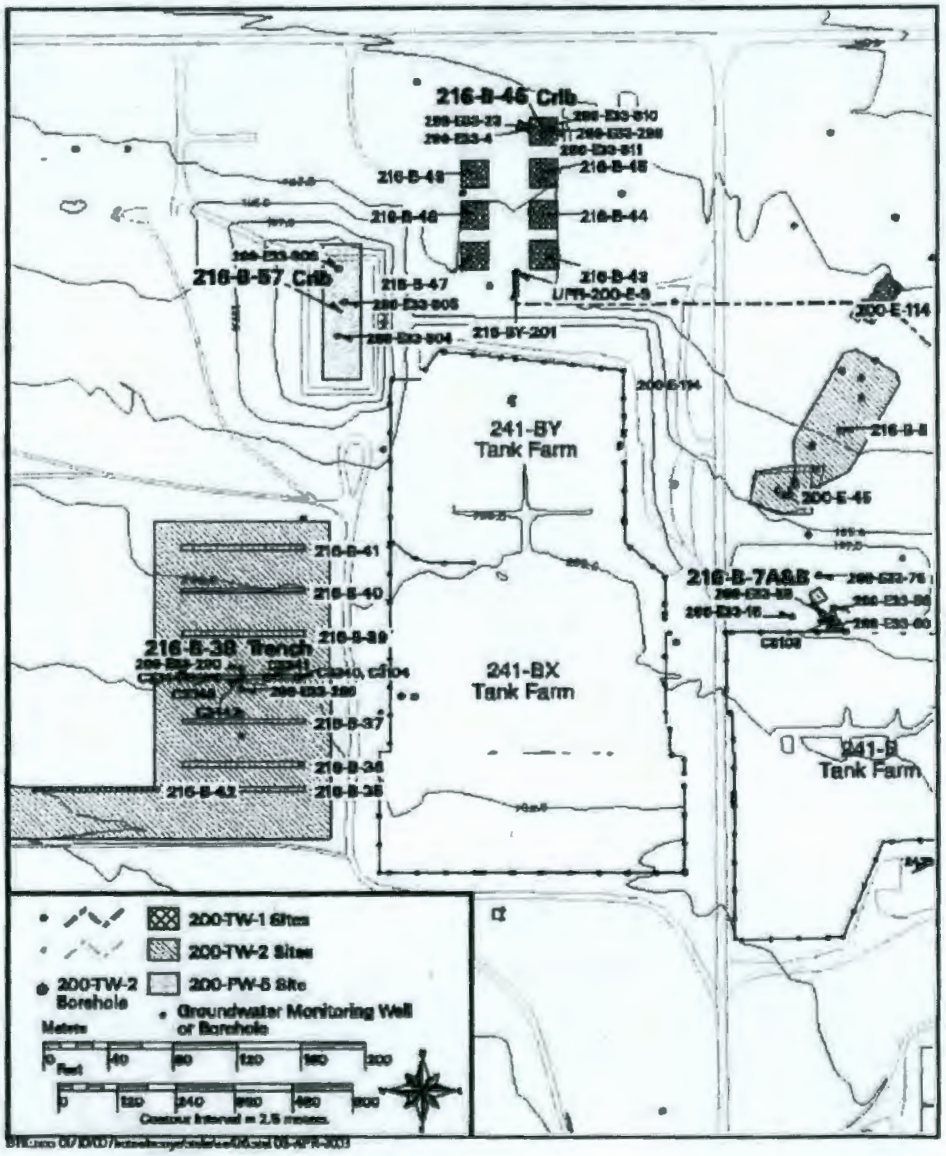


Figure 2-2. Borehole Location Map for 216-T-26 Crib.

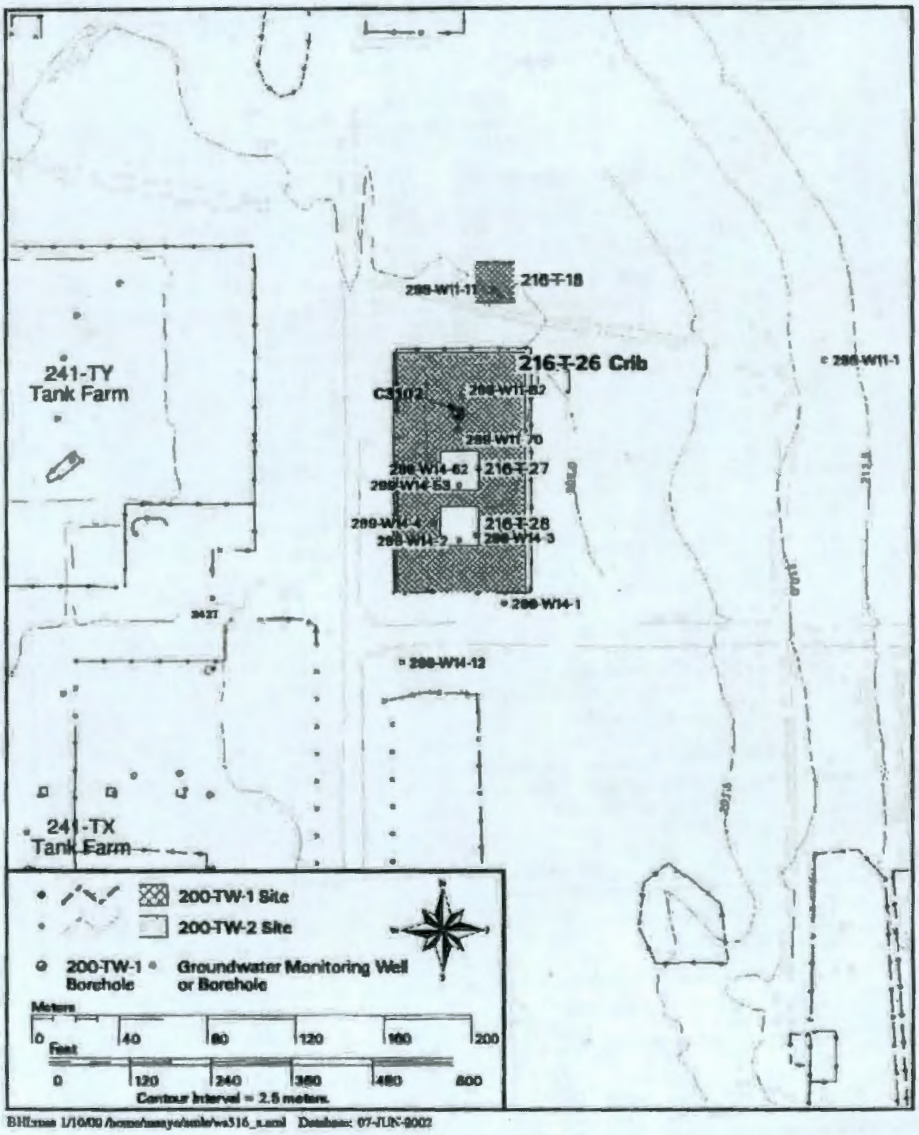


Figure 2-3. Borehole Location Map for the 216-B-5 Reverse Well.

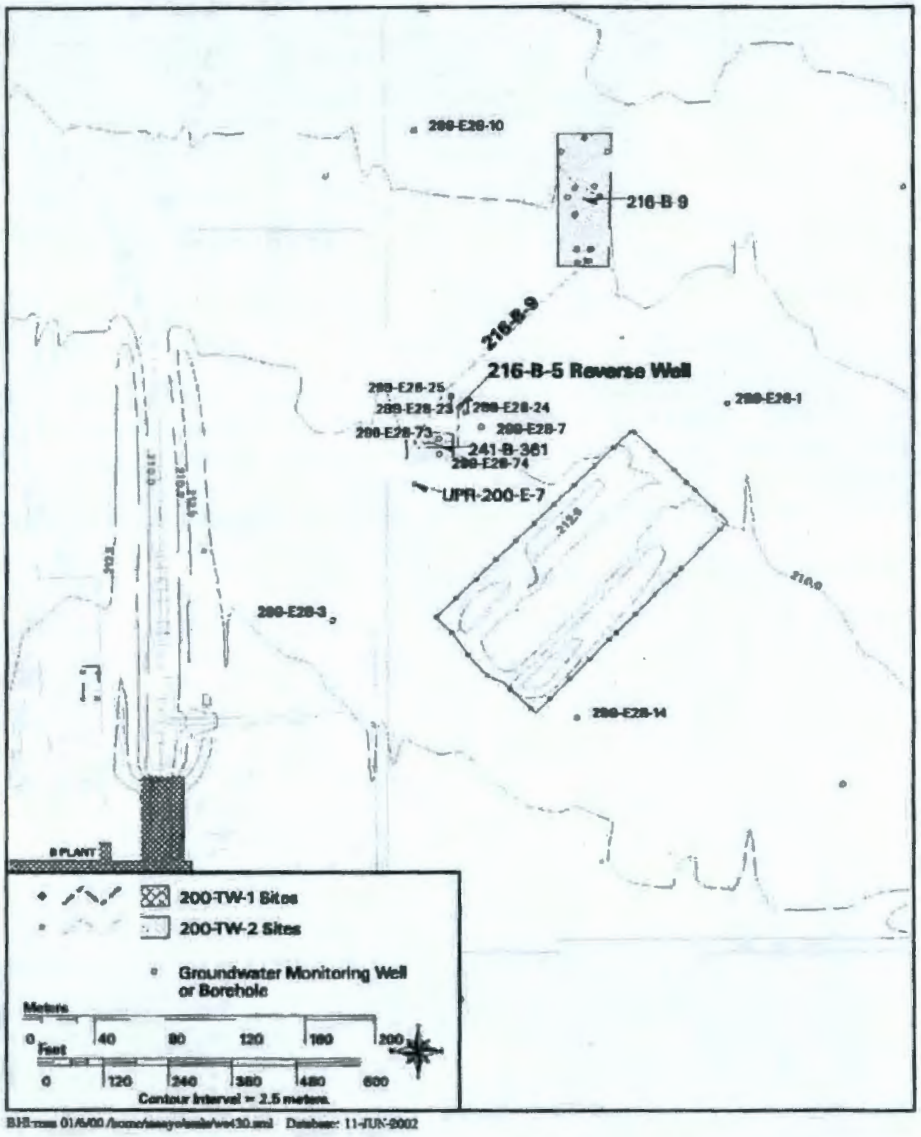


Table 2-1. Summary of Operable Unit Data Collection Activities.

	Number of Boreholes Drilled	Extent of Vadose Investigation	Number of Direct-Push Holes	Number of Chemical Samples	Number of Physical Property	Number of Boreholes Logged	Data Source
200-TW-1 Operable Unit							
216-T-26 Crib	1	226 ft	0	10	6	3	New
216-B-46 Crib	3[a]/25	227 ft	0	12[a]/104	0[a]/67	4[a]/24	Existing
200-TW-2 Operable Unit							
216-B-7A Crib	1	222.5 ft	0	14	5	6	New
216-B-5 Reverse Well	4	287 ft	0	51[b]	Grain size[c]	4	Existing
216-B-38 Trench	1	263 ft	5	12	4	8	New
200-PW-5 Operable Unit							
216-B-57 Crib	3	233 ft	0	23	89	NA	Existing

[a]Summary includes data from 216-B-43, 216-B-44 216-B-45, 216-B-46, 216-B-47, 216-B-48, 216-B-49, and 216-B-50 Cribs as reported in DOE/RL-92-70, 1993, *Phase I Remedial Investigation Report for 200-BP-1 Operable Unit*, Vols. 1 and 2, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

[b]Fifty-one samples were collected from the vadose zone. Additional sediment samples were collected from the aquifer.

[c]The number of samples collected was not reported.

N/A = not analyzed.

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Table 2-2. Summary of Soil Analytical Parameters and Methods. (3 pages)

Method	Constituent or Property	216-T-26 Crib												216-B-38 Trench														216-B-7A Crib														
		0-0.5	10-12.5	18-20.5	22-24.5	27.5-30	34-36	67.3-69.8	Duplicate	92-94.5	147.5-148.5	197.5-198.8	Split	226-227	0-0.5	3.5-5	9.5-12	14.5-15.5	18-20.5	22.5-25	29-31.5	37.5-40	Split	52-54.5	Duplicate	97.5-100	147.5-150	197.5-200	264-265.5	0-0.5	2.5-5	5.5-8	10-12.5	12.5-15	18.5-21	22.5-25	25-27.5	30-32.5	35-37.5	48-50.5	Split	72.5-75	Duplicate	97.5-100	147.5-150	219-221.5
Radionuclides																																														
GeLi/HPGe AmAEA	Americium-241		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
Chemical Separation Liquid Scintillation	Carbon-14		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
GeLi/HPGe	Cesium-137		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
GeLi/HPGe	Cobalt-60		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
GeLi/HPGe	Europium-152		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
GeLi/HPGe	Europium-154		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
GeLi/HPGe	Europium-155		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
NpAEA	Neptunium-237		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
Chemical Separation Liquid Scintillation	Nickel-63		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
PuAEA	Plutonium-238		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
PuAEA	Plutonium-239/240		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
GeLi/HPGe	Potassium-40[d]		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
GeLi/HPGe	Radium-226		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
GeLi/HPGe	Radium-228		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
Chemical Separation Liquid Scintillation	Technetium-99		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
Distillation Liquid Scintillation	Tritium		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
ThAEA	Thorium-228[d]		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
ThAEA	Thorium-230[d]		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
ThAEA	Thorium-232		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
RADSr	Total radioactive strontium		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
KPA	Total uranium		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
UAEA	Uranium-233/234[e]		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
UAEA	Uranium-235/236[e]		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
UAEA	Uranium-238[e]		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦

Table 2-2. Summary of Soil Analytical Parameters and Methods. (3 pages)

Method	Constituent or Property	216-T-26 Crib													216-B-38 Trench														216-B-7A Crib													
		0-0.5	10-12.5	18-20.5	22-24.5	27.5-30	34-36	67.3-69.8	Duplicate	92-94.5	147.5-148.5	197.5-198.8	Split	226-227	0-0.5	3.5-5	9.5-12	14.5-15.5	18-20.5	22.5-25	29-31.5	37.5-40	Split	52-54.5	Duplicate	97.5-100	147.5-150	197.5-200	264-265.5	0-0.5	2.5-5	5.5-8	10-12.5	12.5-15	18.5-21	22.5-25	25-27.5	30-32.5	35-37.5	48-50.5	Split	72.5-75	Duplicate	97.5-100	147.5-150	219-221.5
Inorganic Metals																																														
EPA 6010	Aluminum[b]			◆	◆	◆	◆											◆	◆																	◆										
EPA 6010	Bismuth[b]			◆		◆	◆											◆	◆																	◆										
EPA 6010	Cadmium		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
EPA 6010	Chromium (III)		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
EPA 7196	Hexavalent chromium			◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆				◆	◆																	◆										
EPA 6010	Calcium[b]			◆	◆	◆	◆											◆	◆																	◆										
EPA 6010	Copper		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
EPA 6010	Lead		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
EPA 6010	Iron[b]			◆	◆	◆	◆											◆	◆																	◆										
EPA 6010	Magnesium[b]			◆	◆	◆	◆											◆	◆																	◆										
EPA 6010	Manganese[b]			◆	◆	◆	◆											◆	◆																	◆										
EPA 7196	Mercury		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
EPA 6010	Molybdenum[b]			◆	◆	◆	◆											◆	◆																	◆										
EPA 6010	Nickel		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
EPA 6010	Potassium[b]			◆	◆	◆	◆											◆	◆																	◆										
EPA 6010	Silver		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
EPA 6010	Sodium[b]			◆	◆	◆	◆											◆	◆																	◆										
EPA 6010	Vanadium[b]			◆	◆	◆	◆											◆	◆																	◆										
EPA 6010	Zinc[b]			◆	◆	◆	◆											◆	◆																	◆										
General Chemistry																																														
EPA 305.1	Ammonia			◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
EPA 300.0	Chloride		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
EPA 9010	Cyanide			◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
EPA 300.0	Fluoride		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
IC 300 modified and 353.1	Nitrate and nitrate/nitrite as N		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
IC 300 modified and 353.1	Nitrite and nitrate/nitrite as N		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
EPA 300.0	Phosphate		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
EPA 300.0	Sulfate		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

Table 2-2. Summary of Soil Analytical Parameters and Methods. (3 pages)

Method	Constituent or Property	216-T-26 Crib													216-B-38 Trench														216-B-7A Crib																
		0-0.5	10-12.5	18-20.5	22-24.5	27.5-30	34-36	67.3-69.8	Duplicate	92-94.5	147.5-148.5	197.5-198.8	Split	226-227	0-0.5	3.5-5	9.5-12	14.5-15.5	18-20.5	22.5-25	29-31.5	37.5-40	Split	52-54.5	Duplicate	97.5-100	147.5-150	197.5-200	264-265.5	0-0.5	2.5-5	5.5-8	10-12.5	12.5-15	18.5-21	22.5-25	25-27.5	30-32.5	35-37.5	48-50.5	Split	72.5-75	Duplicate	97.5-100	147.5-150	219-221.5
EPA 9045	PH			♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
EPA 9060	Total Organic Carbon			♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
EPA 8151A	Herbicides[b]	♦													♦															♦																
EPA 8270	Tributyl phosphate		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦																												♦	♦	♦	♦	♦
EPA 8260	Carbon Tetrachloride[c]				♦			♦	♦	♦	♦	♦	♦	♦																												♦	♦	♦	♦	♦
NWTPH-Dx modified for kerosene range	Kerosene, normal paraffin hydrocarbons, and diesel fuel		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦																												♦	♦	♦	♦	♦

[a]Isotopic uranium only analyzed if total uranium is greater than background concentrations.
[b]Analyzed for waste designation purposes.
[c]Analyzed for 200-PW-1 OU Carbon Tetrachloride investigation
[d]Report as part of other analysis.

3.0 REMEDIAL INVESTIGATION RESULTS

This chapter describes the hydrogeologic framework in the 200-TW-1, 200-TW-2, and 200-PW-5 OUs and the nature and vertical extent of contamination at six representative waste sites. The information in this chapter is based on data collected (e.g., geologic logs, depth to water, soil chemistry) during the 200-TW-1 and 200 TW-2 RI and on existing information contained in DOE/RL-92-70, RHO-ST-37, and site geologic logs.

3.1 HYDROGEOLOGIC FRAMEWORK

This section briefly describes the hydrogeologic framework in the 200-TW-1, 200-TW-2, and 200-PW-5 OUs and incorporates site-specific data gathered during the RI with historical data. Additional information on the hydrogeologic setting of these areas can be found in the implementation plan (DOE/RL-98-28); DOE/RL-92-05, *B Plant Source Aggregate Area Management Study Report*; and DOE/RL-91-61, *T Plant Source Aggregate Area Management Study Report*. Figure 3-1 is the generalized stratigraphic column for the OUs. Stratigraphic relationships near the representative waste sites (216-B-5 Reverse Well, 216-B-7A Crib, 216-B-38 Trench, 216-B-46 Crib, 216-B-57 Crib, and 216-T-26 Crib) are shown in Figures 3-2 through 3-6.

3.1.1 Topography

The 200-TW-1, 200-TW-2, and 200-PW-5 OU waste sites are located in the 200 East and 200 West Areas on the 200 Areas Plateau. The 200 Areas Plateau is the common reference used to describe the broad, flat area forming a local topographic high around the 200 Areas at the Hanford Site (Figure 3-7). The plateau was formed approximately 13,000 years ago during the cataclysmic Missoula floods. The northern boundary of the 200 Areas Plateau is defined by an erosional channel that runs east-southeast before turning south just east of the 200 East Area. The northern half of the 200 East Area lies within this flood channel. A secondary flood channel running southward off the main channel bisects the 200 West Area (Figure 3-7).

Waste sites in the 200 West Area are situated in a relatively flat area in a secondary flood channel. Surface elevations range from approximately 205 m (673 ft) to 217 m (712 ft) (datum is from NAVD88), and the surface slopes gently to the west. Waste site surface elevations in the 200 East Area and vicinity range from approximately 189 m (620 ft) (NAVD88) in the northern portion of the 200 Areas to 230 m (755 ft) at waste sites just south of the 200 East Area. The 200 East Area surface slopes gently to the northeast.

3.1.2 Geology

The 200-TW-1, 200-TW-2, and 200-PW-5 OUs are located in the Pasco Basin on the Columbia Plateau (Figure 3-8). They are underlain by basalt of the Columbia River Basalt Group and a sequence of suprabasalt sediments. From oldest to youngest, major geologic units of interest are the Elephant Mountain Basalt Member, the Ringold Formation, the Plio-Pleistocene unit, the Hanford formation/Plio-Pleistocene unit (?), the Hanford formation, Holocene age deposits, and backfill.

Elephant Mountain Member. The Elephant Mountain Member is bedrock beneath the OUs. Bedrock consists of a medium- to fine-grained tholeiitic basalt (DOE/RW-0164, *Consultation Draft Site Characterization Plan*). Depth to basalt varies at the representative sites. In the 200-TW-1 OU, depth to basalt is approximately 152 m (500 ft) at the 216-T-26 Crib and 69.8 m (229 ft) at the 216-B-46 Crib. In the 200-TW-2 OU, depth to basalt is approximately 79.0 m (258 ft) at the 216-B-7A Crib, 85 m (276 ft) at the 216-B-38 Trench, and 104 m (340 ft) at the 216-B-5 Reverse Well. In the 200-PW-5 OU at the 216-B-57 Crib, the depth to basalt is 72 m (236 ft). Depth to basalt increases to the south.

Ringold Formation. DOE/RL-92-70 indicates that the basalt is overlain by the Ringold Formation in the east, south, and central sections of the 200 East Area. In the 200 West Area, the basalt is completely overlain by the Ringold Formation. The Ringold Formation consists of an interstratified sequence of unconsolidated clay, silt, sand, and granule-to-cobble gravel deposited by the ancestral Columbia River. These alluvial sediments consist of four major units; these are (from oldest to youngest) the fluvial gravel and sand of unit A, the buried soil horizons and lake deposits of the lower mud sequence, the fluvial sand and gravel of unit E, and the lacustrine mud of the upper Ringold. Units A and E consist of a silty-sandy gravel with secondary lenses and interbeds of gravely sand, sand, and muddy sands to silt and clay. The lower mud unit consists mainly of silt and clay. The upper Ringold consists of silty over-bank deposits and fluvial sand.

Plio-Pleistocene units. Overlying the Ringold Formation in the 200 West Area is a locally derived subunit called the Plio-Pleistocene unit. This unit is interpreted to be a weathered (WHC-SD-EN-TI-290, *Geologic Setting of the Low-Level Burial Ground*; PNL-7336, *Geohydrology of the 218-W-5 Burial Ground, 200 West Area, Hanford Site*) and eolian facies (Slate 1996, "Buried Carbonate Paleosols Developed in Pliocene-Pleistocene Deposits of the Pasco Basin, South-Central Washington, U.S.A.") that consists of poorly sorted, locally derived, interbedded reworked loess, silt, sand, and basaltic gravel. The subunit consists of a layer of interbedded carbonate-poor to carbonate-rich paleosol. The upper silty eolian facies was previously interpreted to be early Pleistocene loess and has been referred to as the early Palouse soil (PNL-7336). Generally, it is well-sorted quartz-rich/basalt-poor silty sand to sandy silt (BHI-00270, *Pre-Operational Baseline and Site Characterization Report for the Environmental Restoration Disposal Facility*).

A recently identified unit of uncertain origin, referred to as the Hanford formation/ Plio-Pleistocene unit (?), is present in the 200 East Area overlying the basalt beneath the 216-B-7A Crib, 216-B-38 Trench, and 216-B-46 Crib. The Hanford formation/Plio-Pleistocene unit (?) may be equivalent or partially equivalent to the Plio-Pleistocene unit, or it may represent the earliest ice age flood deposits, overlain by a locally thick sequence of fine-grained, nonflood deposits of the lower Hanford formation (HNF-5507, *Subsurface Conditions Description for the B-BX-BY Waste Management Area*). The continuity of the Hanford formation/Plio-Pleistocene unit (?) across the 200 East Area has not been evaluated.

The Hanford formation/Plio-Pleistocene unit (?) is made up of two facies. The lower facies overlies basalt and is described in HNF-5507 as loose, unconsolidated sandy gravel to gravelly sand. These gravels contain 50 to 70 percent basalt and are similar to and often indistinguishable from Hanford formation flood gravel in the absence of the second facies. The second facies consists of an olive brown to olive gray, well-sorted calcareous eolian/overbank silt with laminations and pedogenic structures. However, this facies also has been observed to be massive

and void of any sedimentary or pedogenic structures. Where the Ringold Formation and Hanford formation/Plio-Pleistocene unit (?) are not present, Hanford formation sediments overlie the basalt in the 200 East Area.

Hanford formation. The Hanford formation overlies the Plio-Pleistocene unit in the 200 West Area. In the 200 East Area, it overlies the Hanford formation/Plio-Pleistocene unit (?) at the 216-B-7A Crib, the 216-B-38 Trench, the 216-B-46 Crib, and the 216-B-57 Trench. At the 216-B-5 Reverse Well, the Hanford formation overlies the Ringold Formation.

The Hanford formation consists of unconsolidated gravel, sand, and silts deposited by cataclysmic floodwaters (DOE/RL-92-70). These deposits consist of gravel-dominated (H1 and H3) and sand-dominated facies (H2). The gravel-dominated facies consist of cross-stratified, coarse-grained sands and granule to boulder gravel. The gravel is uncemented and matrix poor. The sand facies consists of well-stratified fine- to coarse-grained sand and granule gravel. Silt in these facies is variable and may be interbedded with the sand. Where the silt content is low, an open-framework texture is common. An upper and lower gravel unit and a middle sand facies are present in the study area.

Holocene-Aged Deposits and Backfill. Holocene-aged deposits and material used for backfill overlie the Hanford formation. Holocene-aged deposits are dominated by eolian sheets of sand that form a thin veneer across the Site, except in localized areas. The soils consist of very fine- to medium-grained sand to occasionally silty sand.

Fill material was placed in and over representative waste sites during construction of cribs and trenches for contamination control. The fill consists of silty-sandy gravel, silty sand to sandy silt, or both. The silt horizon consists of at least 40 percent silt and often has a "flour appearance" at the surface. The thickness of the backfill is up to 25 ft (7.6 m) at representative sites.

3.1.3 Hydrostratigraphy

Hydrostratigraphic units of concern in the 200-TW-1 and 200-TW-2 OUs are separated into six zones: the Elephant Mountain Basalt member (confining horizon), the Ringold Formation (water-bearing zone and lower part of the vadose zone at the 216-B-5 Reverse Well), Plio-Pleistocene unit (vadose zone), Hanford formation/Plio-Pleistocene unit (?) (water-bearing zone and lower part of the vadose zone), Hanford formation (vadose zone), and backfill (vadose zone) (Figure 3-1).

Vadose Zone. The vadose zone is the area between the ground surface and water table. In the southern section of the 200 East Area, the vadose zone is approximately 103.7 m (340 ft) thick. At the 216-B-5 Reverse Well, the vadose zone is 87.5 m (287 ft) thick and thins to the north toward the 216-B-46 Crib. The vadose zone is dominated by the Hanford formation and the Hanford formation/Plio-Pleistocene unit (?) at representative sites in the 200 East Area, although a small section of the Ringold Formation may be present at the 216-B-5 Reverse Well. The thickness of the vadose zone is 69.5 to 87.5 m (228 to 287 ft) at representative sites in the 200 East Area.

In the 200 West Area, the vadose zone thickness ranges from 40.2 to 102.7 m (132 to 337 ft). Sediments in the vadose zone are the Ringold Formation, the Plio-Pleistocene unit, and the

Hanford formation. The thickness of the vadose zone at the 216-T-26 Crib is approximately 68.9 m (226 ft).

Moisture content in the 200 Areas vadose zone typically ranges between 2 and 10 percent under ambient conditions (DOE/RL-98-28), but historically has ranged widely from 10 percent to saturation (perched water) at liquid waste receiving sites. With the reduction of artificial recharge in the 200 Areas in 1995, the downward flux of liquid in the vadose zone beneath waste sites has been decreasing. Moisture content in the vadose zone is expected to remain elevated over preoperational conditions for some time near waste sites. Before 1995, liquid waste sites provided a significant driving force for contaminant transport. In the absence of artificial recharge, recharge from natural precipitation becomes the dominant driving force for moving contamination remaining in the vadose zone to groundwater.

Data collected with the neutron-moisture logging tool indicate that volumetric moisture content beneath representative sites ranges between 1.0 and 19.0 percent. Over most of the log interval, the moisture content was less than 4 percent. Zones of higher moisture are associated with elevated levels of contamination within 12.2 m (40 ft) of the surface, fine-grained textures, formation contacts, and other lithologic features, such as clastic dikes and brecciated and altered zones. A slight increase in moisture content (approximately 1 to 4 percent) is noted within 6.1 m (20 ft) of the water table at each site. This reflects the decline of the water table surface across the 200 Areas.

The area of highest moisture was detected beneath the 216-B-7A Crib within the Hanford formation/Plio-Pleistocene silt (?) at a depth of 66.5 m (218 ft). Soil samples from this zone were very wet, because milliliters of water drained out of samples by gravity after collection. Monitoring of this zone during a 24-h period showed that a hydraulic head did not develop in the well; therefore, this zone is not considered a perching horizon. Possible sources of moisture in this zone may be from the 216-B-7A Crib, other waste sites, and/or potential leaking water lines.

A limited number of soil samples were collected to determine moisture content by American Society of Testing and Materials (ASTM) Method D2216, *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*; grain-size distribution by ASTM Method D422, *Standard Test Method for Particle-Size Analysis of Soils*; and bulk density by BHI-EE-05, *Field Screening Procedures*, Section 3.9, "Determination of Soil Bulk Density Using a Split-Spoon Sampler." One sample was to be collected from each geologic unit for each of the three boreholes. Physical property samples were not collected in several intervals, because of high radiological contamination or insufficient volume. Laboratory moisture content ranged between 1.4 and 22.5 percent (equivalent to 3.88 and 34.17 volumetric moisture percent). Bulk densities ranged between 1.4 and 2.06. The physical property testing data collected during the RI are summarized in Table 3-1. The laboratory results are presented in Appendix C.

Unconfined Aquifer. The unconfined aquifer beneath the 200 West Area occurs within the Ringold Formation Unit E. Beneath representative sites in the 200 East Area, it occurs within the Hanford formation/Plio-Pleistocene unit (?) and in the Ringold Formation. Current sources of recharge to the aquifer in the 200 Areas include rain, snowmelt, septic system, leaking water lines, and irrigation from private land west of the Hanford Site. Past-practice sources of artificial recharge on the Hanford Site consisted mainly of effluent discharges to the ground from liquid waste receiving sites (e.g., ponds, cribs, trenches). Recharge between 1944 and reductions in discharges in 1995 has resulted in an increase of the water table elevation across the Site. Since

termination of most of the artificial recharge onsite in 1995, the elevation of the water table has been and is currently declining.

The elevation of the water table varies across the 200 West Area (Figure 3-9). At OU waste sites, water table elevations are between 136 and 140 m (446 and 459 ft). Groundwater flows from west to east. March/April 2000 and March 2001 depth to water measurements in PNNL-13788, *Hanford Site Groundwater Monitoring for Fiscal Year 2001*, indicate that the surface of the water table is declining at a rate of 0.35 m/yr (1.1 ft/yr). The decline is the result of cessation of most discharges to the ground. The saturated thickness of the unconfined aquifer is 38.4 m (126 ft) beneath the 216-T-26 Crib, and it is bound by the Ringold lower mud unit. Depth to water at the 216-T-26 Crib is approximately 69 m (226 ft).

Depth to water beneath representative sites in the 200 East Area ranges between 69.5 and 87.5 m (228 and 287 ft) and increases to the south. The elevation of the water table surface across the 200 East Area is bound completely by the 122 and 124 m (400- and 407-ft) contour intervals (Figure 3-9). Groundwater flow is to the northwest toward Gable Mountain and through Gable Gap, and to the southeast and east toward the Columbia River. The divide between the two flow regimes is not clearly discernable because the water table is very flat. Based on the March/April 2000 and March 2001 depth to water measurements in PNNL-13788, the surface of the water table is declining at a rate of 0.14 m/yr (0.46 ft/yr) in the 200 East Area. The saturated thickness of the unconfined aquifer is less than 1 m (3 ft) at the 216-B-46 Crib and 16 m (53 ft) to the south at the 216-B-5 Reverse Well. The base of the unconfined aquifer is basalt of the Elephant Mountain Member.

3.2 OPERABLE UNIT CONTAMINATION

Contaminants of potential concern (COPC) were preliminarily identified in the DQO process (BHI-01356) based on process information, information from the 200-BP-1 RI (DOE/RL-92-70), and other existing information. The COPCs were screened in the DQO process using a set of criteria based on the nature of the contaminants, their longevity, and the likelihood of their presence in the environment today (BHI-01356). This screened list of COPCs was used to identify sampling requirements for the RI. This RI report takes the data from the RI and further evaluates it as discussed in this section. The data from the 200-BP-1 RI and from RHO-ST-37 were judged in the DQO process to be of sufficient quality to support the decision process for these OUs. Because the investigation reported in RHO-ST-37 did not evaluate nonradiological constituents, the data from the 216-B-7A Crib are used to evaluate the 216-B-5 Reverse Well for these constituents. The effluent originally sent to the 216-B-5 Reverse Well was redirected to the 216-B-7A and 216-B-7B Cribs, so the data from the 216-B-7A Crib were judged in the DQO process to be analogous to the data for the 216-B-5 Reverse Well.

This section describes the data evaluation process used to assess the nature and extent of contamination at representative sites in the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. Appendix C lists the entire data set from the 200-TW-1 and 200-TW-2 RI. The process is used to identify constituents in the soil column that are naturally occurring and contamination that may present significant risk to human health and the environment. Contaminants are identified by subjecting constituents to a step-wise screening process. The extent of contamination is determined by the distribution of contaminants remaining after the screening process is applied. Contaminants with no detections above detection limits were eliminated from consideration.

The initial step in the process involves comparing the data to the Hanford Site background threshold concentrations at the 90th percentile in DOE/RL-92-24 and DOE/RL-96-12. Ecology Publication No. 94-115 also was used for background concentrations where no site-specific background concentrations were available. Comparison to background threshold concentrations was conducted to eliminate sample detects that represent naturally occurring constituents. Contaminants with concentrations above background concentrations and contaminants with no available background concentrations were retained for further evaluation.

To further focus the list of constituents exceeding background concentrations, constituents were subjected to a screening process against existing regulatory standards. Nonradiological constituents with concentrations above background were compared to WAC 173-340-745 Method C soil cleanup levels as presented in Ecology Publication No. 94-145, *Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulations (CLARC).* These constituents also were compared to soil concentrations considered protective of groundwater. Soil concentrations protective of groundwater were calculated based on WAC 173-340-747, using Method B groundwater standards under WAC 173-340-720, "Ground Water Cleanup Standards." Concentrations exceeding background concentrations, WAC 173-340-745 Method C soil cleanup levels, or concentrations protective of groundwater are regarded as evidence of contamination and potential risk, unless information is available that would justify eliminating contaminants from the screening process.

Promulgated soil-based cleanup levels have not been developed for radionuclides. Therefore, radionuclides detected above background are retained for further evaluation in Chapters 4.0 and 5.0 of this report. Table 3-2 summarizes the maximum contaminant concentrations and compares them to background concentrations. Tables 3-3 through 3-5 document the screening process for this section and identify contaminants in the subsurface at representative sites in the respective OUs that exceed background and regulatory levels.

A considerable amount of information is presented in the 200-BP-1 RI report (DOE/RL-92-70) to identify contaminants at the 216-B-46 and 216-B-57 Cribs. Because the screening process has changed since that report was issued in 1993, the data were reevaluated in this report to refine the list of contaminants. The nature and extent of contamination at representative sites in the 200-TW-1, 200-TW-2, and 200-PW-5 OUs are discussed in Sections 3.2.1, 3.2.2, and 3.2.3, respectively.

3.2.1 Nature and Extent of Contamination at the 200-TW-1 Operable Unit Representative Sites

This section describes the nature and extent of contamination at the 216-B-46 and 216-T-26 Cribs in the 200-TW-1 OU.

Nature and Extent of Contamination at 216-B-46 Crib. Twelve soil samples were collected beneath the 216-B-46 Crib during the 200-BP-1 remedial investigation (DOE/RL-92-70). Samples were collected to a maximum depth of 10.7 m (35 ft) in three boreholes. Because no samples were collected greater than 10.7 m (35 ft) bgs, analogous site data from the 216-B-49 Crib (i.e., borehole 299-E33-302) were used to assess deep soil contamination in the vadose zone. The 216-B-49 Crib also was characterized during the 200-BP-1 remedial investigation. The 216-B-49 Crib received approximately the same effluent and contaminant load as the 216-B-46 Crib and is within the same physical setting. Table 3-6 compares the

effluent volume and contaminant load for the 216-B-46 and 216-B-49 Cribs. This table shows that the 216-B-49 Crib is analogous to the 216-B-46 Crib and provides analogous data to evaluate deeper contamination.

The following 19 constituents exceeded the screening in the soil column beneath the 216-B-46 Crib (Table 3-3):

- antimony-125
- cesium-137
- cobalt-60
- plutonium-238
- plutonium-239
- plutonium-239/240
- radium-226
- strontium-90
- technetium-99
- tritium
- total uranium
- bismuth
- cadmium
- sodium
- cyanide
- nitrate
- nitrite
- phosphate
- sulfate

The distribution of contaminants with depth at the 216-B-46 Crib is shown in Figure 3-10 with correlation to stratigraphy. Contamination is present throughout the vadose zone beneath the crib. Only low levels of contamination are present from the surface to a depth of 5.5 m (18 ft). The majority of contaminants and the highest concentrations were detected from 5.5 to 14.9 m (18 to 49 ft) bgs. Figure 3-10 provides vertical profiles of the detected contaminants that show significant contamination from 5.5 to 14.9 m (18 to 49 ft) bgs and decreasing concentrations with depth. The maximum concentrations of many of the contaminants were associated with the approximate bottom of the crib at a depth of about 5.5 m (18 ft) bgs. Cesium-137 and strontium-90 were the dominant radionuclides present, with maximum concentrations of 364,000 (decayed to 280,000 in 2004) and 353,000 (decayed to 260,000 in 2004) pCi/g, respectively.

Cobalt-60, radium-226, technetium-99, and total uranium were distributed more widely across the vadose zone and were detected at depths greater than 14.9 m (49 ft) bgs. With the exception of technetium-99, concentrations were less than 5 pCi/g at depths greater than 14.9 m (49 ft) bgs. Technetium-99 concentrations ranged from 65 to 160 pCi/g at depths greater than 14.9 m (49 ft) bgs. The distribution of these contaminants deep in the vadose zone is associated with the mobility of these contaminants in contrast to cesium-137, plutonium-239/240, and strontium-90, which are much less mobile and remain in vadose zone soils close to the point of release to the environment.

Bismuth, cadmium, and sodium were the only metals detected that exceeded the initial screening. Bismuth was detected in one sample at a concentration of 31.3 mg/kg at a depth of 58 m (190.5 ft) bgs. Sodium was distributed throughout the vadose zone starting at a depth of about 5.5 m (18 ft) and had a maximum concentration of 4,360 mg/kg. Neither constituent has a cleanup level identified through WAC 173-340-745. Sodium was detected above the Hanford Site background; no background has been established for bismuth. Cadmium was detected at a maximum concentration of 2 mg/kg at a depth of 0.9 to 1.8 m (3 to 6 ft) bgs and was not detected below 3.7 m (12 ft).

Cyanide, nitrate, nitrite, phosphate, and sulfate were detected in significant concentrations beneath the crib. Nitrate and sulfate were detected near the surface and also in the deeper portion of the vadose zone at maximum concentrations of 5,470 mg/kg as nitrate and 1,080 mg/kg,

respectively. Nitrite and phosphate were distributed at depths less than 14.9 m (49 ft) bgs at maximum concentrations of 12.2 mg/kg (as nitrate) and 86.7 mg/kg, respectively. Cyanide was detected from about 5.5 m (18 ft) bgs to a depth of 58.5 m (193 ft) with a maximum concentration of 12.0 mg/kg.

Cesium-137 was detected with the RLS from the surface to a depth of 27.4 m (90 ft) with significantly elevated levels from 4.9 to 17.4 m (16 to 57 ft) bgs. The RLS data indicate that the maximum estimated concentration was about 1,400,000 pCi/g at a depth of 7.6 m (25 ft) in well 299-E33-4. A true maximum concentration was not determined, because the tool saturated or exceeded the dead time in this zone. Very little cesium was detected in near-surface sediments and at depths greater than 22 m (72 ft) bgs. The data suggest that the deeper contamination may be attributed to the drag down of contamination during drilling. The RLS data from well 299-E33-4 indicate that cesium-137 contamination extends laterally from the crib several meters to the west.

Based on the data generated for the 216-B-46 Crib during the 200-BP-1 RI, on the screening process conducted in this RI, and on recent geophysical logging of nearby boreholes, the contaminant distribution model presented in the 200-TW-1 and 200-TW-2 Work Plan (DOE/RL-2000-38) was revised. The new contaminant distribution model for the 216-B-46 Crib is shown in Figure 3-11. The contaminant distribution model agrees quite well with the conceptual contaminant distribution model in the Work Plan. The zone of major contamination was predicted to be about 9 m (30 ft) thick. This is consistent with the sampling and logging data. However, the lesser zone of contamination extended deeper in the borehole than originally expected (58 m [190 ft] versus 39.5 m [130 ft]). Some spreading of contaminants was predicted at the Hanford formation sand/Hanford formation gravel interface. Logging in adjacent boreholes seems to uphold this assumption. Logging of these boreholes at different times indicates that the contamination does not seem to be moving.

3.2.1.1 Current Impacts to Groundwater at the 216-B-46 Crib. The effluent volume discharged to the 216-B-46 Crib was roughly 70 percent of the rough-estimated soil column pore volume beneath the waste site. This information suggests that the volume of effluent released may not have been sufficient to reach the aquifer during operations of the waste site from September to December 1955. Additional assessment of potential impact to groundwater is constrained at this site because soil data only were collected to a depth of 10.7 m (35 ft) bgs. However, as stated previously, the 216-B-49 Crib was used to evaluate deep contamination in the lower vadose zone.

Mobile contaminants, such as technetium, nitrate, and cobalt-60, were detected in deep vadose zone soil samples beneath the 216-B-49 Crib (i.e., near the top of the water table), suggesting the likelihood of historical impacts to groundwater at the waste site. The status of groundwater near the crib is shown in Figures 3-12 and 3-13. The maps indicate four major groundwater plumes associated with mobile constituents (nitrate, iodine-129, technetium-99, and uranium) near the crib. Future impacts to groundwater at this crib are evaluated in Chapter 4.0.

3.2.1.2 Nature and Extent of Contamination at 216-T-26 Crib. Ten soil samples were collected beneath the 216-T-26 Crib during the RI. Soil samples were collected from near the surface to a depth of 69.2 m (227 ft) bgs in borehole C3102 and were analyzed for select radionuclides, inorganics (metals), general chemistry anions, semivolatile compounds, and diesel-range organic compounds. A majority of samples also were analyzed for carbon

tetrachloride to assess the presence of carbon tetrachloride in the vadose zone for the 200-PW-1 OU RI.

The following 26 constituents exceeded the initial screening criteria in the soil column beneath the 216-T-26 Crib:

- americium-241
- cesium-137
- cobalt-60
- europium-154
- europium-155
- plutonium-238
- plutonium-239/240
- potassium-40
- radium-226
- radium-228
- strontium-90
- technetium-99
- tritium
- total uranium
- uranium-233/234
- uranium-235
- uranium-238
- bismuth
- sodium
- ammonia
- cyanide
- fluoride
- nitrate
- nitrite
- phosphate
- sulfate

The distribution of contaminants with depth at the 216-T-26 Crib is shown in Figure 3-14 with correlation to stratigraphy and geophysical log data. Radiological contamination was not detected in the soil samples from the surface to a depth of 5.5 m (18 ft) bgs. The main zone of radiological contamination extends from 5.5 to 11 m (18 to 36.5 ft) bgs. The predominant radionuclides in this zone are contaminants that generally are assumed to be immobile or only slightly mobile, such as americium-241, cesium-137, europium-154, europium-155, plutonium-238, plutonium-239/240, and strontium-90. The maximum cesium-137 concentration was 47,900 pCi/g in the 5.5 to 6.3 m (18- to 20.5-ft) sample; the 10.4 to 11 m (34- to 36.5-ft) sample had 21,200 pCi/g of cesium-137. Cesium-137 was not detected in the samples below this level. The maximum concentrations of the other contaminants occurred in the 10.4 to 11 m (34- to 36.5-ft) sample interval with only slightly elevated-above-detection-limit concentrations for the remainder of the borehole. This zone is associated with the effluent release point at the waste-site bottom (i.e., contact between the backfill and the gravel-dominated sequence of the Hanford formation). The maximum concentration for strontium-90 was 49,100 pCi/g. The maximum concentration for plutonium-239/240 was 6,320 pCi/g (see Table C-1).

More mobile radiological contaminants, such as cobalt-60, technetium-99, tritium, and uranium isotopes, were detected in soil samples to a depth of 28.8 m (94.5 ft), which is the approximate top of the Plio-Pleistocene unit. Only technetium-99 and tritium were detected at depths greater than 28.8 m (94.5 ft) deep; however, concentrations of these contaminants were less than 4 pCi/g each in this zone (see Table C-1).

Bismuth and sodium were the only metals that exceeded the initial screening. Maximum concentrations were 198 mg/kg and 1,510 mg/kg, respectively, in the 10.4 to 11 m (34- to 36.5-ft) sample (see Tables 3-2, 3-3, and C-2). Neither constituent has a cleanup level identified through WAC 173-340-745. Sodium was detected above the Hanford Site background; no background has been established for bismuth.

For the general chemistry constituents, ammonia, cyanide, fluoride, nitrate, nitrite, phosphate, and sulfate exceeded the initial screening (Table 3-3). Phosphate was detected at concentrations above background throughout most of the borehole (Table C-3); the maximum concentration of 213 mg/kg was detected in the 28 to 28.8 m (92- to 94.5-ft) sample. Maximum concentrations for ammonia (94.9 mg/kg), cyanide (7.9 mg/kg), and nitrite (47.7 mg/kg as nitrite) were detected from depths of 20.5 to 28.8 m (67.3 to 94.5 ft). Fluoride was detected from 5.5 to 28.7 m (18 to 94 ft) bgs at a maximum concentration of 168 mg/kg. Phosphate, sulfate, and nitrate were detected at maximum concentrations of 213 mg/kg, 250 mg/kg, and 3,070 mg/kg as nitrate, respectively, at 28.8 m (94.5 ft) bgs.

Cesium-137 was detected with the RLS from near the surface to a depth of 39 m (128 ft) bgs. Log data indicate that most of the cesium-137 was detected from 5.5 to 27.7 m (18 to 91 ft) bgs and is distributed deeper in the vadose zone toward the south end of the site. The maximum concentration detected is estimated to be greater than 3,000 pCi/g. Contamination extends laterally beyond the 216-T-26 Crib boundary to the south and may intersect contamination associated with the 216-T-27 Crib. The contaminant profile suggests that little contamination is spreading to the north. The lateral and vertical extents of cesium-137 contamination detected in boreholes C3102, 299-W11-70, and 299-W11-82 with the RLS are shown in Figure 3-15.

Based on the data generated for this crib during the 200-TW-1 and 200-TW-2 RI, on the screening process conducted in this RI, and on recent geophysical logging of nearby boreholes, the conceptual contaminant distribution model presented in the 200-TW-1 and 200-TW-2 Work Plan (DOE/RL-2000-38) was revised. The new contaminant distribution model for the 216-T-26 Crib is shown in Figure 3-16. The conceptual contaminant distribution model in the Work Plan indicated a high zone of contamination from the crib bottom to approximately 31.3 m (103 ft); the sampling and geophysical logging showed this zone extending to 18.3 m (60 ft) with significantly reduced contamination below this depth. Deeper contaminants mainly were the mobile contaminants. The predicted enhanced mobility of the cesium-137 was not evident in the sampling and logging data. No cobalt-60 was identified as had been anticipated in the Work Plan. The models are very similar in overall understanding of the distribution of contaminants, however, with the more immobile contaminants, such as cesium-137, strontium-90, and plutonium, being located with a few meters of the bottom of the waste site, and lower concentrations of more mobile contaminants deeper in the vadose.

3.2.1.3 Current Impact to Groundwater at the 216-T-26 Crib. The effluent volume discharged to the 216-T-26 Crib was greater than the estimated soil column pore volume beneath the crib. This information suggests that the volume of effluent released was sufficient to reach the aquifer during operations of the waste site from 1955 to 1956. PNNL-13788 indicates that mobile contaminants (nitrate, carbon tetrachloride, trichloroethylene, technetium-99, tritium, and iodine-129) exceed groundwater protection standards near the crib. Nitrate, tritium, and iodine-129 may be associated with waste disposal practices at the crib as well as at other waste sites in the 200 West Area. Immobile contaminants, such as cesium, were not detected in the aquifer. The status of groundwater near the crib is shown in Figures 3-17 and 3-18. Future impacts to groundwater at this crib are evaluated in Chapter 4.0.

3.2.2 Nature and Extent of Contamination at 200-TW-2 Operable Unit Representative Sites

This section describes the nature and extent of contamination at the 216-B-5 Reverse Well, the 216-B-7A Crib, and the 216-B-38 Trench in the 200-TW-2 OU.

3.2.2.1 Nature and Extent of Contamination at 216-B-5 Reverse Well. This section describes the nature and extent of contamination in soils adjacent to the 216-B-5 Reverse Well. The distributions of cesium-137, plutonium-239/240, and strontium-90 are shown in Figures 3-19, 3-20, and 3-21, respectively (adapted from RHO-ST-37). The figures have been updated with current depth to water data and stratigraphic interpretations. Figure 3-19 shows the correlation between cesium-137 data from RHO-ST-37 and RLS data collected in 2001. Analytical results are presented in RHO-ST-37. During the DQO (BHI-01356), the DOE, EPA, and Ecology agreed that the nonradiological data from the 216-B-7A Crib would be used to evaluate nonradiological impacts at the 216-B-5 Reverse Well. The 216-B-5 Reverse Well waste stream was diverted to the 216-B-7A Crib when the 216-B-5 Reverse Well was taken out of service.

3.2.2.2 Well 299-E28-23. Well 299-E28-23, located about 1.8 m (6 ft) from the 216-B-5 Reverse Well, had the highest levels of contamination detected near the reverse well. RHO-ST-37 reports that cesium-137, strontium-90, plutonium-239/240, and americium-241 were detected in the soil samples collected.

Cesium-137 was detected in the vadose zone in concentrations ranging between 0.11 and 1,800 pCi/g. These concentrations were associated with the perforated interval in the reverse well from 74 to 86.6 m (243 to 284 ft) bgs in the vadose zone. Concentrations generally increased with depth from near the top of the perforated zone to the 1980 water table at a depth of 86.6 m (284 ft). The maximum concentration of 1,800 pCi/g was at the water table.

Cesium-137 also was detected across the saturated thickness (26.5 m [87 ft]) of the aquifer. Within the aquifer, 11,400 to 51,300 pCi/g were detected from depths of 86 to 93.3 m (282 to 306 ft) bgs. Concentrations ranged from 124 to 1,800 pCi/g between 93.3 m (306 ft) bgs and the top of the basalt at a depth of 100 m (330 ft) bgs. The decrease in contamination is associated with the termination of the perforated zone in the reverse well at a depth of 92 m (302 ft) bgs within the aquifer. The maximum activity in the vadose zone, based on the current depth to water of 286 ft (87 m), is 51,300 pCi/g. The maximum concentration is proximal to the groundwater/vadose zone interface.

Plutonium-239/240 was detected in the vadose zone in concentrations ranging between 0.00154 and 26.5 pCi/g. Concentrations increased with depth to the top of the 1980 water table. Concentrations in the aquifer ranged between 32.9 and 75,000 pCi/g and generally decreased with depth to the bottom of the well. The maximum activity in the vadose zone, based on the current depth to water of 87 m (286 ft) bgs, is 70,200 pCi/g. The maximum concentration is proximal to the groundwater/vadose zone interface.

Americium was detected in the vadose zone in concentrations ranging from 0.00236 to 0.175 pCi/g. Concentrations generally increased with depth from near the top of the perforated zone at 243 ft (74 m) bgs to the 1980 water table at 86.6 m (284 ft) bgs. The maximum concentration at the water table was 0.175 pCi/g. Concentrations in the aquifer ranged between 0.589 and 2,540 pCi/g and generally decreased with depth to the bottom of the well. The

maximum activity in the vadose zone, based on the current depth to water of 87 m (286 ft), is 1,330 pCi/g.

Strontium-90 was detected in the vadose zone in two samples. Concentrations were 145 and 209 pCi/g. Concentration in the aquifer ranged between 84.1 and 60,300 pCi/g and generally decreased with depth to the bottom of the well (Figure 3-21). The maximum activity in the vadose zone, based on the current depth to water of 87 m (286 ft), is 60,300 pCi/g.

3.2.2.3 Wells 299-E28-7, 299-E28-24, and 299-E28-25. Lower levels of cesium-137, americium-241, strontium-90, and plutonium-238/239 were detected in wells adjacent to the 216-B-5 Reverse Well. Similar to well 299-E28-23, low levels of contamination were detected in the vadose zone relative to the 1980 water table. Higher concentrations were detected in the aquifer. The concentrations of contaminants in the vadose zone were typically less than 1,000 pCi/g. Concentrations in the aquifer were up to 16,000 pCi/g. The maximum activity at the groundwater/vadose zone interface, based on the current depth to water in these wells of 87 m (286 ft), is 170 pCi/g.

3.2.2.4 Radionuclide Logging System Logging at the 216-B-5 Reverse Well. Wells 299-E28-7, 299-E28-23, 299-E28-24, and 299-E28-25 were geophysically logged with the spectral-gamma tool in 2001. Cesium-137 was the only gamma-emitting radionuclide detected in these wells. In well 299-E28-7, cesium-137 only was detected sporadically at the minimum detection level of the logging tool. In well 299-E28-23, cesium-137 was detected starting at about 76.2 m (250 ft) and extending to the water table (logging was discontinued before the saturated zone because of waste management issues). The cesium-137 detected in this zone is associated with the perforated interval in the 216-B-5 Reverse Well. The log was saturated (i.e., dead time exceeds 40 percent) from 86 m (282 ft) (approximate depth of 1980 water table) to the end of the log run at 87.5 m (287 ft) bgs. In this zone, the activity exceeds 1,000 pCi/g. In well 299-E28-24, cesium-137 was detected from 82.3 to 87.5 m (270 to 287 ft) bgs, with a maximum concentration of 3,000 pCi/g at 83 m (272 ft) bgs. In well 299-E28-25, cesium-137 was detected from 76.9 to 87.7 m (252.2 to 287.5 ft) bgs with a maximum concentration of 398 pCi/g at 77.6 m (254.5 ft) bgs. The cesium-137 distribution below 61 m (200 ft) bgs, including correlation to the soil data, is shown in Figure 3-19. The contaminant distribution model for the 216-B-5 Reverse Well is shown in Figure 3-22. No changes were made to the model that was presented in the Work Plan (DOE/RL-2000-38). Nitrate was the only nonradiological contaminant detected at the 216-B-7A Crib in the deeper zones at an appreciable concentration (Figure 3-23).

3.2.2.5 Current Impact to Groundwater at 216-B-5 Reverse Well. Effluent and contaminants were discharged immediately above and directly into the aquifer at the 216-B-5 Reverse Well. Contaminants detected in aquifer sediments, groundwater samples, or both include americium-241, cesium-137, plutonium-239/240, strontium-90, iodine-129, uranium, tritium, and nitrate. The status of groundwater near the crib is shown in Figures 3-12 and 3-13.

3.2.2.6 Nature and Extent of Contamination at the 216-B-7A Crib. Fourteen soil samples were collected beneath the 216-B-7A Crib. Soil samples were collected from the surface to a depth of 67.5 m (221.5 ft) in borehole C3103 and were analyzed for radionuclides, inorganics (metals), general chemistry anions, herbicides, volatile and semivolatile organics, and diesel range organic compounds.

The following 22 constituents exceeded the initial screening in the soil column beneath the 216-B-7A Crib:

- americium-241
- carbon-14
- cesium-137
- europium-154
- plutonium-238
- plutonium-239/240
- potassium-40
- strontium-90
- technetium-99
- tritium
- total uranium
- uranium-233/234
- uranium-235
- uranium-238
- bismuth
- iron
- manganese
- sodium
- ammonia
- fluoride
- nitrate
- phosphate

The distribution of contaminants with depth at the 216-B-7A Crib is shown in Figure 3-23 with correlation to stratigraphy, field screening data, and geophysical log data. Radiological contaminants were detected the length of the borehole starting at 0.76 m (2.5 ft) bgs. Low levels of cesium-137 and strontium-90 were found from 0.76 to 5.6 m (2.5 ft to 18.5 ft) bgs. A portion of this zone likely is associated with UPR 200-E-144, where contaminated soils associated with the unplanned release were consolidated over the 216-B-7A Crib in 1992. The maximum activity in this zone was 42.5 pCi/g of cesium-137; however, most of the concentrations were below 10 pCi/g.

The main zone of radiological contamination extends from 5.6 to 11.4 m (18.5 to 37.5 ft) bgs. The maximum concentrations of all the radionuclides detected were found in this zone. The main radionuclides in the zone are americium-241 (5,690 pCi/g), cesium-137 (153,000 pCi/g), plutonium-239/240 (153,000 pCi/g), and strontium-90 (5,710,000 pCi/g). The concentration of plutonium-239-240 exceeds the regulatory definition of TRU waste without even counting the other TRU radionuclides. Contaminants were detected associated with the backfill material, the gravel-dominated sequence of the Hanford formation, and the upper portion of the sand-dominated sequence of the Hanford formation. From 11.4 to 67.5 m (37.5 to 221.5 ft) bgs, radionuclide concentrations were less than 1.0 pCi/g with few exceptions (e.g., strontium-90 was 39.5 pCi/g and cesium-137 was 5.06 pCi/g at 15.4 m [50.5 ft] bgs). In the upper 15.4 m (50.5 ft) of the soil column, contamination correlates to increases in silt and moisture contents. At depths greater than 15.4 m (50.5 ft) bgs, tritium was the only radionuclide present above background, with a maximum concentration in this zone of less than 0.3 pCi/g.

Bismuth, iron, and sodium exceeded the initial screening at the 216-B-7A Crib (Table 3-4). Bismuth, iron, and sodium were analyzed for and were detected associated with the bottom of the crib at depths from 6.9 to 7.6 m (22.5 to 25 ft) bgs. Maximum concentrations were 3,300 mg/kg for bismuth; 34,900 mg/kg for iron; and 1,310 mg/kg for sodium.

Ammonia, fluoride, nitrate, and phosphate exceeded the initial screening at the 216-B-7A Crib (Table 3-4). Nitrate and phosphate were distributed throughout the soil column from 0.76 to 67.5 m (2.5 ft to 221.5 ft) at maximum concentrations of 493 (as nitrate) and 105 mg/kg, respectively. Fluoride was detected from depths of 5.6 to 67.5 m (18.5 to 221.5 ft) bgs with a maximum concentration of 205 mg/kg. Ammonium was detected in one sample (21.3 mg/kg as ammonia) above the background concentration near the surface.

Cesium-137 was detected continuously with the RLS from the surface to a depth of 17 m (56 ft) bgs, with the highest zone of contamination from 5.5 to 11 m (18 to 36 ft) bgs. The maximum activity in this zone is approximately 300,000 pCi/g at a depth of 7 m (23 ft). Concentrations decreased with depth from 13.7 m (45 ft) bgs to the bottom of the borehole. Adjacent to the crib, lower levels of cesium-137 were detected, with contamination extending to a depth of about 30 m (100 ft) and a lateral extent greater than 21.3 m (70 ft). Cesium-137 concentrations measured in boreholes adjacent to the crib (wells 299-E33-19, 299-E33-20, 299-E33-58, 299-E33-60, and 299-E33-75) ranged from less than 2 pCi/g to 7,600 pCi/g. The lateral and vertical extents of cesium-137 contamination detected adjacent to the 216-B-7A Crib with the RLS are shown in Figures 3-24 and 3-25.

Based on the data generated for the 216-B-7A Crib during the 200-TW-1 and 200-TW-2 RI, on the screening process conducted in this RI, and on recent geophysical logging of nearby boreholes, the conceptual contaminant distribution model presented in the 200-TW-1 and 200-TW-2 Work Plan (DOE/RL-2000-38) was revised. The new contaminant distribution model for the 216-B-7A Crib is shown in Figure 3-26. These two models agreed very well. A major zone of contamination was found at the base of the crib. This zone extended to 11.4 m (37.5 ft) bgs. Concentrations dropped significantly below this depth to 15.4 m (50.5 ft) bgs. Below this depth, contamination consisted mainly of lower levels of mobile constituents. The data and logging do not indicate significantly enhanced mobility of the cesium-137 as was anticipated. The geophysical data indicate some spreading at the interface of the Hanford formation sands and gravels. The anticipated lateral spreading at the Hanford formation/Plio-Pleistocene unit was not evident in the geophysical logging data.

3.2.2.7 Current Impact to Groundwater at 216-B-7A Crib. The effluent volume discharged to the 216-B-7A Crib is about 75 times greater than the rough-estimated soil column pore volume. This information indicates that the volume of effluent released was sufficient to reach the aquifer during operations of the waste site from 1946 to 1967. PNNL-13788 indicates that mobile contaminants (nitrate, uranium, technetium-99, and iodine-129) exceed groundwater standards near the crib. Immobile contaminants were not detected in the aquifer. Impact to groundwater is attributed to the 216-B-7A Crib, as well as to other waste sites in the 200 East Area. The status of groundwater near the crib is shown in Figures 3-12 and 3-13. Future impacts to groundwater at this crib are evaluated in Chapter 4.0.

3.2.2.8 Nature and Extent of Contamination at the 216-B-38 Trench. Twelve soil samples were collected beneath the 216-B-38 Trench. Soil samples were collected from the surface to a depth of 80.9 m (265.5 ft) in borehole C3104 and were analyzed for radionuclides, inorganics (metals), general chemistry anions, and herbicides.

The following 19 constituents exceeded the initial screening in the soil column beneath the 216-B-38 Trench:

- americium-241
- cesium-137
- cobalt-60
- plutonium-238
- plutonium-239/240
- potassium-40
- strontium-90
- technetium-99
- tritium
- total uranium
- uranium-233/234
- uranium-238
- ammonia
- fluoride
- nitrate
- nitrite
- phosphate
- sulfate
- sodium

The distribution of contaminants with depth at the 216-B-38 Trench is shown in Figure 3-27 with correlation to stratigraphy, field screening data, and geophysical log data. Radiological contaminants were detected between 1.1 and 61 m (3.5 and 200 ft) bgs. Cesium-137 was detected at low levels from 1.1 to 3.8 m (3.5 to 12.5 ft) bgs with a maximum activity of 1.82 pCi/g.

The major zone of radiological contamination extends from 4.4 to 12 m (14.5 to 40 ft) bgs. The maximum concentrations of cesium-137 (226,000 pCi/g), plutonium-238 (7.85 pCi/g), plutonium-239/240 (159 pCi/g), potassium-40 (273 pCi/g), strontium-90 (2,050 pCi/g), and uranium (32.5 μg/g) were detected in this zone. Contaminants in this zone were detected within the gravel-dominated sequence of the Hanford formation and the upper portion of the sand-dominated sequence of the Hanford formation. From 12 to 61 m (40 to 200 ft) bgs, radionuclide concentrations were less than 2.0 pCi/g, with the exception of tritium. Tritium was detected at a maximum concentration of 28.7 pCi/g at a depth of 16.6 m (54.5 ft) and decreased to less than 1 pCi/g at the groundwater/vadose zone interface.

Sodium, the only metal that exceeded the initial screening, was detected from 4.4 to 6.3 m (14.5 to 20.5 ft) bgs (i.e., the bottom of the trench) at a maximum concentration of 848 mg/kg.

Ammonia, fluoride, nitrate, nitrite, phosphate, and sulfate exceeded the initial screening at the trench. Nitrate and nitrite were distributed deep in the vadose zone to a maximum depth of 61 m (200 ft) bgs. Ammonium, fluoride, and phosphate were not detected deeper than 16.6 m (54.5 ft) bgs. Maximum concentrations were 65.2 mg/kg for ammonia (as ammonia), 33.4 mg/kg for fluoride, 3,180 mg/kg for nitrate (as nitrate), 41.2 mg/kg for nitrite (as nitrite), and 149 mg/kg for phosphate. Sulfate was detected throughout the borehole with a maximum concentration of 248 mg/kg in the 2.9 to 3.7 m (9.5 to 12 ft) sample.

The distribution of cesium-137 also was assessed with the RLS. Logs from one borehole and five direct-push holes installed along the axis of the 216-B-38 Trench indicate that the vertical extent of cesium-137 contamination is about 18.3 m (60 ft). However, most of the contamination is located at approximately 13.7 m (45 ft) bgs. Cesium-137 contamination extends more than 38 m (125 ft) from the east end of the ditch (i.e., half of the ditch) and 6.1 to 7.6 m (20 to 25 ft) on either side of the ditch. The extent of cesium-137 contamination detected adjacent to the trench with the RLS is shown in Figure 3-28.

Based on the data generated for this crib during the 200-TW-1 and 200-TW-2 RI, on the screening process conducted in this RI, and on recent geophysical logging of nearby boreholes, the conceptual contaminant distribution model presented in the 200-TW-1 and 200-TW-2 Work Plan (DOE/RL-2000-38) was revised. The new contaminant distribution model for the 216-B-38 Trench is shown in Figure 3-29. The conceptual contaminant distribution model in the Work Plan did not indicate the head end of the ditch, because the historical information was not sufficient to determine the discharge point in the trench. The geophysical logging conducted during the RI clarified the head end and provided information on the distribution of contamination along the length of the trench. Only about two-thirds of the trench is contaminated. Geophysical logging of two nearby wells also allowed some understanding of the lateral distribution of contaminants perpendicular to the length of the trench. The major zone of contamination predicted in the Work Plan was similar to that found during the RI (9 m [30 ft] in the Work Plan versus 7.6 m [25 ft] based on the RI data). Below this zone, contaminant concentrations decreased significantly.

3.2.2.9 Current Impact to Groundwater at the 216-B-38 Trench. The effluent volume discharged to the 216-B-38 Crib was less than a third of the associated soil column pore volume (DOE/RL-96-81). This information suggests that the volume of effluent released was not sufficient to reach the aquifer during operations of the waste site in 1954. PNNL-13788 indicates that mobile contaminants (nitrate, technetium-99, and iodine-129) exceed groundwater protection standards near the crib. However, plume geometry, soil pore volume estimates, and actual soil concentrations suggest that the trench has not impacted groundwater even though some limited quantities of these types of contaminants may have been disposed to the crib. The status of the groundwater near the crib is shown in Figures 3-12 and 3-13. Future impacts to groundwater at this trench are evaluated in Chapter 4.0.

3.2.3 Nature and Extent of Contamination at the 200-PW-5 Operable Unit (216-B-57 Crib)

The 216-B-57 Crib was characterized during the 200-BP-1 OU RI, and the results are presented in DOE/RL-92-70. Twenty-four soil samples were collected from three boreholes (299-E33-304, 299-E33-305, and 299-E33-306) within the crib. Soils were analyzed for radionuclides, inorganics (metals), general chemistry anions, semivolatile and volatile organics, pesticides, and polychlorinated biphenyls. Soil samples were collected from near the surface to a depth of 71 m (235.5 ft) bgs in borehole 299-E33-304 and to 15 m (50 ft) bgs in boreholes 299-E33-305 and 299-E33-306.

The following 10 constituents exceeded the initial screening in the soil column beneath the 216-B-57 Crib:

- cesium-137
- plutonium-238
- plutonium-239
- radium-226
- strontium-90
- technetium-99
- tritium
- nitrate
- nitrite
- phosphate

The distribution of contaminants with depth beneath the 216-B-57 Crib is shown in Figure 3-30 with correlation to stratigraphy. Depths are reported from the original ground surface and do not

consider the 7.9 m (26-ft) thick engineered cap that has been placed over the site as a treatability test and remedial action.

Radiological contamination was detected from near the surface to a depth of 71.7 m (235.5 ft) bgs beneath the crib. The major zone of radiological contamination extends from 4.6 to 10.1 m (15 to 33 ft) bgs and is associated with the bottom of the waste site and the gravel- and sand-dominated sequences of the Hanford formation. The maximum concentrations of cesium-137 (67,000 [50,000 decayed to 2004] pCi/g), strontium-90 (67 [50 decayed to 2004] pCi/g), plutonium-239 (0.01 pCi/g), technetium-99 (60 pCi/g), and tritium (16 [12.5 decayed to 2004] pCi/g) were detected in this zone. Very low levels (less than 2 pCi/g) of contamination were detected from 0 to 4.6 m (0 to 15 ft) bgs and at depths greater than 10 m (33 ft) bgs with the exception of cesium-137. The maximum vertical extent of contamination at levels greater than 1 pCi/g is 15.4 m (50.5 ft) (i.e., cesium-137 at 68.4 [52 decayed to 2004] pCi/g). Technetium-99 and radium-226 were the only radionuclides present at depths greater than 25.6 m (84.5 ft) bgs; concentrations were less than 1 pCi/g.

Nitrate, nitrite, and phosphate were detected at concentrations above initial screening levels. Nitrate is present from near the surface to a depth 25.6 m (84 ft) with the maximum concentration of 2,120 mg/kg as nitrate at a depth of 5.2 m (17 ft) bgs. Nitrite and phosphate were detected at depths less than 17 ft (5.2 m) bgs. Maximum concentrations were 8.3 (as nitrite) and 2.7 mg/kg, respectively.

Based on the data generated for the 216-B-57 Crib during the 200-BP-1 RI and on the screening process conducted in this RI, a contaminant distribution model was generated and is shown in Figure 3-31.

Current Impact to Groundwater at 216-B-57 Crib. Four major groundwater plumes (nitrate, iodine-129, technetium-99, and uranium) are near the crib. These plumes are widespread in the area, and identifying a specific source is difficult. The plume geometry and the soil characterization data indicate a lower potential for impacts from the 216-B-57 Crib. The data collected during the 200-BP-1 RI indicate little contamination is present below 25.8 m (84.5 ft) bgs (DOE/RL-92-70).

Figure 3-1. Stratigraphic Column for the 200 Areas.

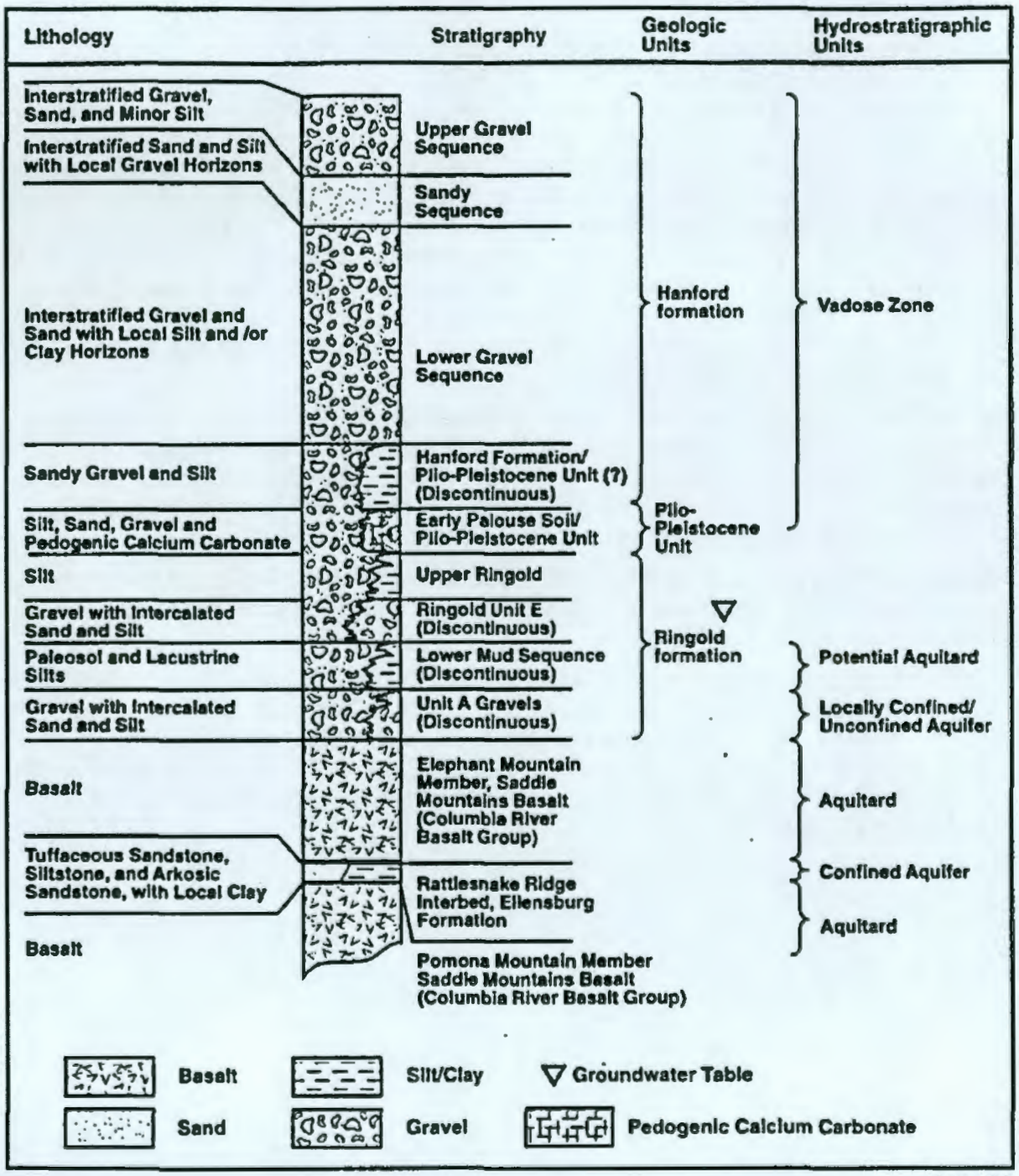


Figure 3-2. Cross-Section Location Map for the 200-TW-1 Operable Unit Representative Site in the 200 West Area.

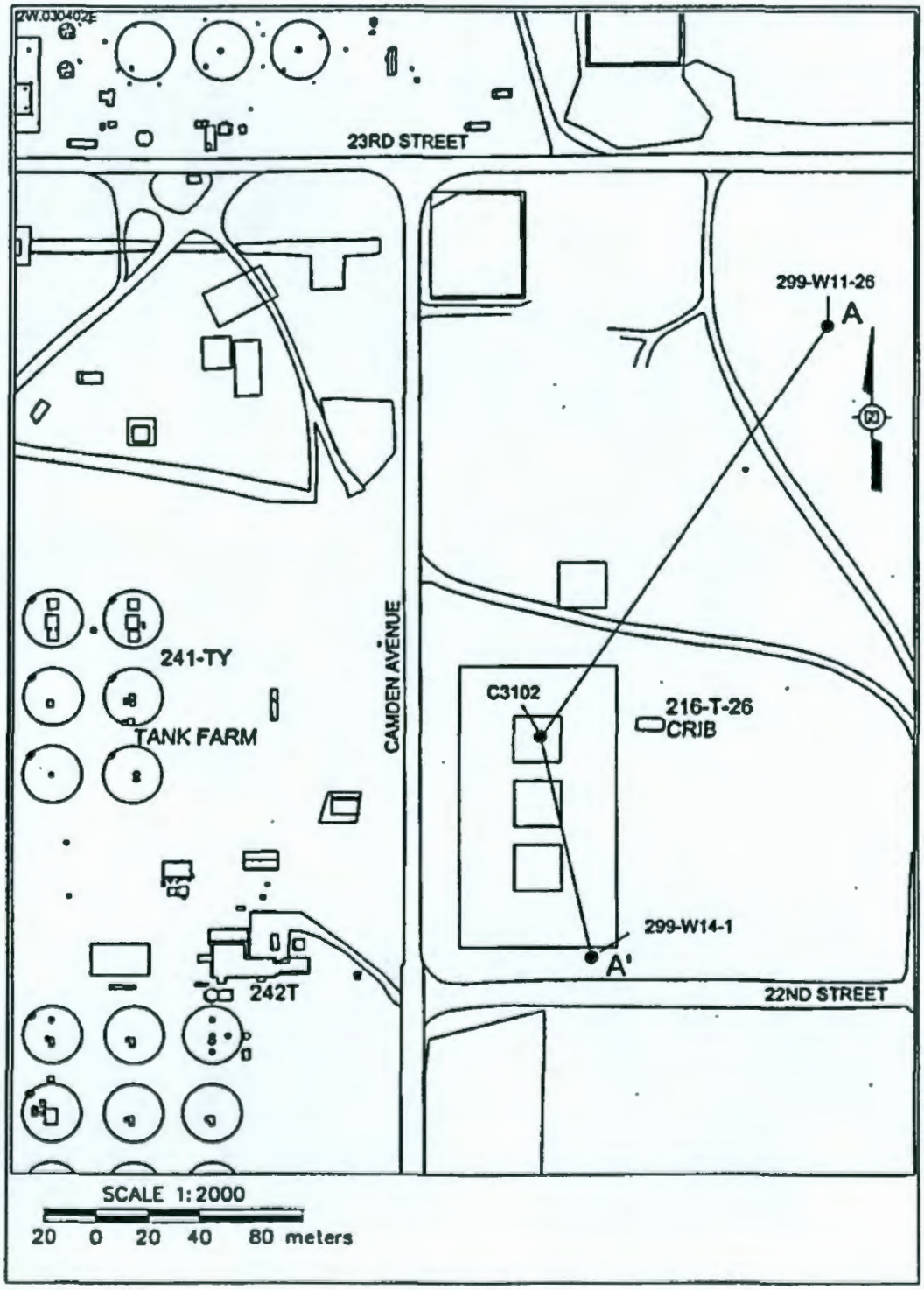


Figure 3-3. Cross-Section Location Map for 200-TW-1, 200-TW-2, and 200-PW-5 Operable Unit Representative Sites in 200 East Area.

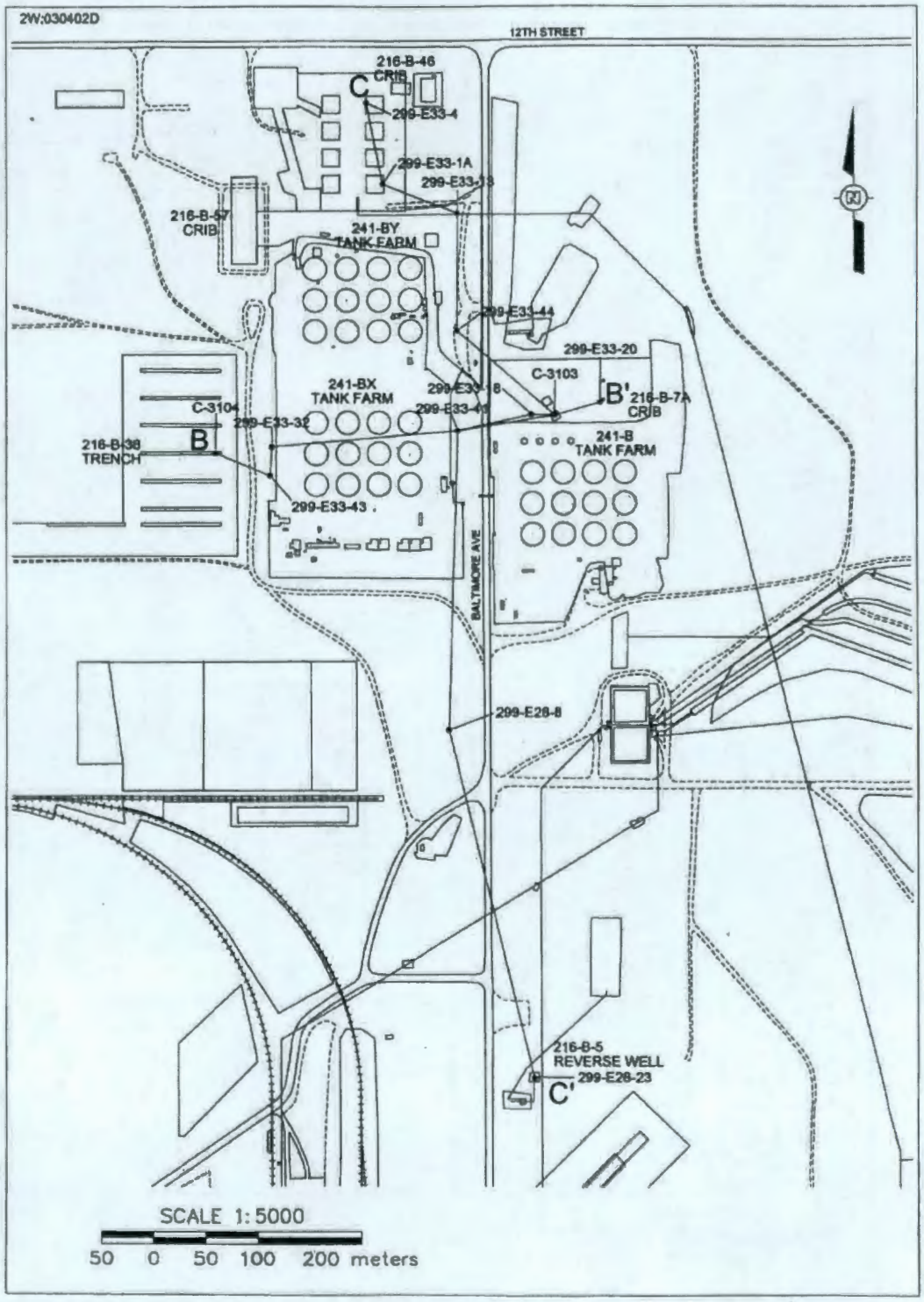


Figure 3-4. North-South Geologic Cross Section through the 216-T-26 Crib.

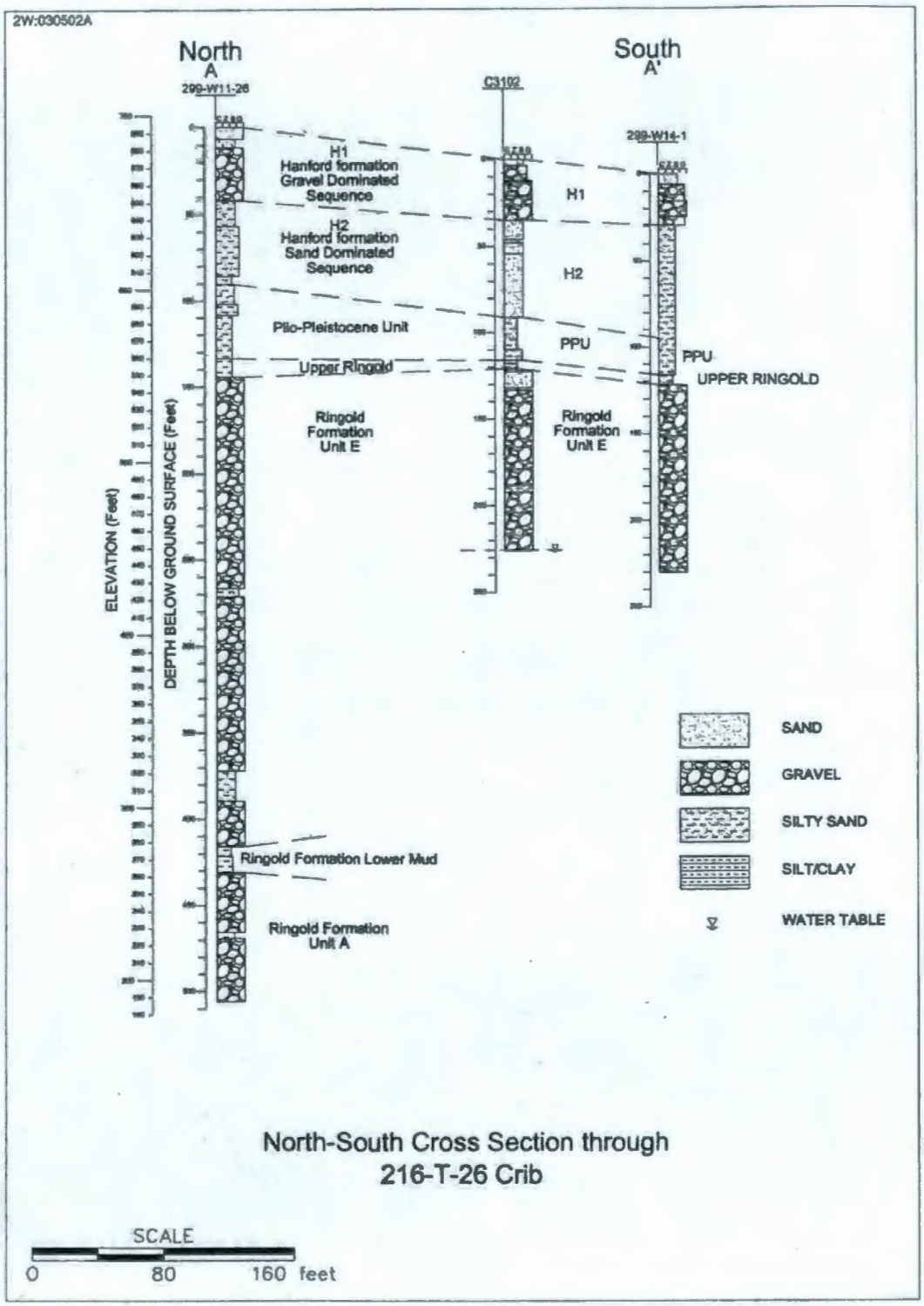


Figure 3-5. North-South Geologic Cross Section from the 216-B-46 Crib to the 216-B-5 Reverse Well.

Figure 3-5

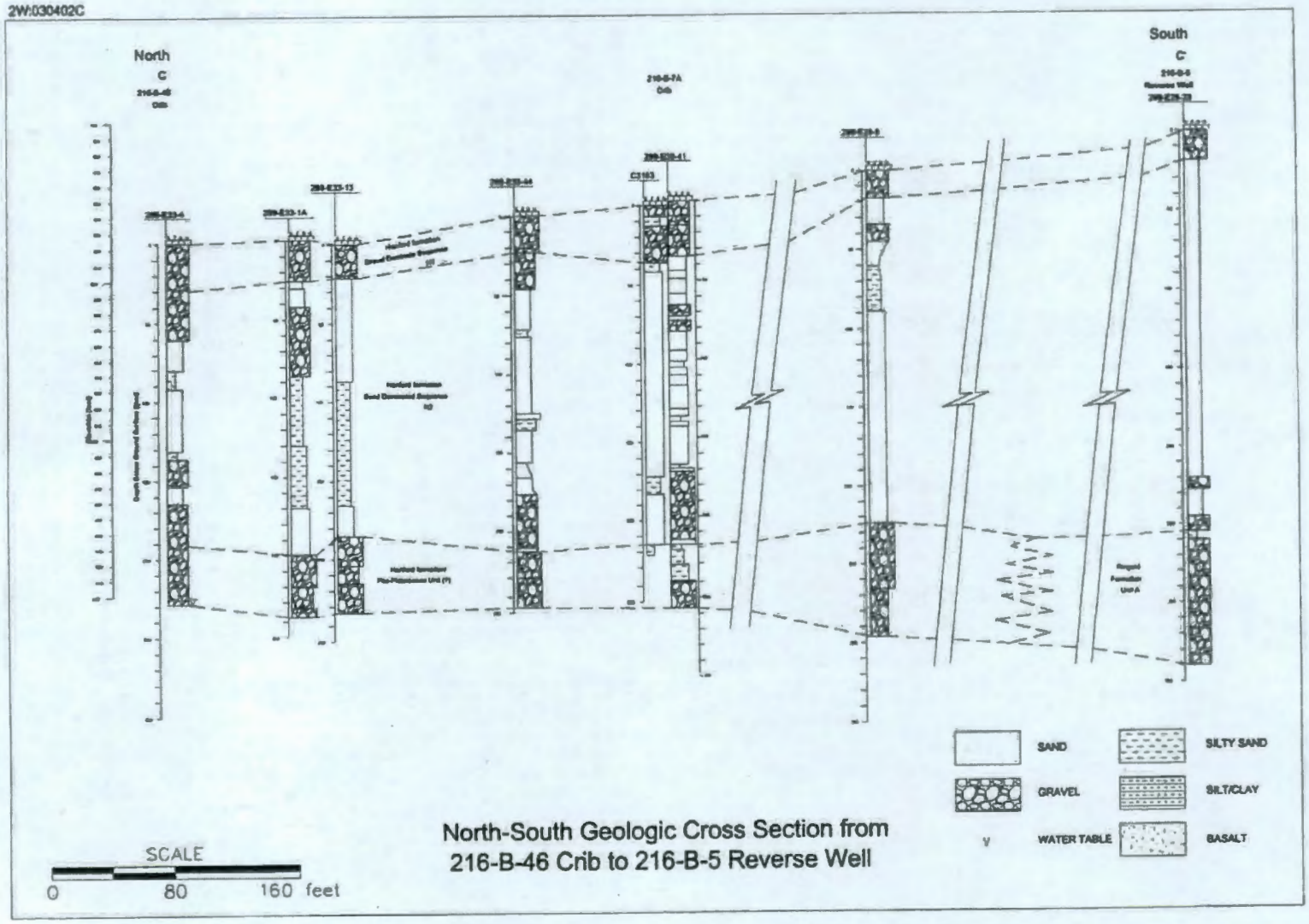


Figure 3-6. West-East Geologic Cross Section Through the 216-B-38 Trench to the 216-B-7A Crib.

Figure 3-6

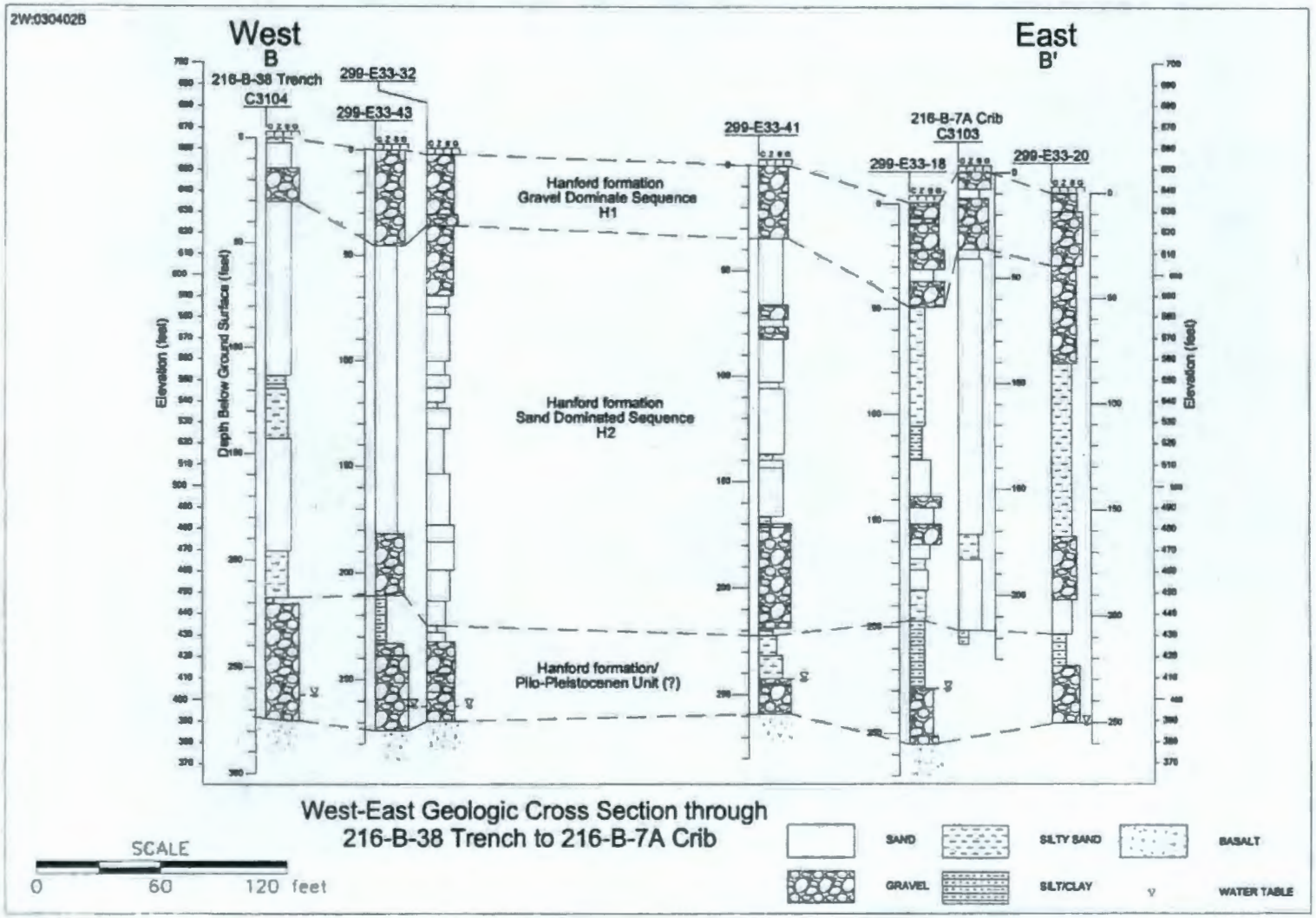
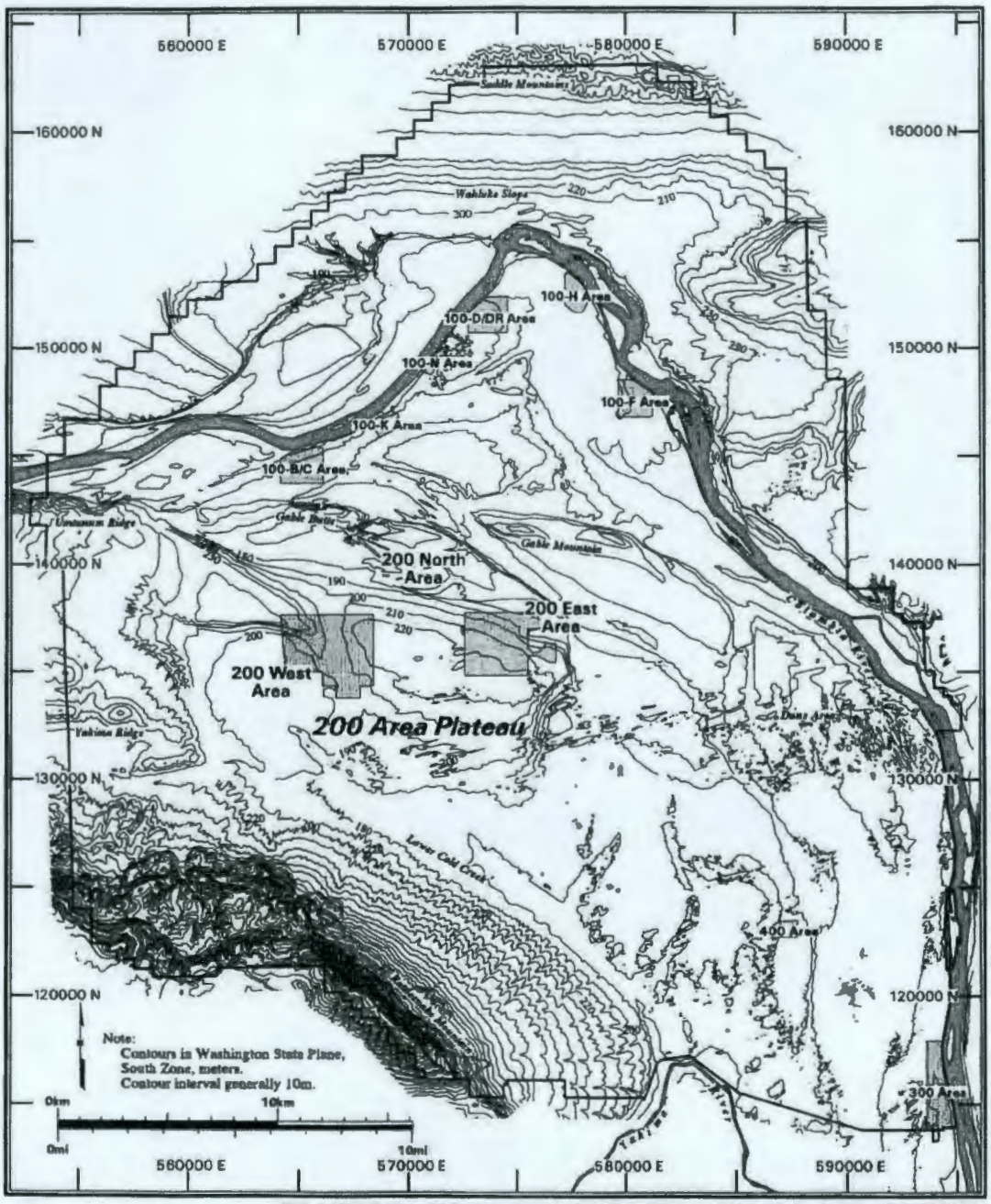


Figure 3-7. Topographic Map of the Hanford Site.



ERC:dhf:02/22/02:/home/dhfenske/projects/singlekm/164sr0257/ad-topo200.aml:Rev. 0 Database: 02/27/02 1:30 PM

Figure 3-8. Pasco Basin Location Map.

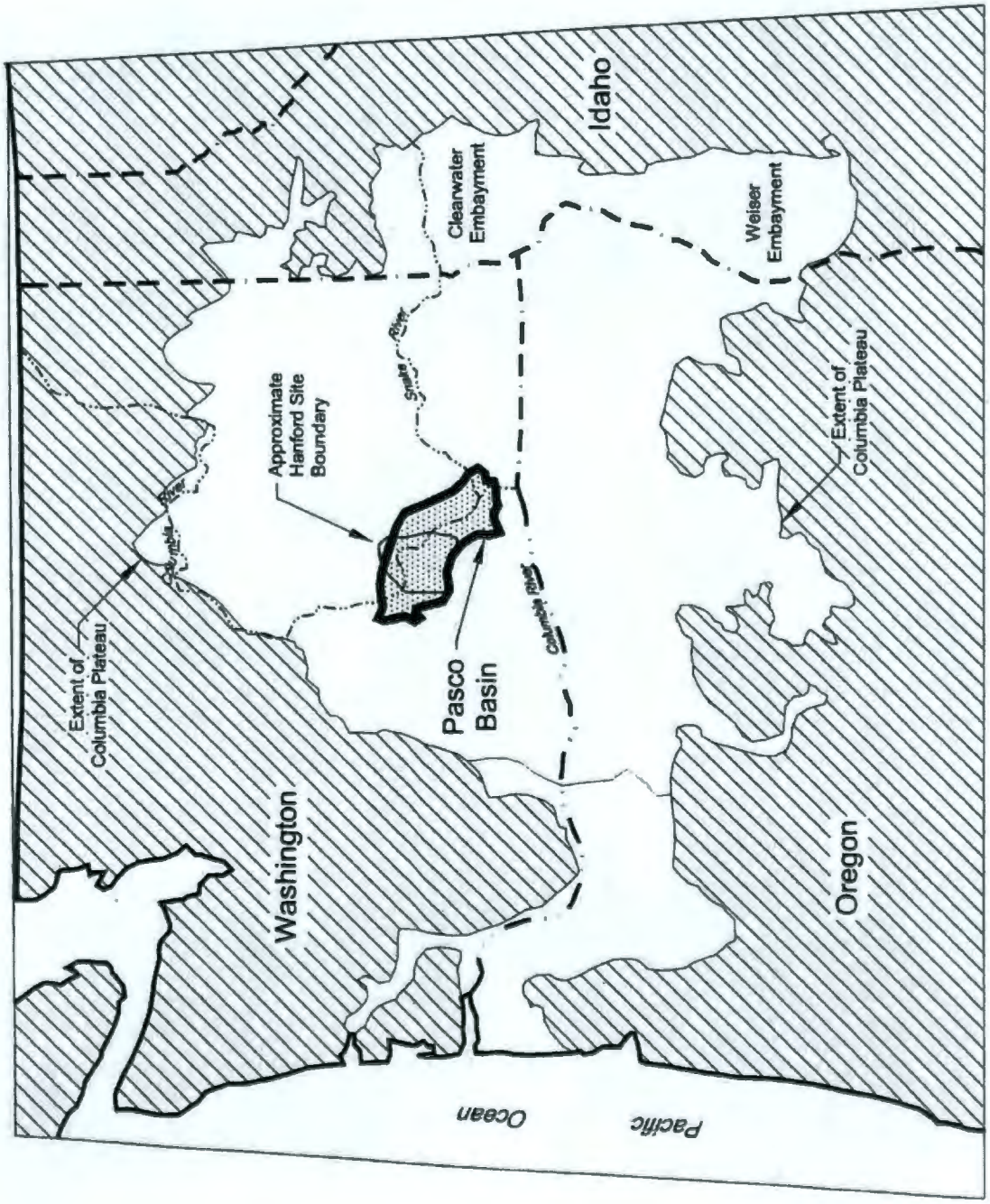


Figure 3-9. 200 Areas Water Table Map.

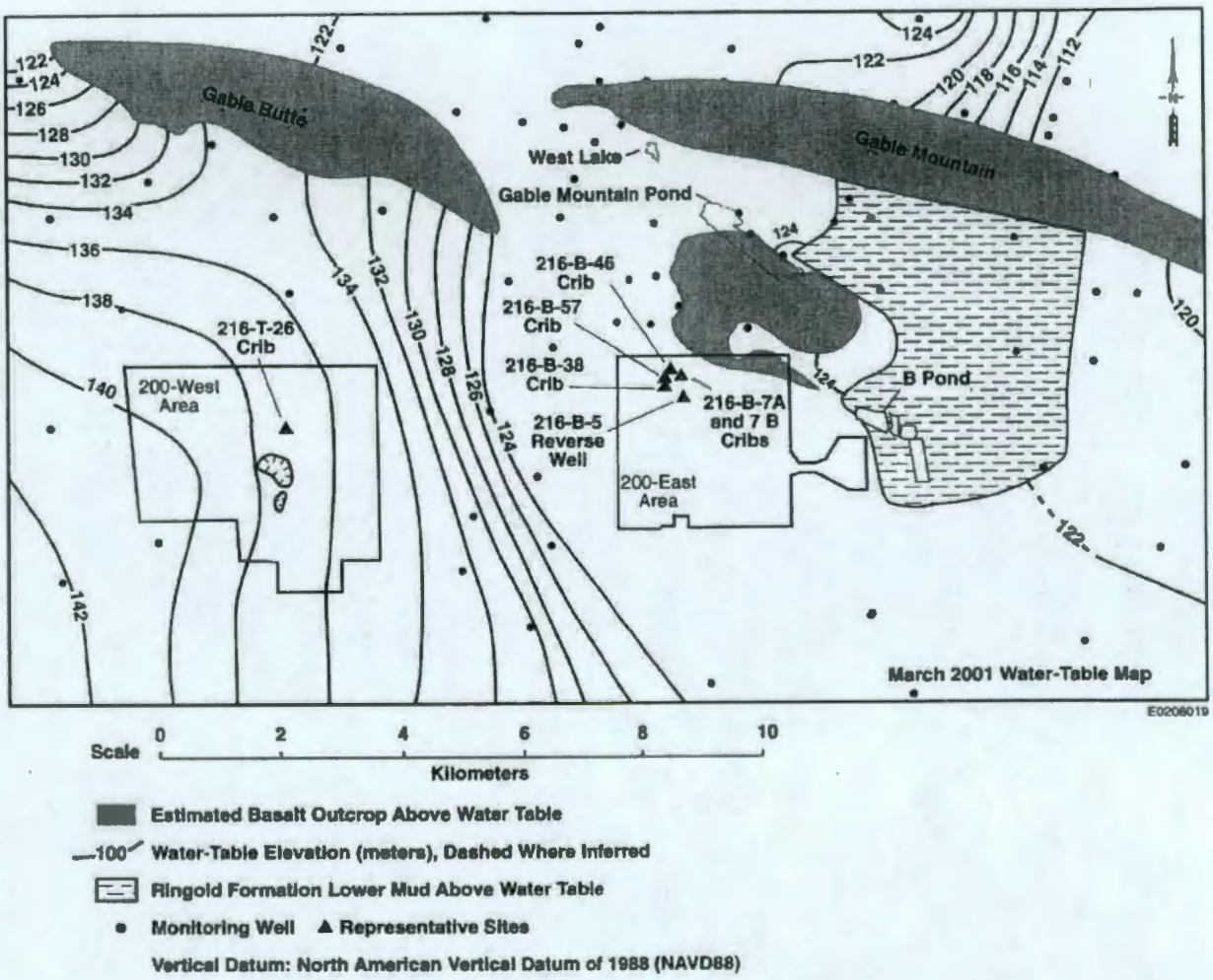


Figure 3-10. Vertical Profile of the Contamination at the 216-B-46 Crib with Correlation to Stratigraphy and Geophysical Log Data.

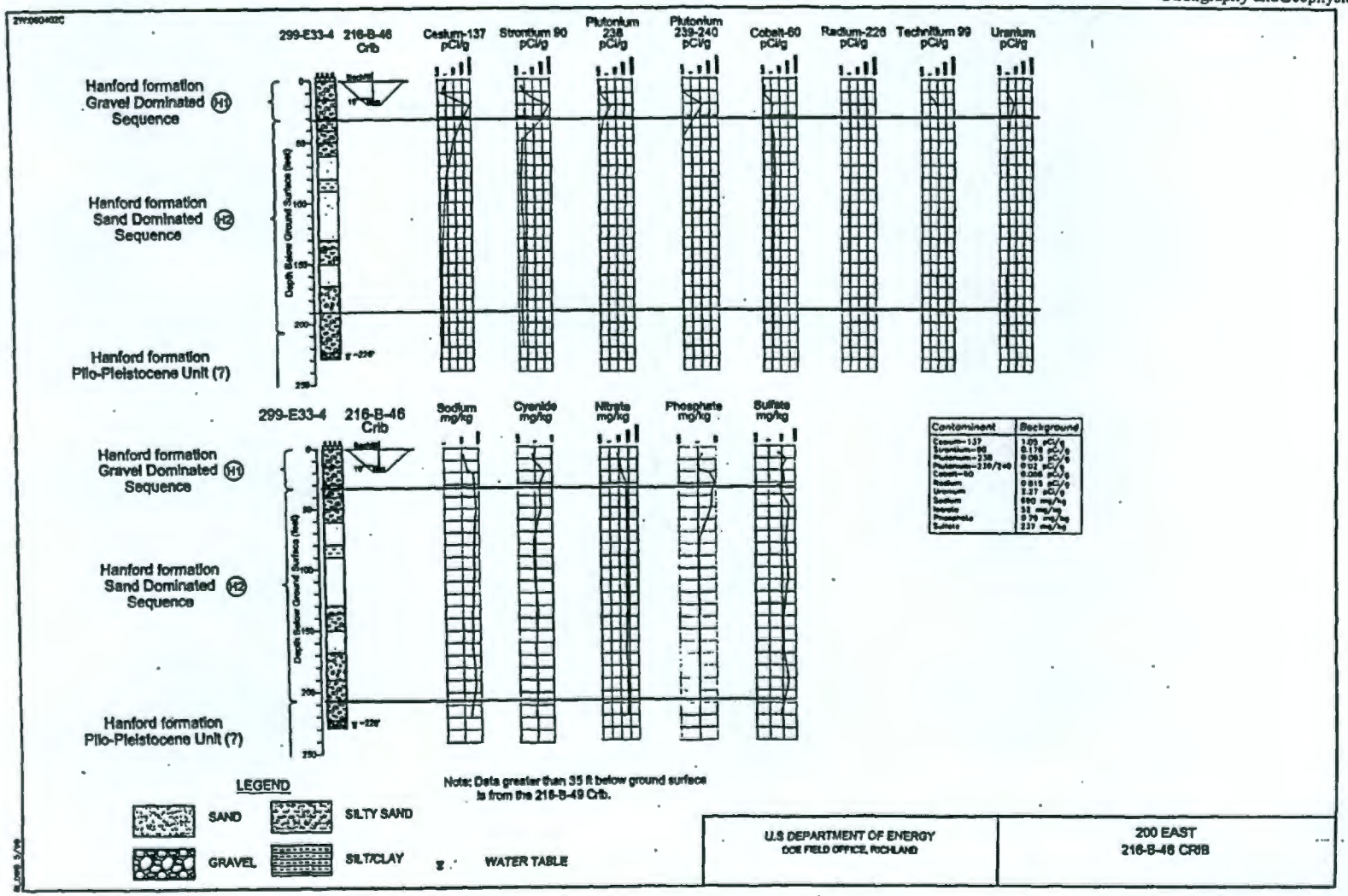


Figure 3-11. 216-B-46 Crib Contaminant Distribution Model.

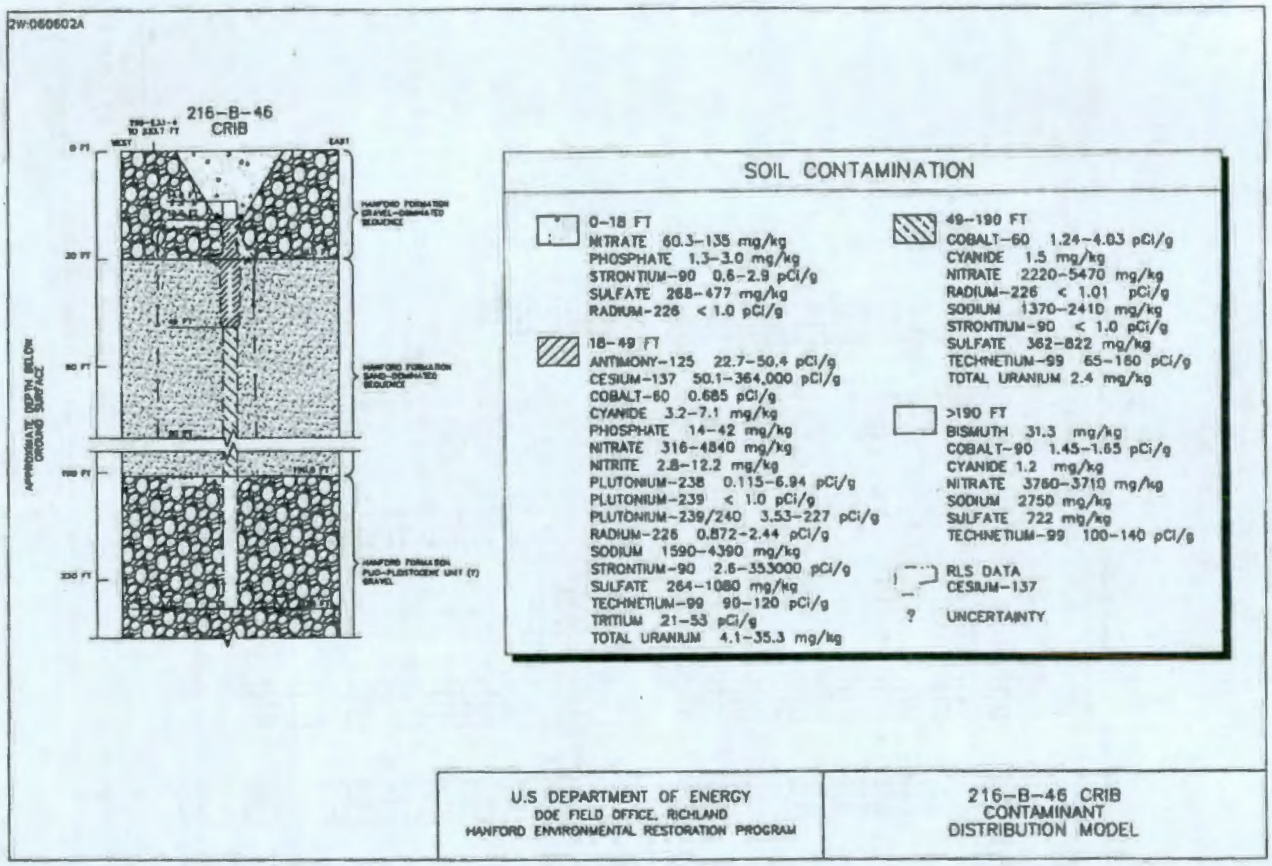


Figure 3-12. Nonradiological Groundwater Plumes Near the 200 East Area (adapted from PNNL-13788).

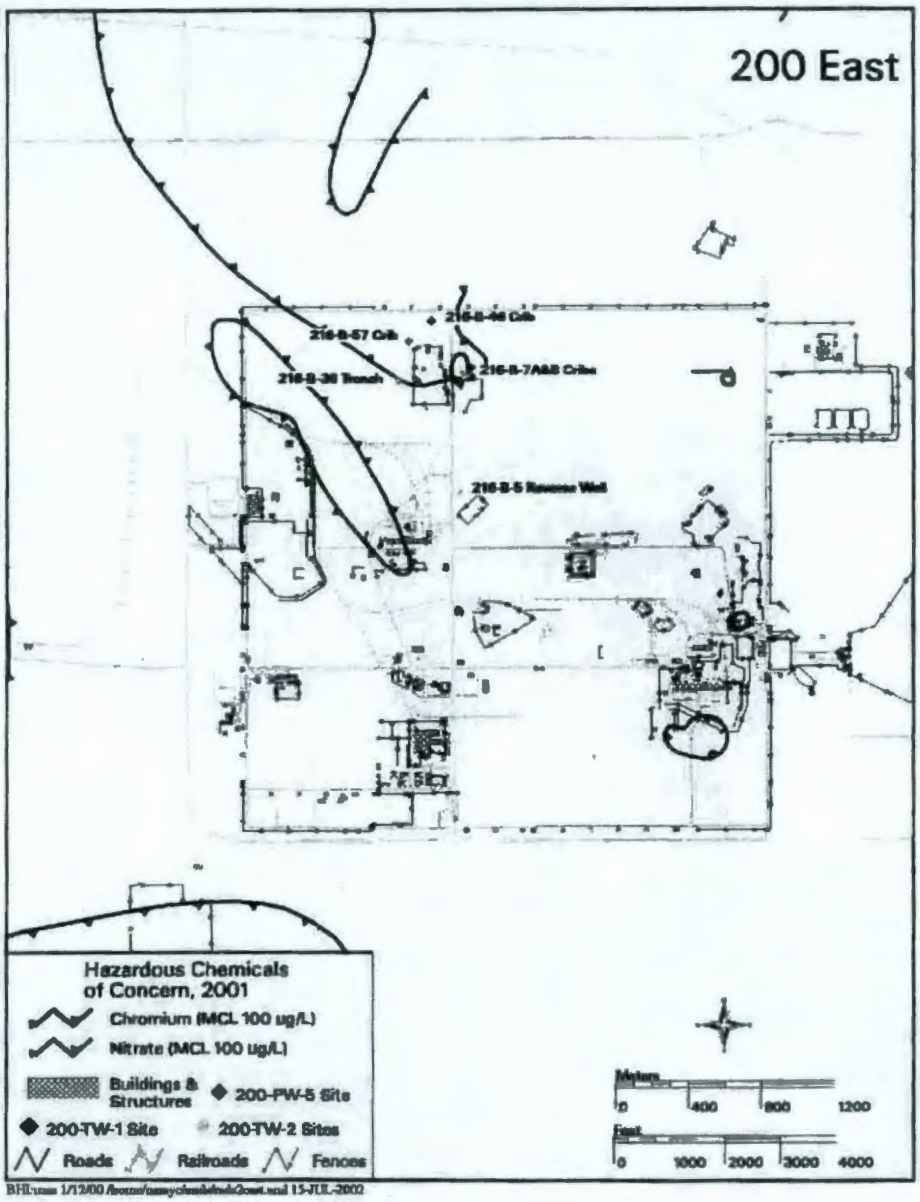


Figure 3-13. Radiological Groundwater Plumes Near the 200 East Area (adapted from PNNL-13788).

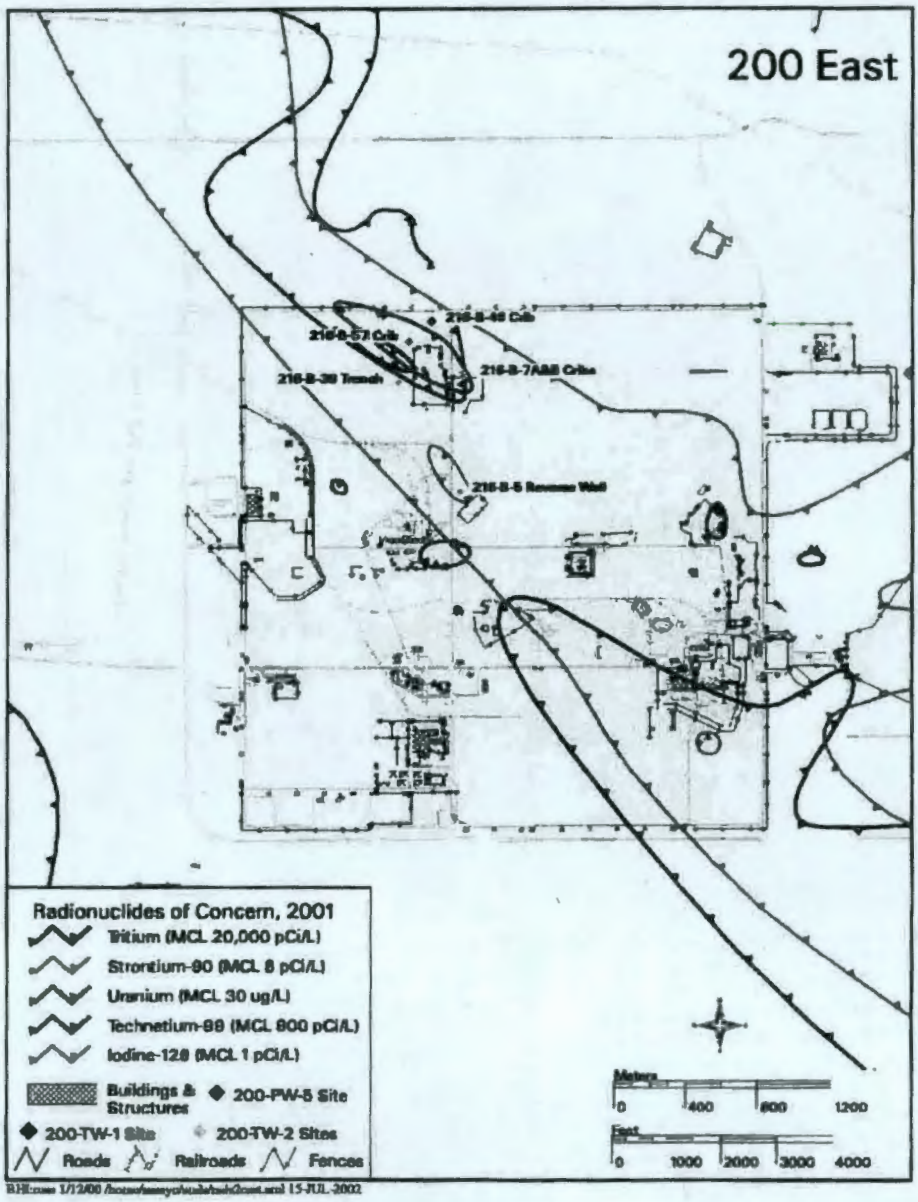


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Figure 3-14. Vertical Profile of the Contamination at the 216-T-26 Crib with Correlation to Stratigraphy and Geophysical Log Data.

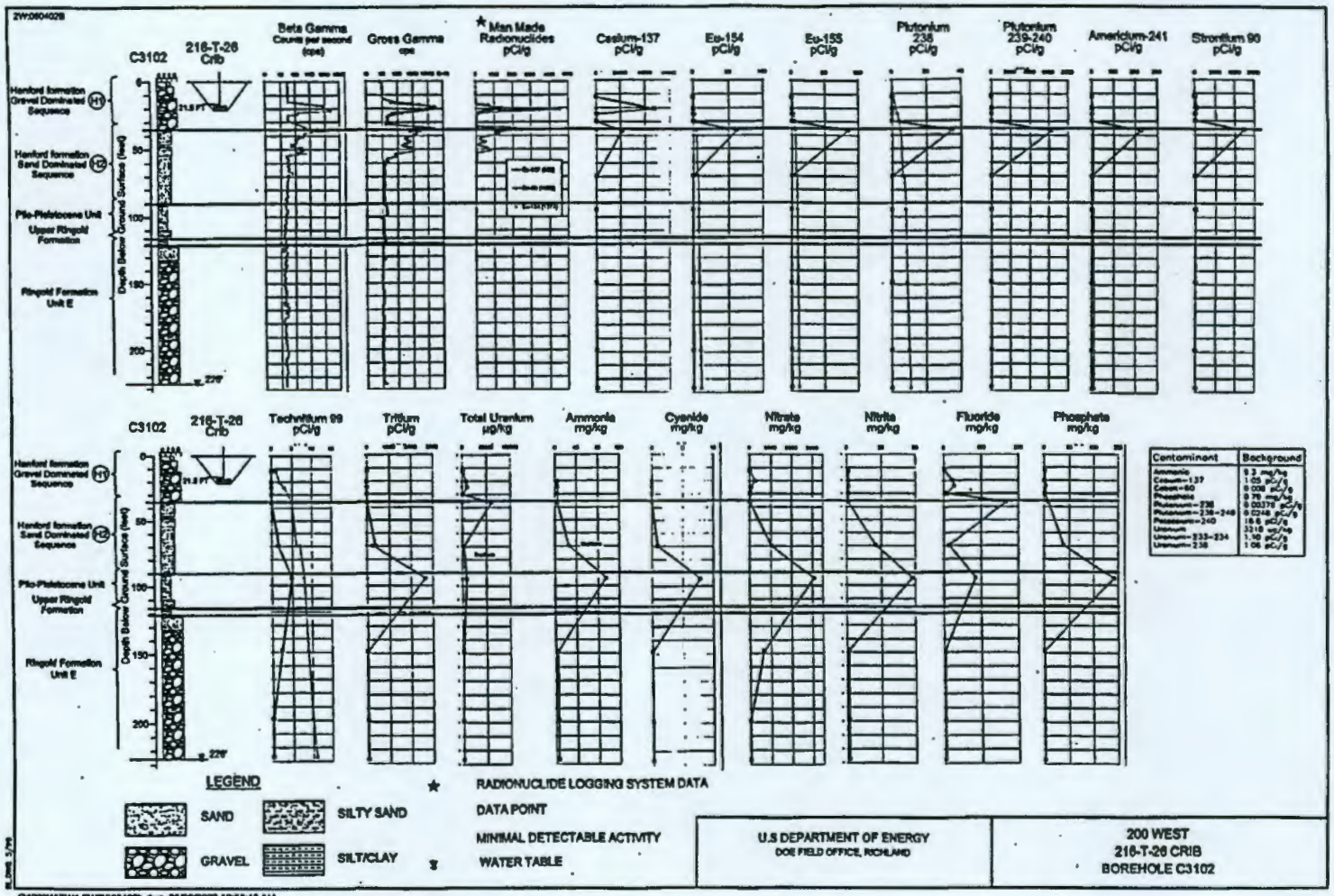


Figure 3-15. Vertical and Lateral Extent of Cesium-137 at 216-T-26 Crib – Radionuclide Logging System Data.

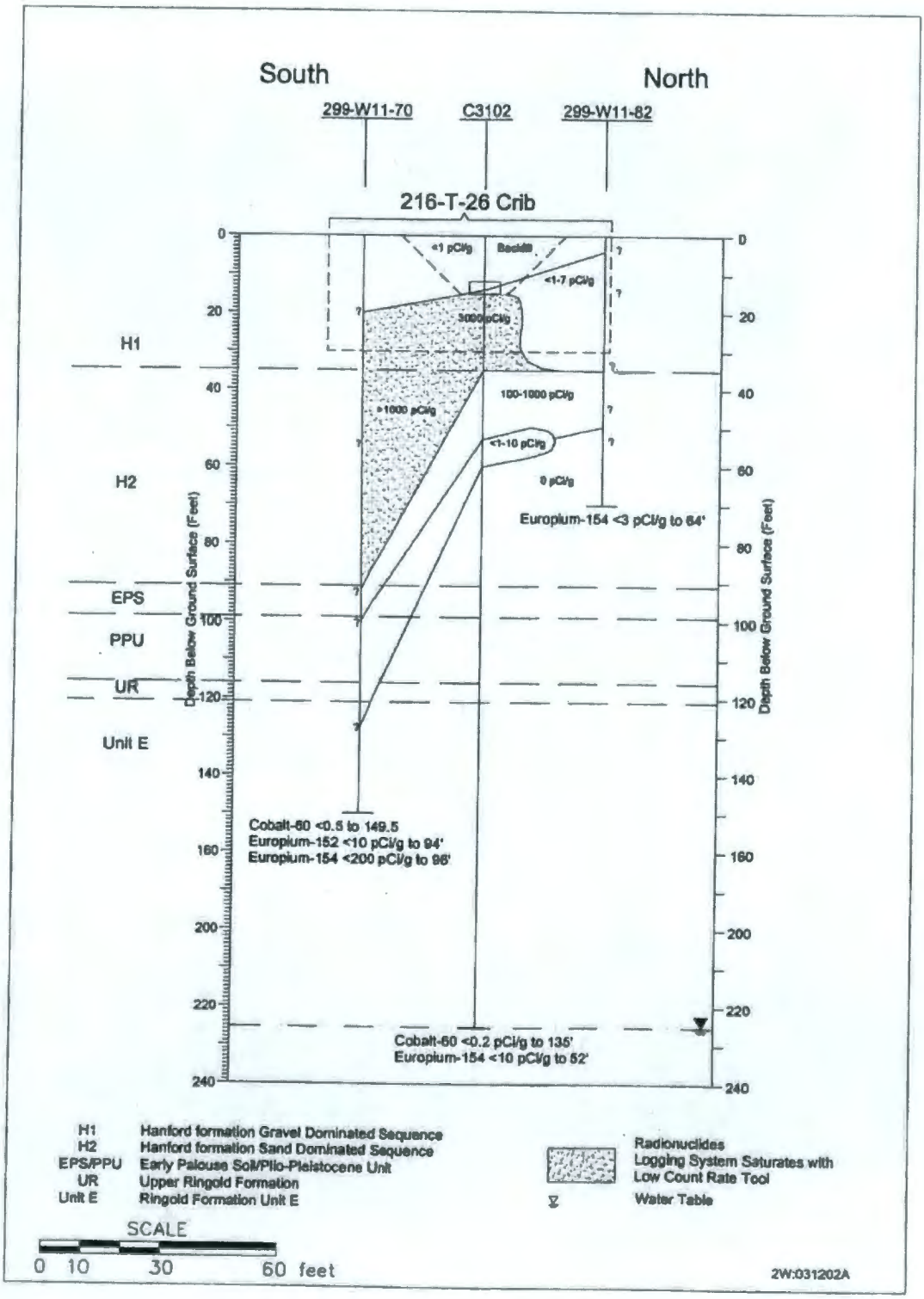


Figure 3-16. 216-T-26 Crib Contaminant Distribution Model.

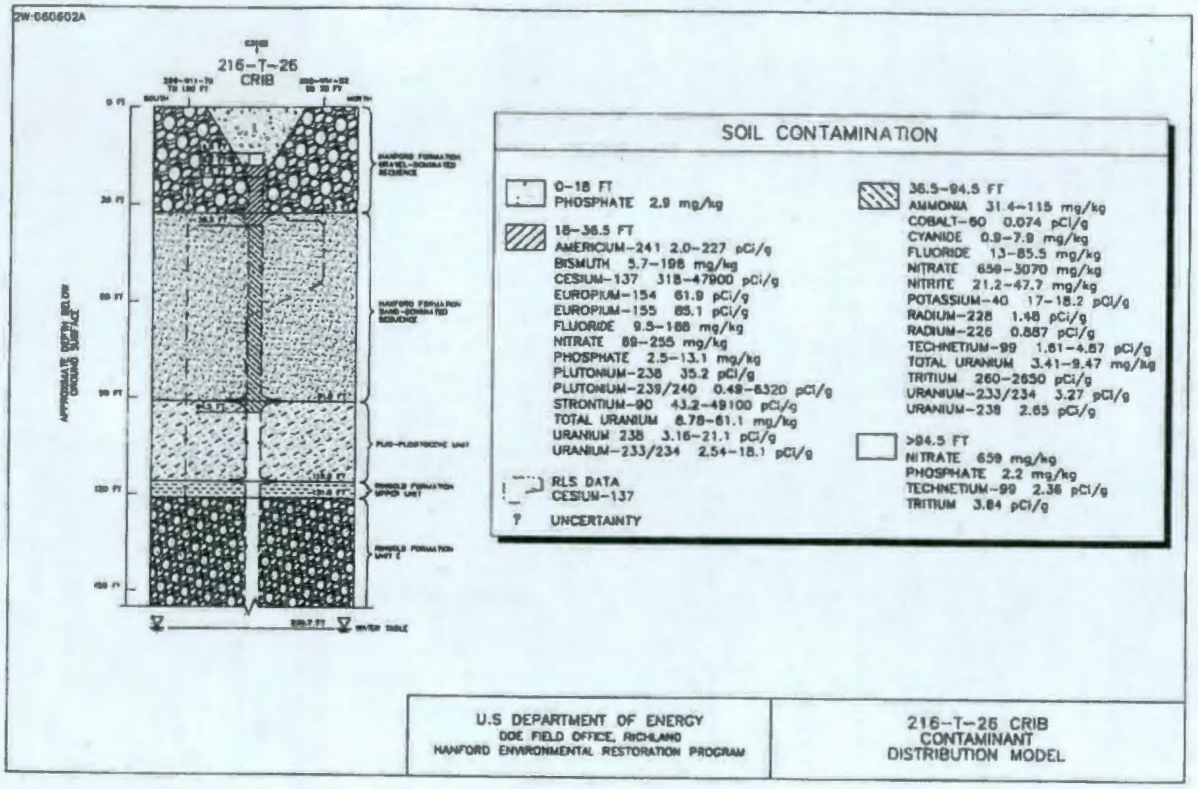


Figure 3-17. Nonradiological Groundwater Plumes Near the 200 West Area (adapted from PNNL-13788).

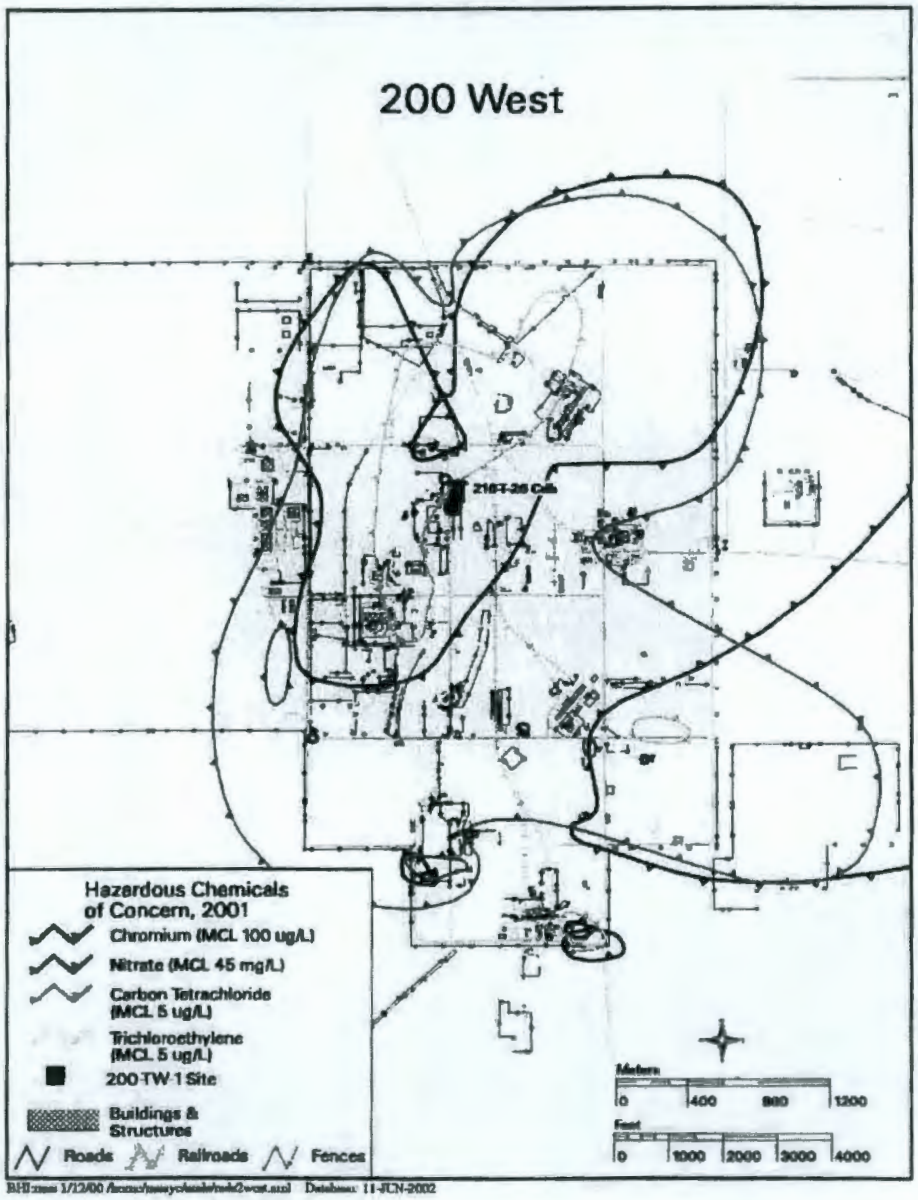
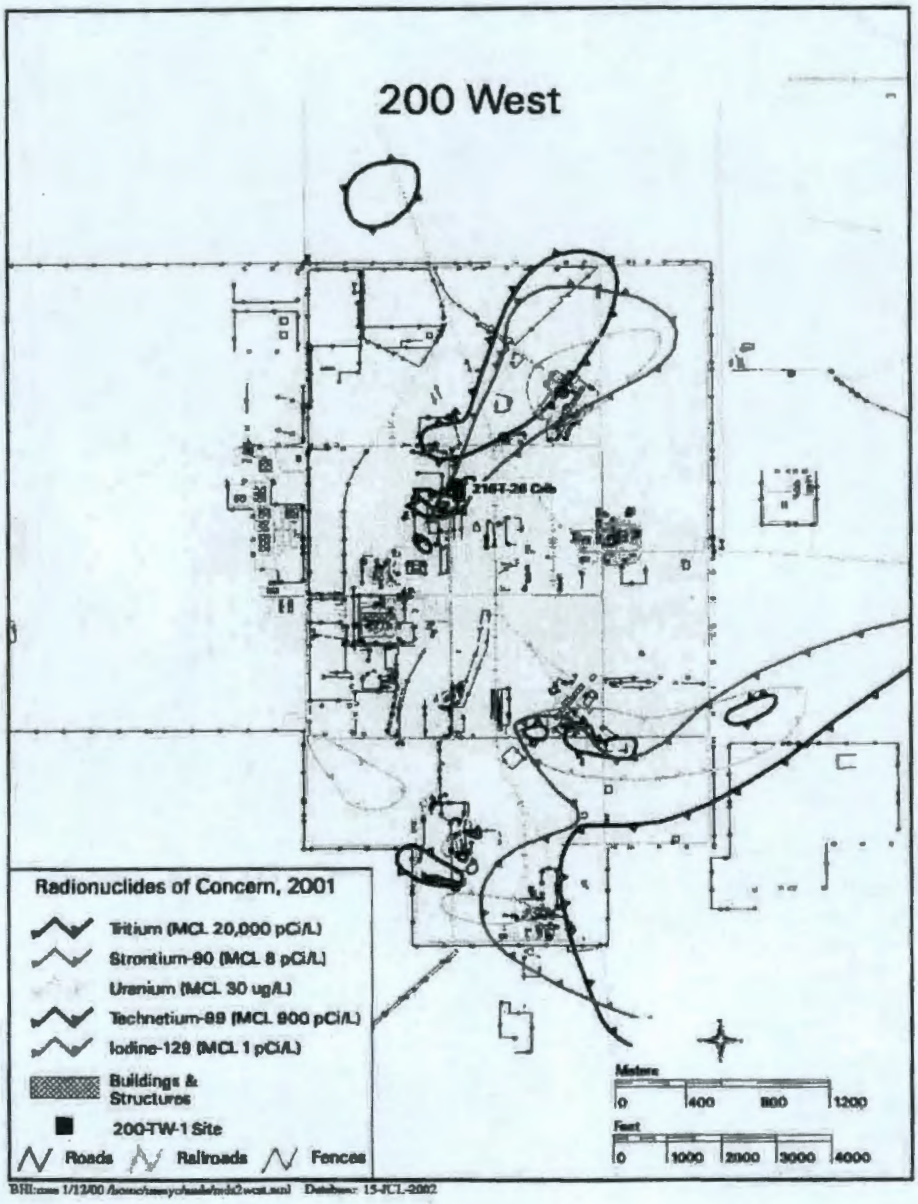


Figure 3-18. Radiological Groundwater Plumes Near the 200 West Area (adapted from PNNL-13788).



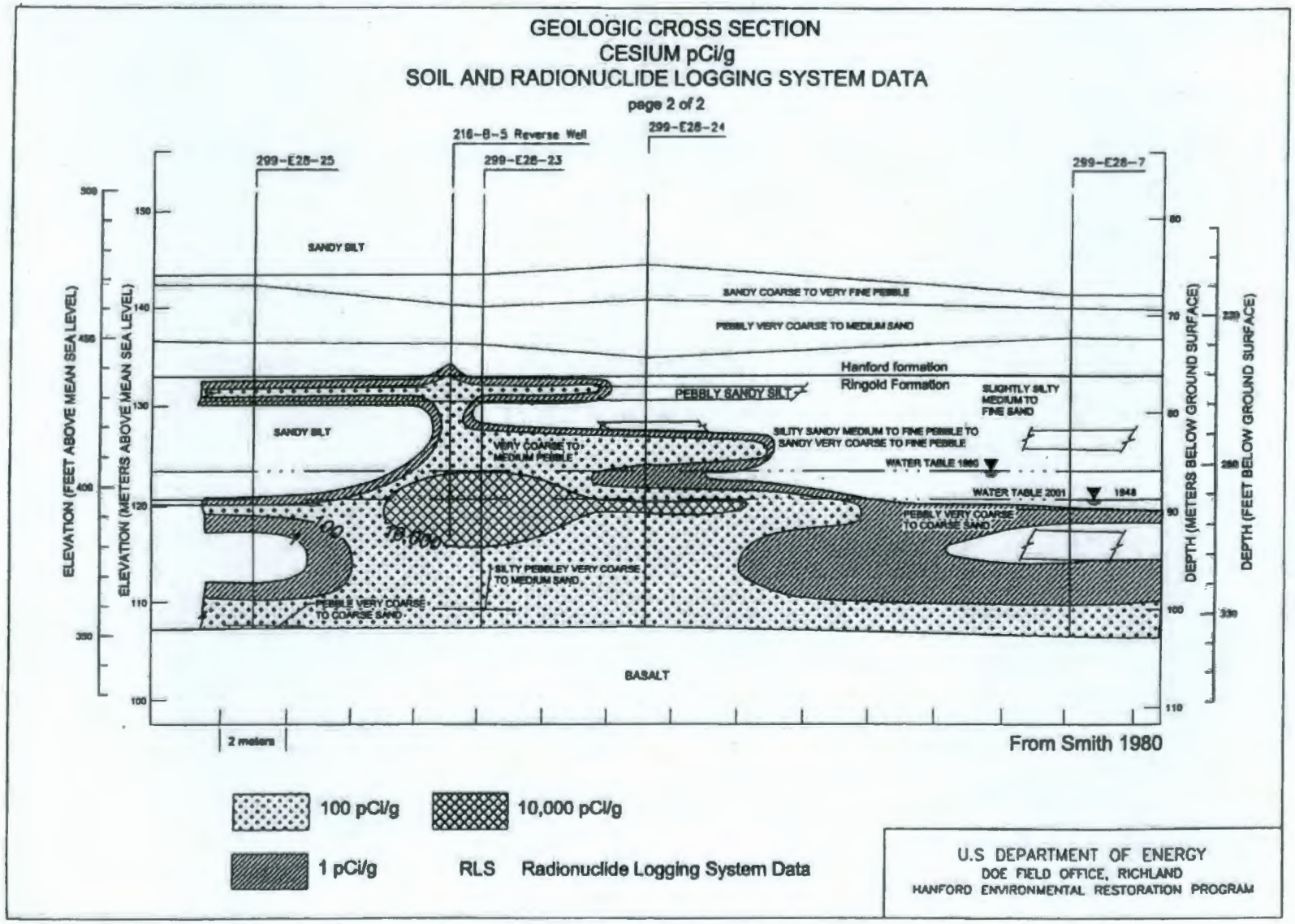


Figure 3-19. Distribution of Cesium-137 at the 216-B-5 Reverse Well – Modified from RHO-ST-37 with Radionuclide Logging System Data.

Figure 3-20. Distribution of Plutonium-239/240 at the 216-B-5 Reverse Well – Modified from RHO-ST-37.

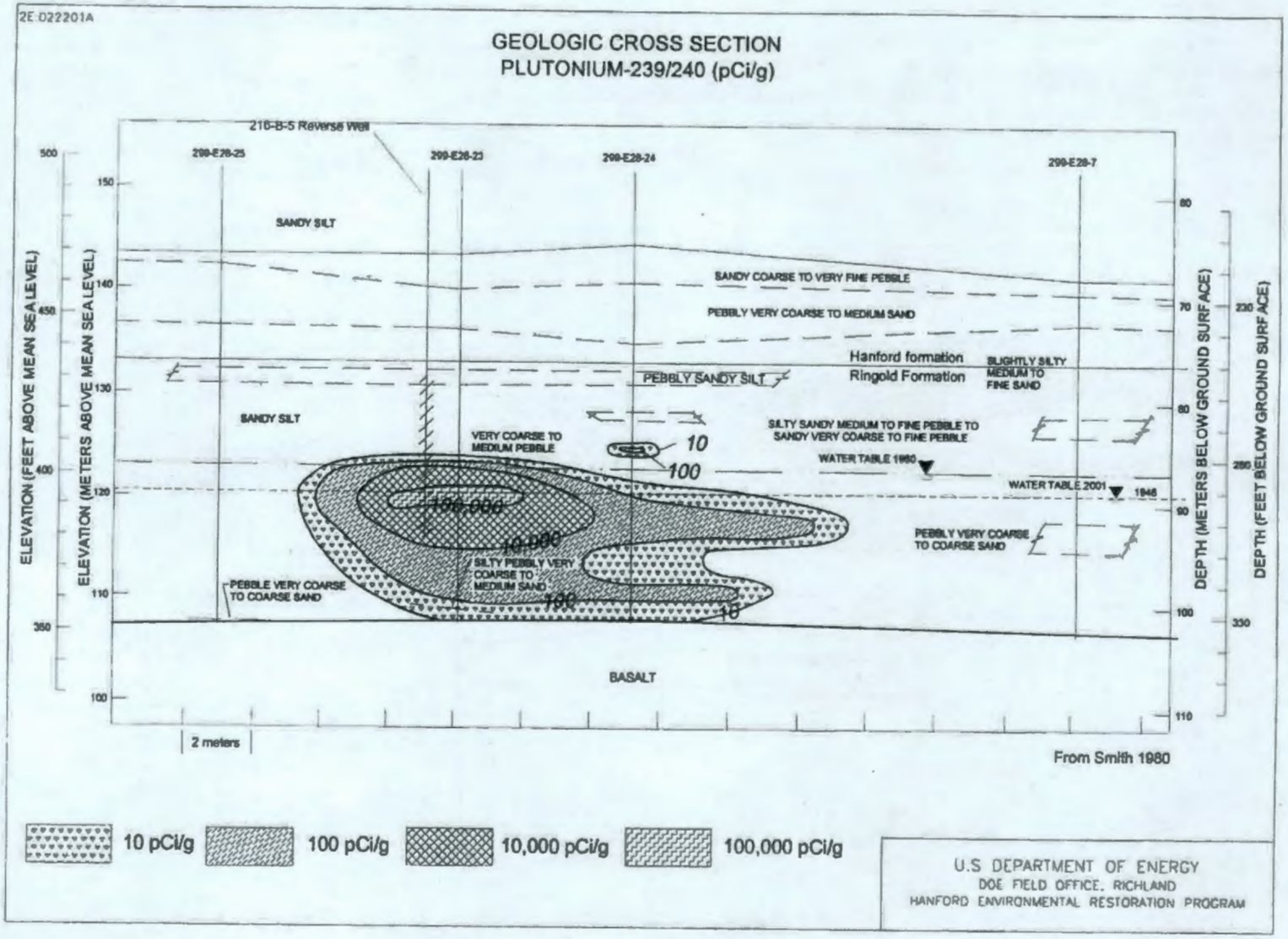


Figure 3-20

Figure 3-21. Distribution of Strontium-90 at the 216-B-5 Reverse Well – Modified from RHO-ST-37.

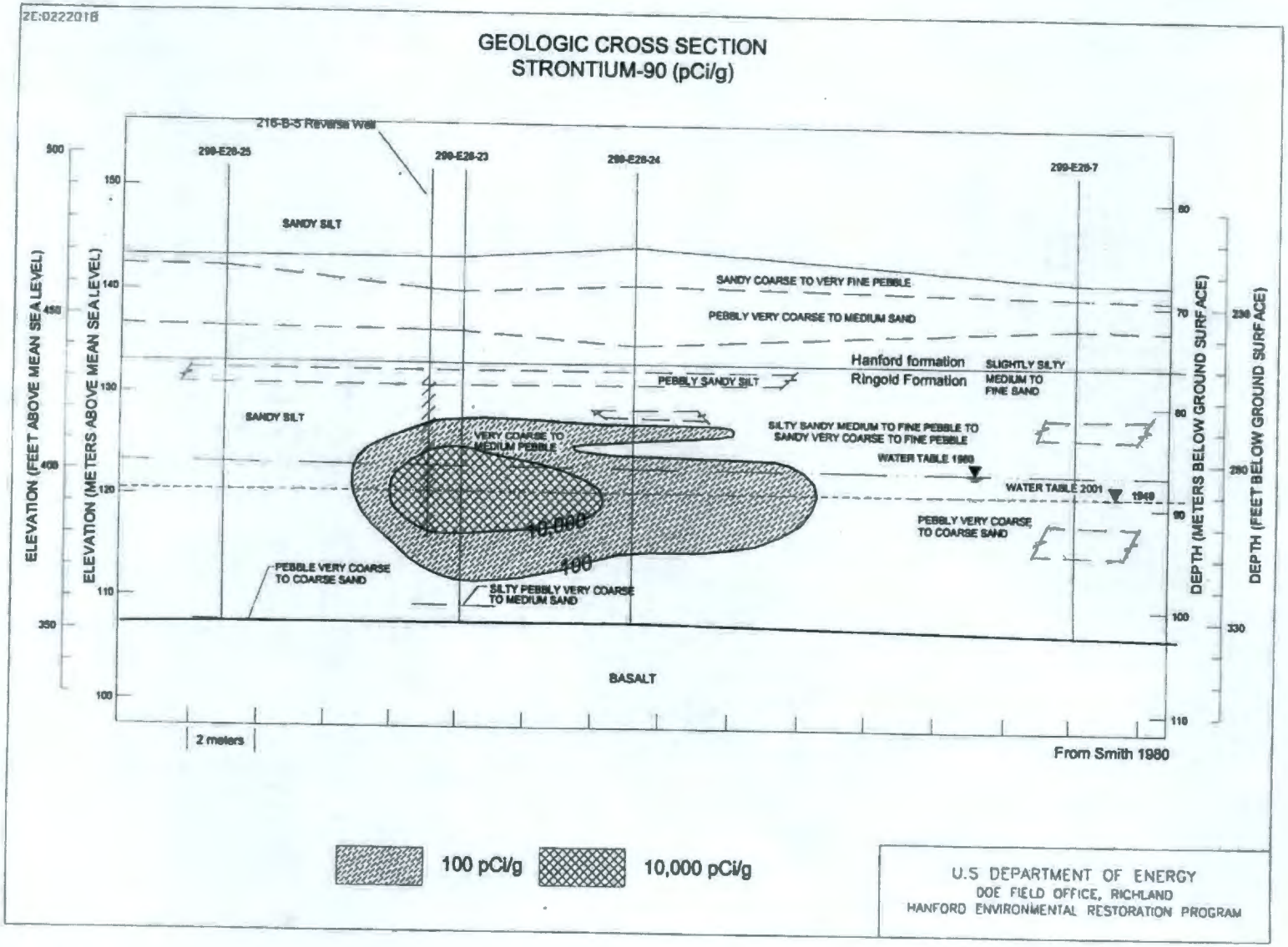
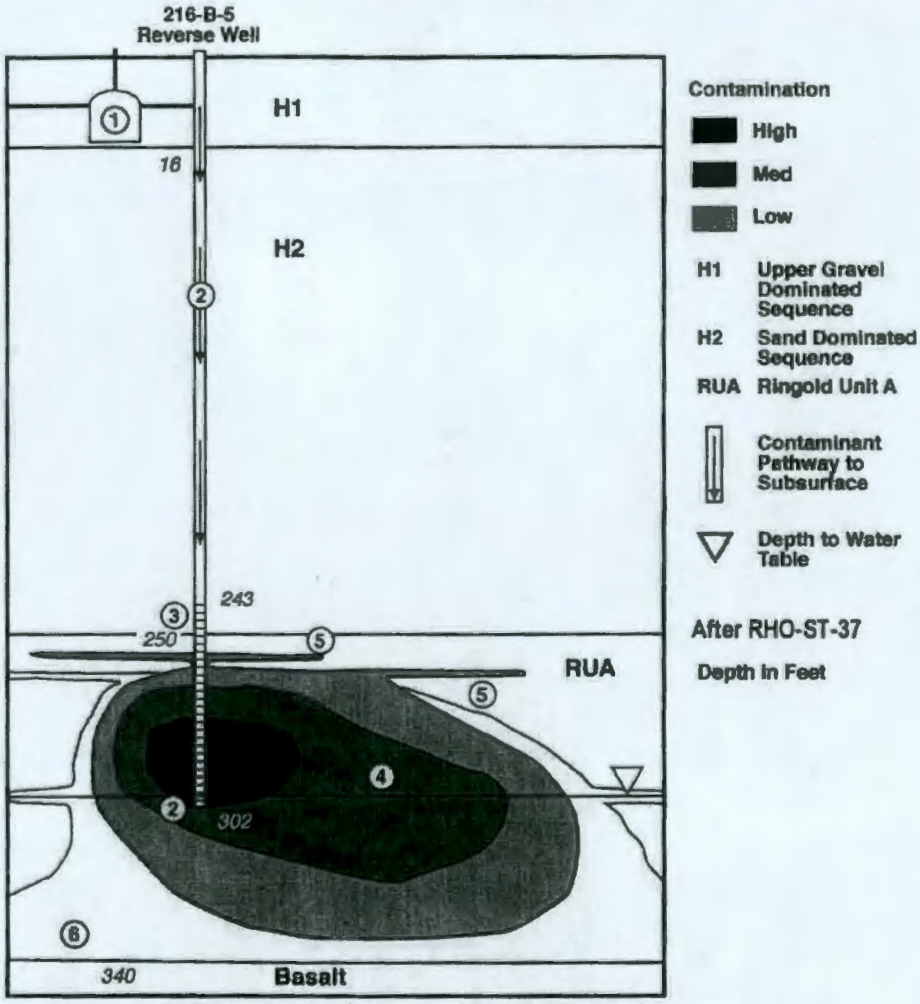


Figure 3-21

Figure 3-22. 216-B-5 Reverse Well Contaminant Distribution Model.



1. High salt, neutral/basic/low organic liquid waste with high quantities of plutonium 239/240. Cesium-137, and strontium-90 were discharged to the 216-B-361 settling tank. Contaminants precipitated/settled out in the tank.
2. Wastewater overflowed from the 216-B-361 settling tank and into the 216-B-5 reverse well through a 5 cm (2-inch) diameter stainless steel inlet pipe about 3.6 m (12 ft) bgs. The reverse well received approximately 30,600,000 L (8.1 million gal) of liquid waste. In addition, studies indicate that the well receive 4.3 kg of Pu.
3. Waste was released to the vadose zone and the water table through a perforated section of the reverse well extending 74 m - 92 m (242 ft - 302 ft) bgs. When the well was actively receiving waste, it penetrated 3 m (10 ft) into the aquifer.
4. Contaminant detected in the subsurface include: cesium-137, strontium-90, plutonium-239/240, and americium-241. The highest activities were detected near the well perforations. Activities generally decrease away from the well.
5. Cesium-137 preferentially sorbs into silt lenses intersected by perforated casing.
6. Plutonium-239/240 may occur in phosphate based mineral phase.
7. The vadose zone and groundwater has been impacted by operation of the 216-B-5 reverse well.

E9912004.1

RHO-ST-37, *216-B-5 Reverse Well Characterization Study*, Rockwell Hanford Operations, Richland, Washington.

Figure 3-23. Vertical Profile of the Contamination at the 216-B-7A Crib with Correlation to Stratigraphy, Field Screening, and Geophysical Log Data.

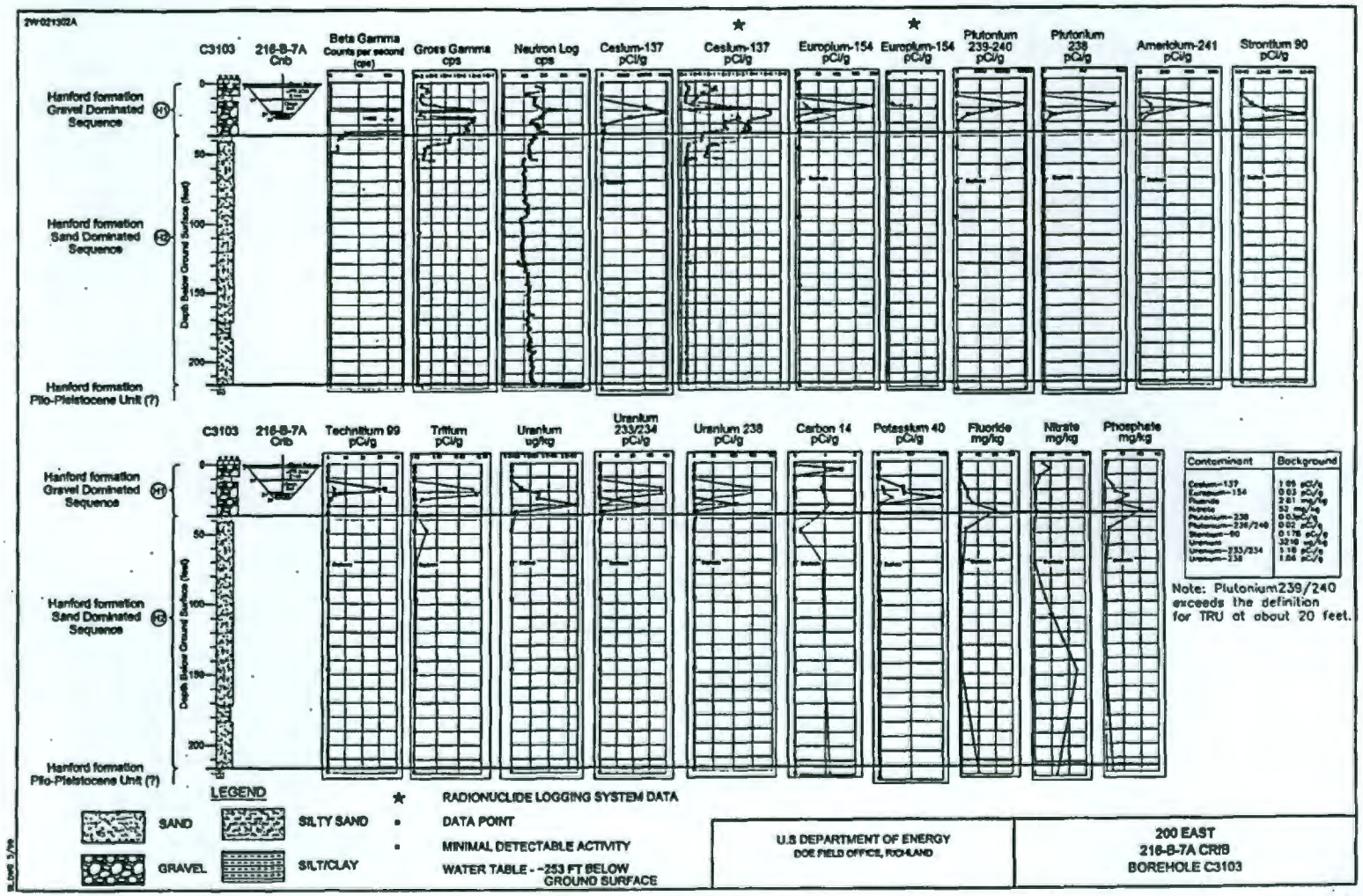


Figure 3-24. North-South Cross Section of Vertical and Lateral Extent of Cesium-137 at the 216-B-7A Crib – Radionuclide Logging System Data.

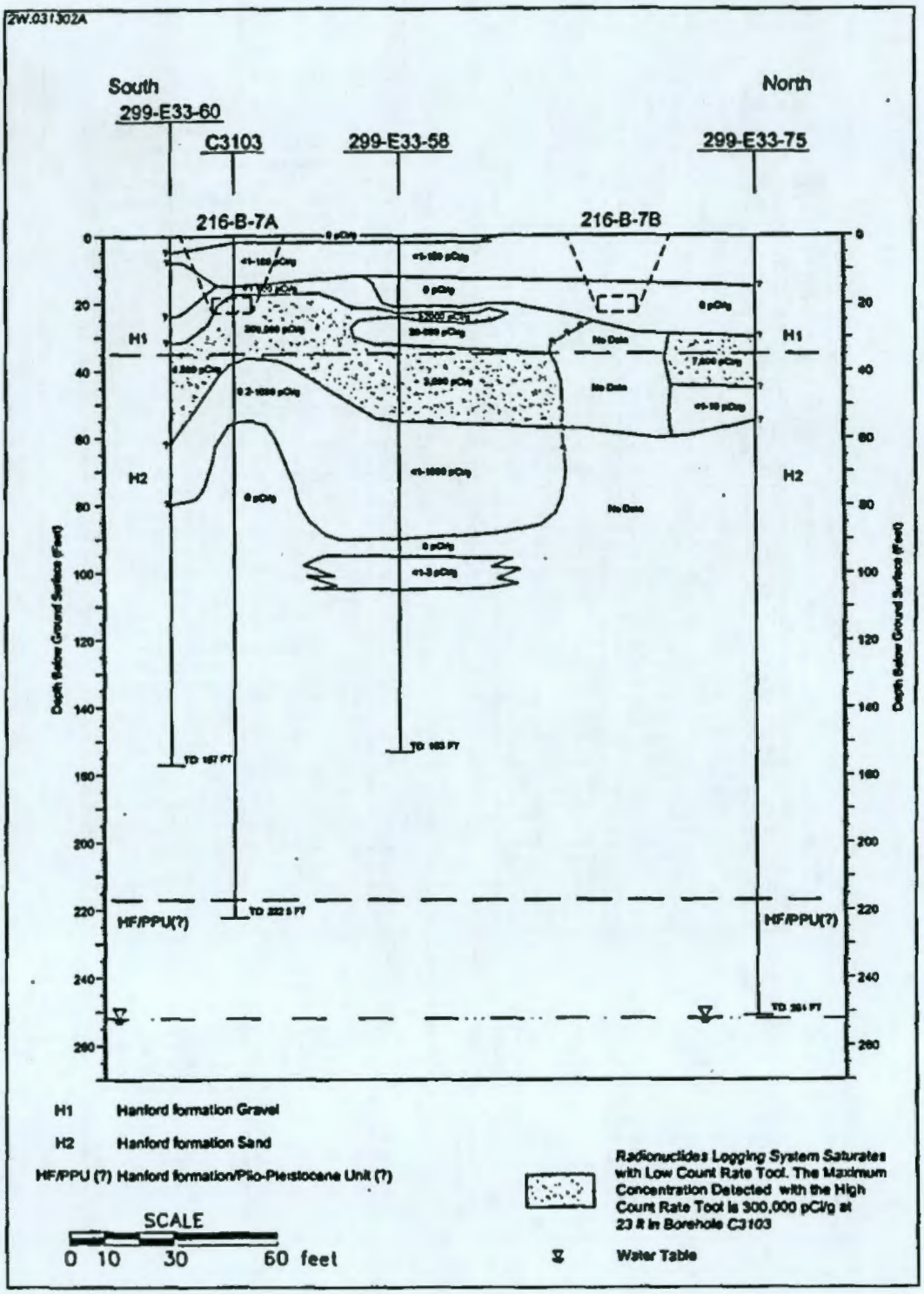


Figure 3-25. East-West Cross Section of Vertical and Lateral Extent of Cesium-137 at 216-B-7A Crib –Radionuclide Logging System Data.

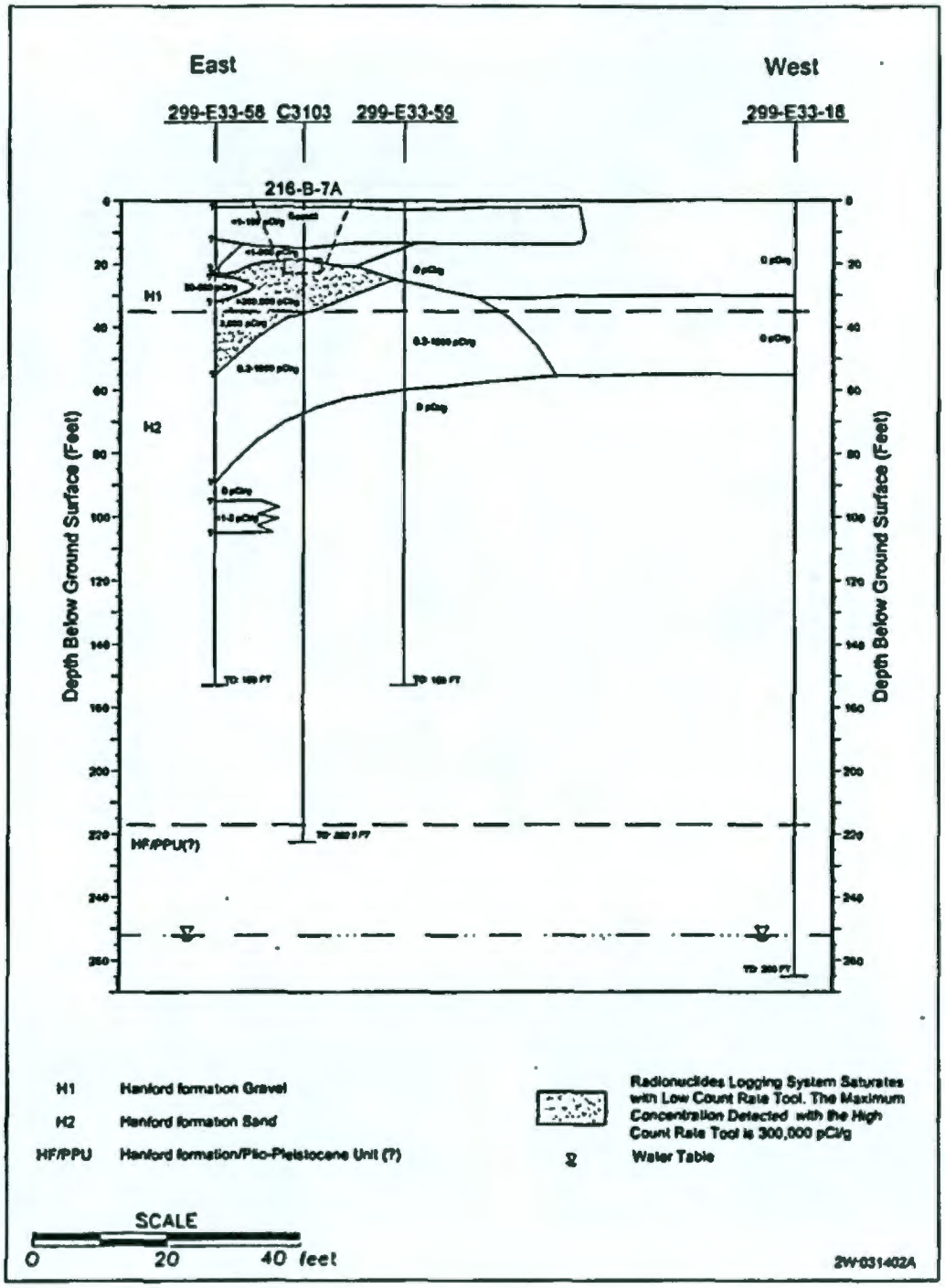


Figure 3-26. 216-B-7A Crib Contaminant Distribution Model.

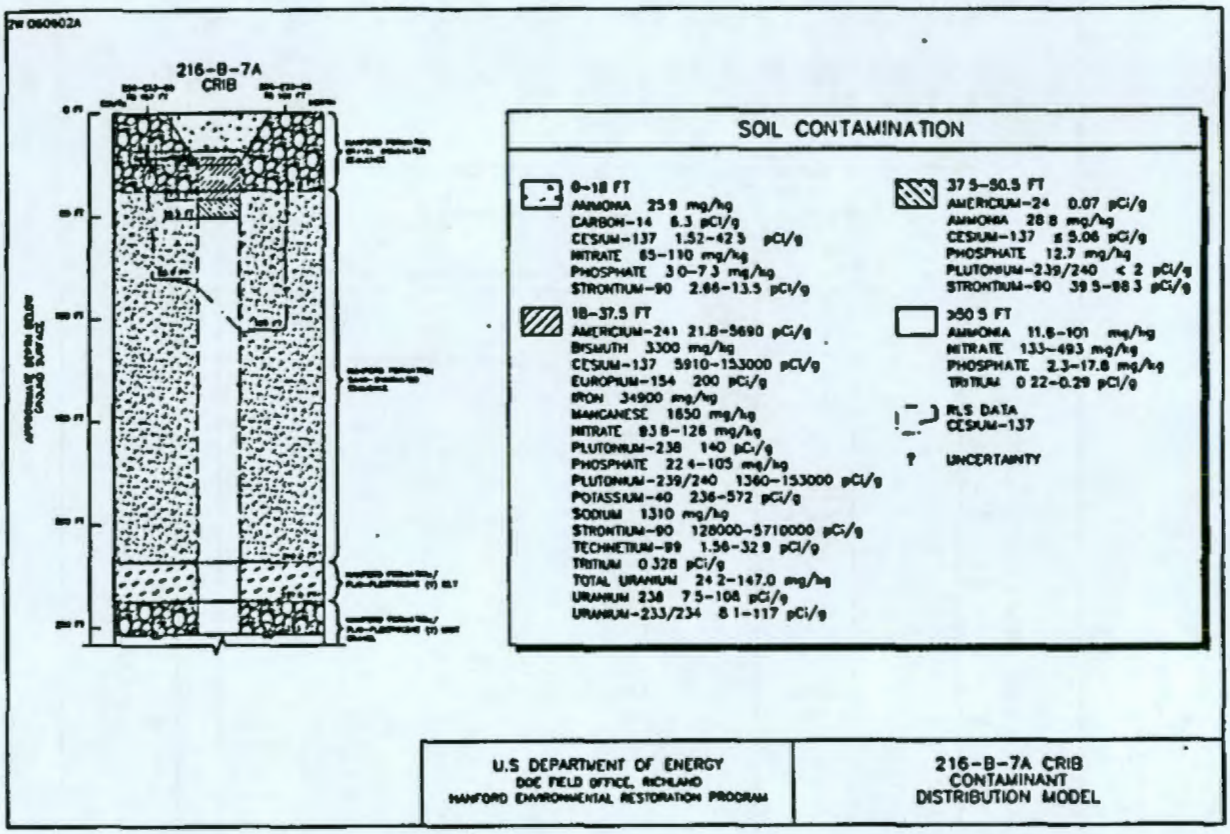


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Figure 3-27. Vertical Profile of Contamination at the 216-B-38 Trench with Correlation to Stratigraphy, Field Screening, and Geophysical Log Data.

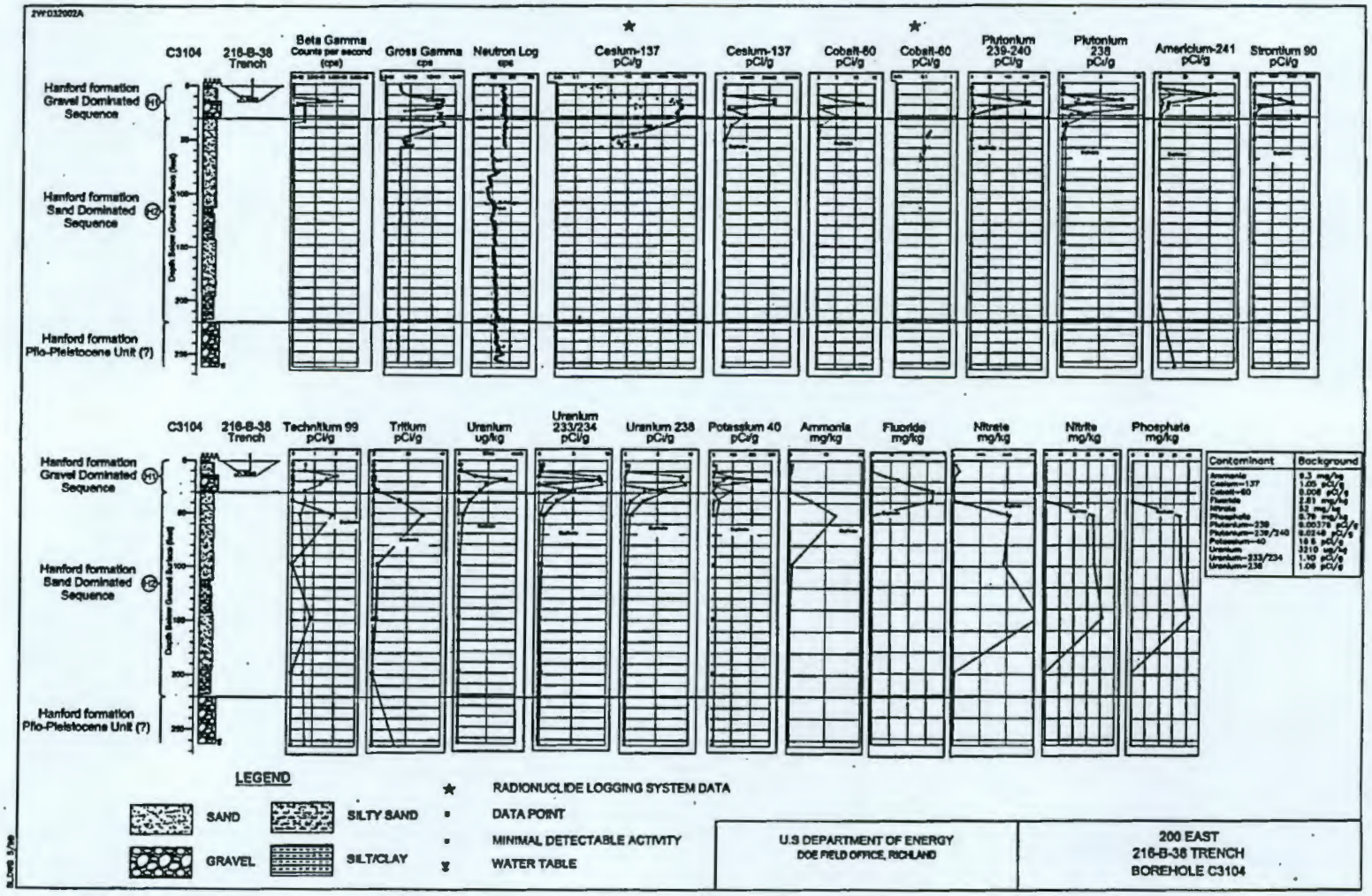

Figure 3-28. Vertical and Lateral Extent of Cesium-137 at 216-B-38 Trench – Radionuclide Logging System Data.

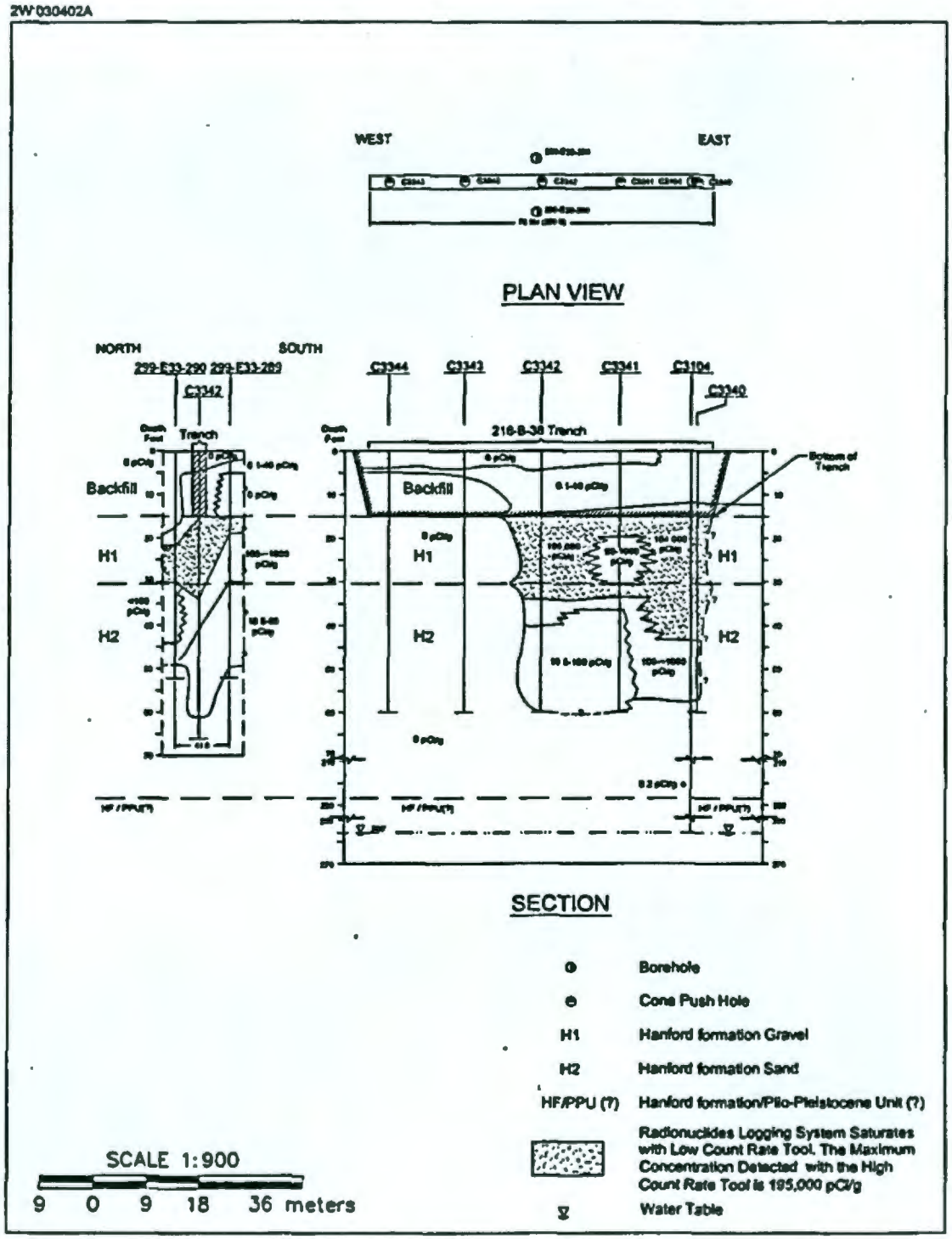

Figure 3-29. 216-B-38 Trench Contaminant Distribution Model.

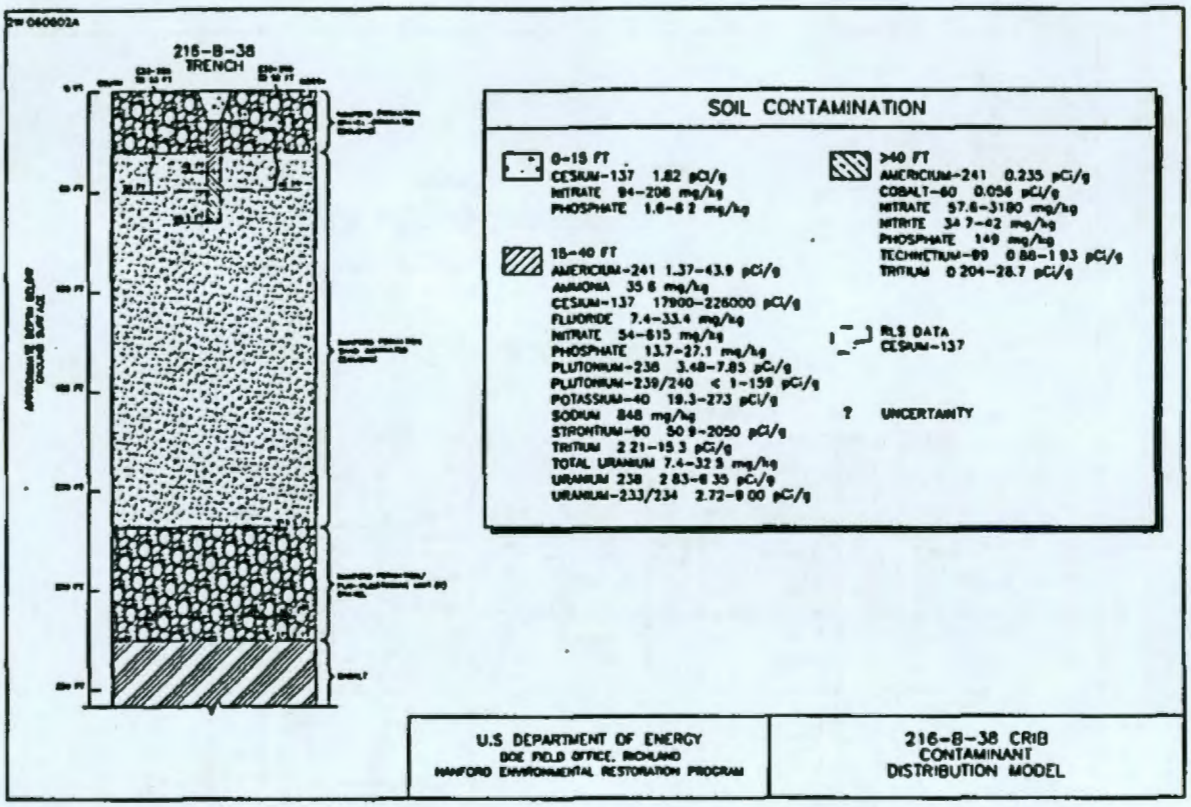

Figure 3-30. Vertical Profile of Contamination at the 216-B-57 Crib with Correlation to Stratigraphy.

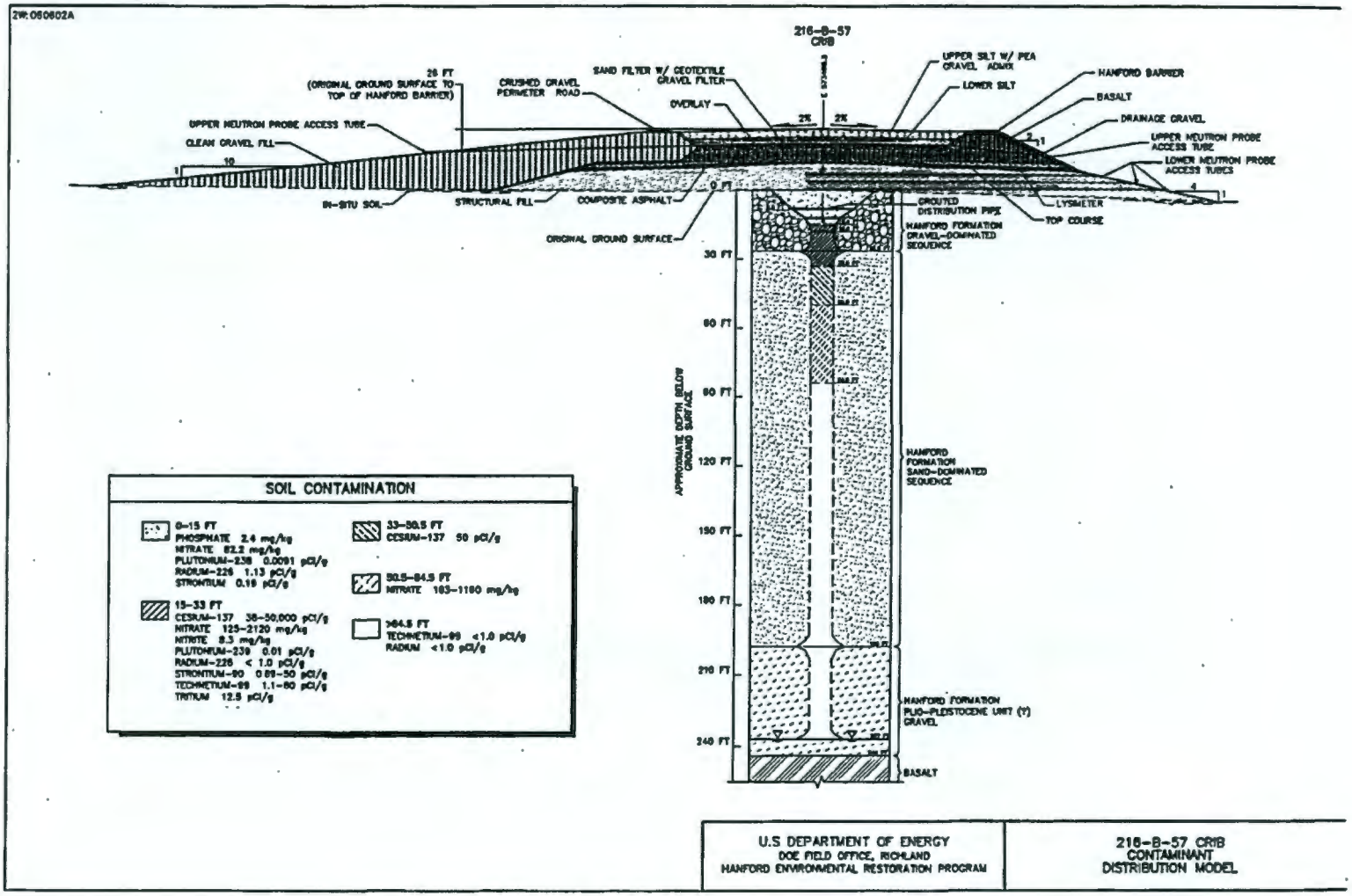

Figure 3-31. 216-B-57 Crib Contaminant Distribution Model.

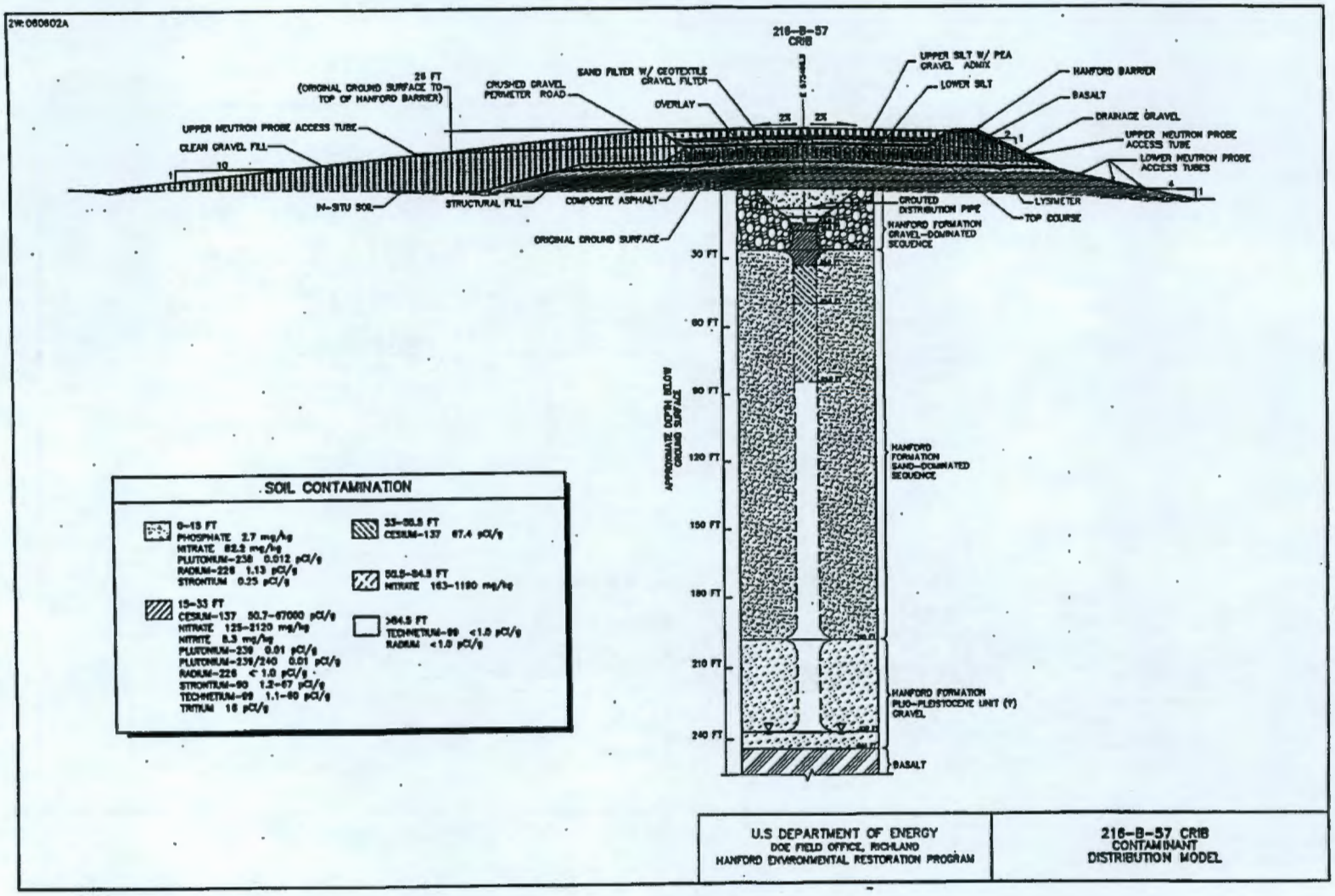

Table 3-1. Physical Property Testing Data.

Depth (ft)	% Moisture (weight)	Bulk Density	% Volumetric Moisture	Grain Size Distribution Sample No.
216-T-26 Crib				
10	2.6	1.49	3.88	--
29	4	1.49	5.97	B12676
76	3.3	1.72	5.69	B12677
92	18.5	1.57	29.10	B12678
119	15.1	1.61	24.36	B12BR4
147.5	2.7	1.99	5.38	B12BR5
216-B-38 Trench				
3	3.4	1.4	4.77	B12CB7
18	4.1*	1.98	8.13	--
97.5	1.4	1.69	2.37	B12CB8
261	4.6*	1.91	8.80	--
216-B-7A Crib				
2.5	4.9	2.01	9.9	B12BR7
22.5	10*	2.06	20.64	--
25	18*	1.88	33.91	--
97.5	2.7	1.61	4.36	B12BR8
220	22.5	1.56	35.17	B12BR9

*Moisture content not analyzed by ASTM Method 1226 due to high radiological contamination or insufficient volume. Number shown represents moisture value from chemical data analysis.

-- Sample unable to be collected due to high radiological contamination or insufficient volume.

Table 3-2. Maximum Concentration Detected. (3 Pages)

Analyte	Hanford Site Background Concentrations	Screening Level (WAC 173-340-745 or 15 mrem/yr)	216-T-26 Crib	216-B-46 Crib	216-B-38 Trench	216-B-7A Crib	216-B-57 Crib
Radionuclides (pCi/g)							
Americium-241	--	335	227	NA	43.9	5,690	NA
Antimony-125	--	NC	NA	50.4	NA	NA	NA
Carbon-14	--	33,100	ND	NA	ND	6.3	NA
Cesium-137	1.05	23.4	47,900	364,000 (280,000 decayed to 2004)	226,000	153,000	67,000 (50,000 decayed to 2004)
Cobalt-60	0.00842	4.9	0.074	4.03 (0.8 decayed to 2004)	0.056	ND	ND
Europium-152	--	11.4	ND	ND	ND	ND	NA
Europium-154	0.0334	10.3	61.9	ND	ND	200	NA
Europium-155	0.0539	426	85.1	ND	ND	ND	NA
Neptunium-237	--	59.2	ND	NA	ND	ND	NA
Nickel-63	--	3,070,000	ND	NA	ND	ND	NA
Plutonium-238	0.00378	47	35.2	6.94 (6.3 decayed to 2004)	7.85	140	0.012 (0.0091 decayed to 2004)
Plutonium-239	0.0248	NC	NA	0.93	NA	NA	0.01
Plutonium-239/240	0.0248	425	6,320	227	159	153,000	0.00325
Potassium-40	16.6	76.4	18.2	16.5	273	572	17.2
Radium-226	0.815	7.03	0.89	2.69	0.594	0.682	1.13
Radium-228	1.32[b]	8.15	1.48	NA	0.974	1.07	NA
Total radioactive strontium	0.178	2,410	49,100	353,000 (260,000 decayed to 2004)	2,050	5,710,000	67 (50 decayed to 2004)
Technetium-99	--	412,000	4.87	160	1.9	32.9	60
Tritium	--	66,900	2,650	53 (27 decayed to 2004)	28.7	0.328	16 (2.5 decayed to 2004)
Thorium-228	1.32	7.73	1.07	1.17 (0.014 decayed to 2004)	1.26	1.28	0.875 (0.0096 decayed to 2004)
Thorium-230	1.1	NC	0.74	NA	0.665	0.936	NA
Thorium-232	1.32	4.8	0.87	NA	0.621	0.86	NA

Table 3-2. Maximum Concentration Detected. (3 Pages)

Analyte	Hanford Site Background Concentrations	Screening Level (WAC 173-340-745 or 15 mrem/yr)	216-T-26 Crib	216-B-46 Crib	216-B-38 Trench	216-B-7A Crib	216-B-57 Crib
Total uranium (mg/kg)	3.21	10,500	61.1	44.1	32.5	346	2.53
Uranium-233/234	1.1	2,660	18.1	NA	9	117	NA
Uranium-235/236	0.109	101	0.26	NA	ND	0.586	NA
Uranium-238	1.06	504	21.1	NA	6.35	108	NA
Inorganic Metals (mg/kg)							
Aluminum	11,800	NC	9,540	7,720	7,830	9,630	7,610
Antimony		1,400	NA	5.7	NA	NA	ND
Arsenic	20	87.5	NA	3.8	NA	NA	3.2
Barium	132	245,000	NA	70.7	NA	NA	88.6
Beryllium	1.51	280,000	NA	0.5	NA	NA	0.45
Bismuth	--	NC	198	31.3	ND	3,300	ND
Cadmium	0.81[a]	3,500	0.67	2	0.1	0.07	1.6
Calcium	17,200	NC	9,590	10,400	9,610	11,900	9,450
Chromium (III)	18.5	5,250,000	93.6	29.5	14.5	142	11.3
Hexavalent chromium	--	10,500	4.2	NA	0.49	17.8	NA
Cobalt	15.7	NC	NA	9.4	NA	NA	8.6
Copper	22	130,000	18.1	44	18.8	29.5	42.7
Iron	32,600	NC	24,900	23,500	19,800	34,900	14,700
Lead	10.2	1,000	13.7	15.9	8	349	12.7
Magnesium	7,060	NC	5,460	5,150	4,580	6,460	4,710
Manganese	512	490,000	318	334	317	1,650	457
Mercury	0.33	1,050	0.18	0.29	0.089	0.42	ND
Nickel	19.1	70,000	51	25.6	22	66.6	11
Potassium	2,150	NC	1,720	1,860	1,140	1,900	1,290
Selenium		17,500	NA	0.46	NA	NA	ND
Silver	0.73	17,500	0.5	0.3	ND	3.1	2.3
Sodium	690	NC	1,510	4,360	848	1,310	382
Thallium	--	245	NA	0.6	NA	NA	0.44
Vanadium	85.1	24,500	65.7	56.1	63.9	88.4	24.2
Zinc	67.8	1,050,000	45	52.3	54.9	127	36.8
General Inorganics (mg/kg)							
Ammonia	9.23	Unlimited	94.9	NA	65.2	21.3	NA
Chloride	100	NC	46	79.2	41.1	24.8	12.3
Cyanide	--	70,000	7.9	12	0.42	0.80	ND
Fluoride	2.81	NC	168	6.7	33.4	205	3.7
Nitrate (as Nitrogen)	52	350,000	693	1,235	718	111	479
Nitrite (as Nitrogen)	--	350,000	14.4	3.7	12.5	ND	2.5
Phosphate	0.785	NC	213	86.7	149	105	2.7
Sulfate	237	NC	250	1,080	248	185	139
Total Organic Carbon	--	NC	281	2,410	2,760	3,850	6,750

Table 3-2. Maximum Concentration Detected. (3 Pages)

Analyte	Hanford Site Background Concentrations	Screening Level (WAC 173-340-745 or 15 mrem/yr)	216-T-26 Crib	216-B-46 Crib	216-B-38 Trench	216-B-7A Crib	216-B-57 Crib
Volatile Organics (µg/kg)							
Acetone	--	350,000	35	ND	NA	13	26
Methylene Chloride	--	17,500	27	100	NA	17	110
Toluene	--	700,000	6	ND	NA	ND	13
Xylenes (total)	--	7,000,000	5	ND	NA	ND	ND
Semi-Volatile Organics (µg/kg)							
Aroclor-1254	--	70,000	NA	ND	NA	NA	770
Benzoic Acid	--	Unlimited	NA	41	NA	NA	160
Bis(2-ethyl-hexyl) phthlate	--	9,380,000	59.05	99	NA	ND	2,700
Butylbenzylphthalate	--	Unlimited	ND	ND	NA	ND	1,400
Chrysene	--	18,000	ND	ND	NA	ND	40
Diethyl ether	--	NC	NA	NA	NA	NA	40
Di-n-butylphthalate	--	Unlimited	ND	3,100	NA	ND	3,000
Di-n-octylphthalate	--	Unlimited	ND	ND	NA	ND	270
Pentachlorophenol	--	109,000	ND	ND	NA	ND	93
Phenol	--	Unlimited	110	ND	NA	ND	ND
Pyrene	--	Unlimited	ND	ND	NA	ND	49
Tributyl phosphate	--	NC	90.99	19.3	NA	ND	NA

[a] State wide background concentration (Ecology 1994).

[b] The background concentration is based on Thorium-232, which is in secular equilibrium with Radium-228.
-- = No background concentration available
NA = Not analyzed.
NC = No criterion
ND = Not detected

Table 3-3. 200-TW-1 Operable Unit Initial Screening. (3 Pages)

Contaminant of Concern	Screening Levels			216-B-46 Crib				216-T-26 Crib			
	Background	Direct Exposure Screening Level (WAC 173-340-745 or 15 mrem)[a]	Groundwater Protection Screening Level (WAC 173-340-747)[b]	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level
Radionuclides (pCi/g)											
Antimony-125	--	NC	[d]	50.4	Yes	NC	[d]	NA	NA	NA	[d]
Americium-241	--	335	[d]	NA	--	NA	[d]	227	--	No	[d]
Carbon-14	--	33,100	[d]	NA	--	NA	[d]	ND	--	No	[d]
Cesium-137	1.05	23.4	[d]	280,000 (decayed to 2004)	Yes	Yes	[d]	47,900	Yes	Yes	[d]
Cobalt-60	0.00842	4.90	[d]	0.8 (decayed to 2004)	Yes	No	[d]	0.074	Yes	No	[d]
Europium-152	--	11.4	[d]	ND	NA	No	[d]	ND	--	No	[d]
Europium-154	0.0334	10.3	[d]	ND	No	No	[d]	61.9	Yes	Yes	[d]
Europium-155	0.0539	426	[d]	ND	No	No	[d]	85.1	Yes	No	[d]
Neptunium-237	--	59.2	[d]	NA	NA	NA	[d]	ND	--	No	[d]
Nickel-63	--	3,070,000	[d]	NA	NA	NA	[d]	ND	--	No	[d]
Plutonium-238	0.00378	47.0	[d]	6.3 (decayed to 2004)	Yes	No	[d]	35.2	Yes	No	[d]
Plutonium-239	0.0248	NC	[d]	0.93	Yes	NC	[d]	NA	NA	NA	[d]
Plutonium-239/240	0.0248	425	[d]	227	Yes	No	[d]	6,320	Yes	Yes	[d]
Potassium-40	16.6	76.4	[d]	16.5	No	No	[d]	18.2	Yes	No	[d]
Radium-226	0.815	7.03	[d]	2.69	Yes	No	[d]	0.89	Yes	No	[d]
Radium-228	1.32	8.15	[d]	NA	NA	NA	[d]	1.48	Yes	No	[d]
Total Radioactive Strontium	0.178	2,410	[d]	260,000 (decayed to 2004)	Yes	Yes	[d]	49,100	Yes	Yes	[d]
Technetium-99	--	412,000	[d]	160	Yes	No	[d]	4.87	--	No	[d]
Tritium	--	66,900	[d]	27 (decayed to 2004)	Yes	No	[d]	2,650	--	No	[d]
Total uranium (mg/kg)	3.21 (2.27 pCi/g)	10,500	2.3	44.1	Yes	No	Yes	61.1	Yes	No	Yes
Thorium-228	1.32	7.73	[d]	0.014 (decayed to 2004)	No	No	[d]	1.07	No	No	No
Thorium-230	1.10	NC	[d]	NA	NA	NA	[d]	0.74	No	NC	No
Thorium-232	1.32	4.8	[d]	NA	NA	NA	[d]	0.87	No	No	No
Uranium-233/234	1.10	2,660	[d]	NA	NA	NA	[d]	18.1	Yes	No	[d]
Uranium-235	0.109	101	[d]	NA	NA	NA	[d]	0.26	Yes	No	[d]
Uranium-238	1.06	504	[d]	NA	NA	NA	NA	21.1	Yes	No	[d]
Inorganic Metals (mg/kg)											
Aluminum	11,800	NC	45.2	7,720	No	NC	No[e]	9,540	No	NC	No

Table 3-3. 200-TW-1 Operable Unit Initial Screening. (3 Pages)

Contaminant of Concern	Screening Levels			216-B-46 Crib				216-T-26 Crib			
	Background	Direct Exposure Screening Level (WAC 173-340-745 or 15 mrem)[a]	Groundwater Protection Screening Level (WAC 173-340-747)[b]	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level
Antimony	--	1,400	5.42	5.7	--	No	Yes	NA	NA	NA	NA
Arsenic	20	87.5	340	3.8	No	No	No	NA	NA	NA	NA
Barium	132	245,000	923	70.7	No	No	No	NA	NA	NA	NA
Beryllium	1.51	280,000	63.2	0.5	No	No	No	NA	NA	NA	NA
Bismuth	--	NC	NC	31.3	Yes	NC	NC	198	--	NC	NC
Cadmium	0.81	3,500	0.69	2.0	Yes	No	Yes	0.67	No	No	No
Calcium	17,200	NC	NC	10,400	No	NC	NC	9,590	No	NC	NC
Chromium (III)	18.5	5,250,000	2,000	29.5	Yes	No	No	93.6	Yes	No	Yes
Chromium, hexavalent	--	10,500	18.4	NA	NA	NA	NA	4.2	No	No	No
Cobalt	15.7	NC	NC	9.4	No	NC	NC	NA	NA	NA	NA
Copper	22	130,000	263	44	Yes	No	No	18.1	No	No	No
Iron	32,600	NC	1,320	23,500	No	NC	No[e]	24,900	No	NC	No[e]
Lead	10.2	1,000	3,000	15.9	Yes	No	No	13.7	Yes	No	No
Magnesium	7,060	NC	NC	5,150	No	NC	NC	5,460	No	NC	NC
Manganese	512	490,000	50.2	334	No	No	No[e]	318	No	No	No[e]
Mercury	0.33	1,050	2.09	0.29	No	No	No	0.18	No	No	No
Nickel	19.1	70,000	130	25.6	Yes	No	No	51	Yes	No	No
Potassium	2,150	NC	NC	1,860	No	NC	NC	1,720	No	NC	NC
Selenium	--	17,500	5.2	0.46	--	No	No	NA	NA	NA	NA
Silver	0.73	17,500	13.6	0.3	No	No	No	0.5	No	No	No
Sodium	690	NC	NC	4,360	Yes	NC	NC	1,510	Yes	NC	NC
Thallium	--	245	38	0.6	--	No	No	NA	NA	NA	NA
Vanadium	85.1	24,500	2,240	56.1	No	No	No	65.7	No	No	No
Zinc	67.8	1,050,000	5,970	52.3	No	No	No	45	No	No	No
General Inorganics (mg/kg)											
Ammonia	9.23	Unlimited	NC	NA	NA	NA	NA	94.9	Yes	No	NC
Chloride	100	NC	NC	79.2	No	NC	NC	46	No	NC	NC
Cyanide	--	70,000	0.80	12	--	No	Yes	7.9	--	No	Yes
Fluoride	2.81	NC	16	6.7	Yes	NC	No	168	Yes	NC	Yes
Nitrate (as Nitrogen)	52	350,000	40	1,235	Yes	No	Yes	693	Yes	No	Yes
Nitrite (as Nitrogen)	--	350,000	4	3.7	--	No	No	14.4	--	No	Yes
Phosphate	0.785	NC	NC	86.7	Yes	NC	NC	213	Yes	NC	NC
Sulfate	237	NC	1,000	1,080	Yes	NC	Yes	250	Yes	NC	No
Volatile Organics (µg/kg)											
Acetone	--	350,000	3,210	ND	--	No	No	35	--	No	No

Table 3-3. 200-TW-1 Operable Unit Initial Screening. (3 Pages)

Contaminant of Concern	Screening Levels			216-B-46 Crib				216-T-26 Crib			
	Background	Direct Exposure Screening Level (WAC 173-340-745 or 15 mrem)[a]	Groundwater Protection Screening Level (WAC 173-340-747)[b]	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level
Methylene chloride	--	17,500	254	100	--	No	No	27	--	No	No
Toluene	--	700,000	7,270	ND	--	No	No	6	--	No	No
Xylenes (total)	--	7,000,000	91,400	ND	--	No	No	5	--	No	No
Semi-volatile Organics (µg/kg)											
Aroclor-1254	--	70,000	990	ND	--	No	No	NA	--	No	No
Benzoic acid	--	Unlimited	257,000	41	--	No	No	NA	--	No	No
Bis(2-ehtyl-hexyl) phthalate	--	9,380,000	14,000	99	--	No	No	59.05	--	No	No
Butylbenzylphthalate	--	Unlimited	893,000	ND	--	No	No	ND	--	No	No
Chrysene	--	18,000	96	ND	--	No	No	ND	--	No	No
Diethyl ether	--	NC	NC	NC	--	NC	NC	NA	--	NC	NC
Di-n-butylphthalate	--	Unlimited	56,500	3,100	--	No	No	ND	--	No	No
Di-n-octylphthalate	--	Unlimited	532,000,000	ND	--	No	No	ND	--	No	No
Pentachlorophenol	--	109,000	115,000	ND	--	No	No	ND	--	No	No
Phenol	--	Unlimited	43,900	ND	--	No	No	110	--	No	No
Pyrene	--	Unlimited	655,000	ND	--	No	No	ND	--	No	No
Tributyl phosphate	--	NC	NC	19.3	--	NC	NC	90.99	--	NC	NC

[a] Washington Administrative Code 173-340-745 "Soil Cleanup Standards for Industrial Properties," Method C for nonradiological contaminants. For radionuclides, the screening level is the concentration of the radionuclide that would result in a 15 mrem/yr dose under an industrial exposure scenario; these values were calculated using RESRAD.

[b] WAC 173-340-747 "Deriving Soil Concentrations for Ground Water Protection." These standards are for nonradiological contaminants and are based on WAC 173-340-720, "Ground Water Cleanup Standards," Method B. Protection of groundwater for radionuclides is evaluated through the RESRAD and STOMP modeling as presented in Chapters 4.0 and 5.0

[c] Background from DOE/RL-92-24, Hanford Site Soil Background; DOE/RL-96-12, Hanford Site Background: Part 2, Soil Background Values for Radioactive Analytes; or Ecology Publication 94-115, 1994, Natural Background Soil Metals Concentrations in Washington State.

[d] Groundwater protection for radionuclides is determined through modeling using RESRAD and STOMP as discussed in Chapters 4.0 and 5.0.

[e] The groundwater protection standard is less than the background concentration; therefore, the background concentration becomes the screening level for groundwater protection.

-- = no background concentration available for the Hanford Site or from the Washington State Department of Ecology (see footnote "c" above).

NA = not analyzed

NC = no criterion available

ND = not detected.

Table 3-4. 200-TW-2 Operable Unit Initial Screening. (3 Pages)

Contaminants of Concern	Screening Levels			216-B-5 Reverse Well				216-B-7A Crib				216-B-38 Trench			
	Background	Direct Exposure Screening Level (WAC 173-340-745 or 15 mrem)[a]	Groundwater Protection Screening Level (WAC 173-340-747)[b]	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level
Radionuclides (pCi/g)															
Americium-241	--	335	[d]	1,330	Yes	--	[d]	5,690	--	Yes	[d]	43.9	--	No	[d]
Carbon-14	--	NC	[d]	NA	NA	NA	NA	6.3	--	NC	[d]	NA	NA	NA	NA
Cesium-137	1.05	33,100	[d]	51,300	Yes	--	[d]	153,000	Yes	Yes	[d]	226,000	Yes	Yes	[d]
Cobalt-60	0.00842	4.9	[d]	NA	NA	NA	NA	NA	NA	NA	NA	0.056	Yes	No	[d]
Europium-152	--	11.4	[d]	NA	NA	NA	NA	ND	--	No	[d]	ND	--	No	[d]
Europium-154	0.0334	10.3	[d]	NA	NA	NA	NA	200	Yes	Yes	[d]	ND	No	No	No
Europium-155	0.0539	426	[d]	NA	NA	NA	NA	ND	No	No	[d]	ND	No	No	No
Neptunium-237	--	59.2	[d]	NA	NA	NA	NA	ND	--	No	[d]	ND	--	No	[d]
Nickel-63	--	3,070,000	[d]	NA	NA	NA	NA	ND	--	No	[d]	ND	--	No	[d]
Plutonium-238	0.00378	47.0	[d]	NA	NA	NA	NA	140	Yes	Yes	[d]	7.85	Yes	No	[d]
Plutonium-239/240	0.0248	425	[d]	70,200	Yes	--	[d]	153,000	Yes	Yes	[d]	159	Yes	No	[d]
Potassium-40	16.6	764	[d]	NA	NA	NA	NA	572	Yes	No	[d]	273	Yes	No	[d]
Radium-226	0.815	7.03	[d]	NA	NA	NA	NA	0.682	No	No	[d]	0.594	No	No	No
Radium-228	1.32	8.15	[d]	NA	NA	NA	NA	1.07	No	No	[d]	0.974	No	No	No
Total Radioactive Strontium	0.178	2,410	[d]	60,300	Yes	--	[d]	5,710,000	Yes	Yes	[d]	2,050	Yes	No	[d]
Technetium-99	--	412,000	[d]	NA	NA	NA	NA	32.9	--	No	[d]	1.9	--	No	[d]
Thorium-228	1.32	7.73	[d]	NA	NA	NA	NA	1.28	No	No	[d]	1.26	No	No	No
Thorium-230	1.1	NC	[d]	NA	NA	NA	NA	0.936	No	No	[d]	0.665	No	No	No
Thorium-232	1.32	4.8	[d]	NA	NA	NA	NA	0.86	No	No	[d]	0.621	No	No	No
Tritium	--	66,900	[d]	NA	NA	NA	NA	0.328	--	No	[d]	28.7	Yes	No	[d]
Total uranium (mg/kg)	3.21	10,500	3.2	NA	NA	NA	NA	346	Yes	No	[d]	32.5	Yes	No	Yes
Uranium-233/234	1.10	2,660	[d]	NA	NA	NA	NA	117	Yes	--	[d]	9.0	Yes	No	[d]
Uranium-235	0.109	101	[d]	NA	NA	NA	NA	0.586	Yes	--	[d]	ND	No	No	No
Uranium-238	1.06	504	[d]	NA	NA	NA	NA	108	Yes	--	[d]	6.35	Yes	No	[d]
Inorganic Metals (mg/kg)															
Aluminum	11,800	NC	45.2	NA	NA	NA	NA	9,630	No	NC	No[e]	7,830	No	NC	No[e]
Bismuth	--	NC	NC	NA	NA	NA	NA	3,300	--	NC	NC	ND	--	NC	NC
Cadmium	0.81	3,500	0.69	NA	NA	NA	NA	0.07	No	No	No	0.1	No	No	No
Calcium	17,200	NC	NC	NA	NA	NA	NA	11,900	No	No	No	9,610	No	No	No
Chromium (III)	18.5	5,250,000	2,000	NA	NA	NA	NA	142	Yes	No	No	14.5	No	No	No
Chromium, hexavalent	--	10,500	18.4	NA	NA	NA	NA	17.8	--	No	No	0.49	--	No	No
Copper	22	130,000	263	NA	NA	NA	NA	29.5	Yes	No	No	18.8	No	No	No
Iron	32,600	NC	1,320	NA	NA	NA	NA	34,900	Yes	NC	Yes	19,800	No	No	No

Table 3-4. 200-TW-2 Operable Unit Initial Screening. (3 Pages)

Contaminants of Concern	Screening Levels			216-B-5 Reverse Well				216-B-7A Crib				216-B-38 Trench			
	Background	Direct Exposure Screening Level (WAC 173-340-745 or 15 mrem)[a]	Groundwater Protection Screening Level (WAC 173-340-747)[b]	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level
Lead	10.2	1,000	3,000	NA	NA	NA	NA	349	Yes	No	No	8	No	No	No
Magnesium	7,060	NC	NC	NA	NA	NA	NA	6,460	No	No	No	4,580	No	No	No
Manganese	512	490,000	50.2	NA	NA	NA	NA	1,650	Yes	No	Yes	317	No	No	No[e]
Mercury	0.33	1,050	2.09	NA	NA	NA	NA	0.42	Yes	No	No	0.089	No	No	No
Nickel	19.1	70,000	130	NA	NA	NA	NA	66.6	Yes	No	No	22	Yes	No	No
Potassium	2,150	NC	NC	NA	NA	NA	NA	1,900	No	No	No	1,140	No	No	No
Silver	0.73	17,500	13.6	NA	NA	NA	NA	3.1	Yes	No	No	ND	No	No	No
Sodium	690	NC	NC	NA	NA	NA	NA	1,310	Yes	NC	NC	848	Yes	NC	NC
Vanadium	85.1	24,500	2,240	NA	NA	NA	NA	88.4	Yes	No	No	63.9	No	No	No
Zinc	67.8	1,050,000	5,970	NA	NA	NA	NA	127	Yes	No	No	54.9	No	No	No
General Inorganics (mg/kg)															
Ammonia	9.23	Unlimited	NC	NA	NA	NA	NA	21.3	Yes	No	NC	65.2	Yes	No	NC
Chloride	100	NC	NC	NA	NA	NA	NA	24.8	No	No	No	41.1	No	No	No
Cyanide	--	70,000	0.80	NA	NA	NA	NA	0.80	--	No	No	0.42	--	No	No
Fluoride	2.81	NC	16	NA	NA	NA	NA	205	Yes	NC	Yes	33.4	Yes	NC	Yes
Nitrate (as Nitrogen)	52	350,000	40	NA	NA	NA	NA	111	Yes	No	Yes	718	Yes	No	Yes
Nitrite (as Nitrogen)	--	350,000	4	NA	NA	NA	NA	ND	--	No	No	12.5	--	No	Yes
Phosphate	0.785	NC	NC	NA	NA	NA	NA	105	Yes	NC	NC	149	Yes	NC	NC
Sulfate	237	NC	1,000	NA	NA	NA	NA	185	No	No	No	248	Yes	NC	No
Volatile Organics (µg/kg)															
Acetone	--	350,000	3,210	NA	NA	NA	NA	13	--	No	No	NA	NA	NA	NA
Methylene chloride	--	17,500	254	NA	NA	NA	NA	17	--	No	No	NA	NA	NA	NA
Toluene	--	700,000	7,270	NA	NA	NA	NA	ND	--	No	No	NA	NA	NA	NA
Xylenes (total)	--	7,000,000	91,400	NA	NA	NA	NA	ND	--	No	No	NA	NA	NA	NA
Semi-volatile Organics (µg/kg)															
Aroclor-1254	--	70,000	990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzoic acid	--	Unlimited	257,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethyl-hexyl) phthalate	--	9,380,000	14,000	NA	NA	NA	NA	ND	--	No	No	NA	NA	NA	NA
Butylbenzylphthalate	--	Unlimited	893,000	NA	NA	NA	NA	ND	--	No	No	NA	NA	NA	NA
Chrysene	--	18,000	96	NA	NA	NA	NA	ND	--	No	No	NA	NA	NA	NA
Diethyl ether	--	NC	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	--	Unlimited	56,500	NA	NA	NA	NA	ND	--	No	No	NA	NA	NA	NA
Di-n-octylphthalate	--	Unlimited	532,000,000	NA	NA	NA	NA	ND	--	No	No	NA	NA	NA	NA

Table 3-4. 200-TW-2 Operable Unit Initial Screening. (3 Pages)

Contaminants of Concern	Screening Levels			216-B-5 Reverse Well				216-B-7A Crib				216-B-38 Trench			
	Background	Direct Exposure Screening Level (WAC 173-340-745 or 15 mrem)[a]	Groundwater Protection Screening Level (WAC 173-340-747)[b]	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level
Pentachlorophenol	--	109,000	115,000	NA	NA	NA	NA	ND	--	No	No	NA	NA	NA	NA
Phenol	--	Unlimited	43,900	NA	NA	NA	NA	ND	--	No	No	NA	NA	NA	NA
Pyrene	--	Unlimited	655,000	NA	NA	NA	NA	ND	--	No	No	NA	NA	NA	NA
Tributyl phosphate	--	NC	NC	NA	NA	NA	NA	ND	--	No	No	NA	NA	NA	NA

[a] Washington Administrative Code 173-340-745 "Soil Cleanup Standards for Industrial Properties," Method C for nonradiological contaminants. For radionuclides, the screening level is the concentration of the radionuclide that would result in a 15 mrem/yr dose under an industrial exposure scenario; these values were calculated using RESRAD.

[b] WAC 173-340-747 "Deriving Soil Concentrations for Ground Water Protection." These standards are for nonradiological contaminants and are based on WAC 173-340-720, "Ground Water Cleanup Standards," Method B. Protection of groundwater for radionuclides is evaluated through the RESRAD and STOMP modeling as presented in Chapters 4.0 and 5.0

[c] Background from DOE/RL-92-24, Hanford Site Soil Background; DOE/RL-96-12, Hanford Site Background: Part 2, Soil Background Values for Radioactive Analytes; or Ecology Publication 94-115, 1994, Natural Background Soil Metals Concentrations in Washington State.

[d] Groundwater protection for radionuclides is determined through modeling using RESRAD and STOMP as discussed in Chapters 4.0 and 5.0.

[e] The groundwater protection standard is less than the background concentration; therefore, the background concentration becomes the screening level for groundwater protection.

-- = no background concentration available for the Hanford Site or from the Washington State Department of Ecology (see footnote "c" above).

NA = not analyzed

NC = no criterion available

ND = not detected.

Table 3-5. 200-PW-5 Operable Unit Initial Screening. (3 Pages)

	Screening Levels			216-B-57 Crib			
Contaminants of Concern	Background	Direct Exposure Screening Level (WAC 173-340-745 or 15 mrem)[a]	Groundwater Protection Screening Level (WAC 173-340-747)[b]	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level
Radionuclides (pCi/g)							
Cesium-137	1.05	23.4	[d]	67,000	Yes	Yes	[d]
Cobalt-60	0.00842	4.9	[d]	ND	No	No	No
Plutonium-238	0.00378	47.0	[d]	0.012	Yes	No	[d]
Plutonium-239	--	425	[d]	0.01	--	No	[d]
Potassium-40	16.6	76.4	[d]	17.2	Yes	No	[d]
Radium-226	0.815	7.03	[d]	1.13	No	No	No
Total radioactive strontium	0.178	2,410	[d]	67	Yes	No	[d]
Technetium-99	--	412,000	[d]	60	Yes	--	[d]
Thorium-228	1.32	7.73	[d]	0.0096	No	No	No
Tritium	--	66,900	[d]	16	Yes	--	[d]
Uranium (total) (mg/kg)	3.21	10,500	61.1	2.53	No	No	No
Inorganic Metals (mg/kg)							
Aluminum	11,800	NC	45.2	7,610	No	No	No
Antimony	--	1,400	5.42	ND	--	No	No
Arsenic	20	87.5	340	3.2	No	No	No
Barium	132	245,000	923	88.6	No	No	No
Beryllium	1.51	280,000	63.2	0.45	No	No	No
Bismuth	--	NC	NC	ND	No	No	No
Cadmium	0.81	3,500	0.69	1.6	Yes	No	Yes
Calcium	17,200	NC	NC	9,450	No	No	No
Chromium (III)	18.5	5,250,000	2,000	11.3	No	No	No
Cobalt	15.7	NC	NC	8.6	No	No	No
Copper	22	130,000	263	42.7	Yes	No	No
Iron	32,600	NC	1,320	14,700	No	No	No
Lead	10.2	1,000	3,000	12.7	Yes	No	No
Magnesium	7,060	NC	NC	4,710	No	No	No
Manganese	512	490,000	50.2	457	No	No	No
Mercury	0.33	1,050	2.09	ND	No	No	No
Nickel	19.1	70,000	130	11	No	No	No
Potassium	2,150	NC	NC	1,290	No	No	No
Selenium	--	17,500	5.2	ND	No	No	No

Table 3-5. 200-PW-5 Operable Unit Initial Screening. (3 Pages)

	Screening Levels			216-B-57 Crib			
Contaminants of Concern	Background	Direct Exposure Screening Level (WAC 173-340-745 or 15 mrem)[a]	Groundwater Protection Screening Level (WAC 173-340-747)[b]	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level
Silver	0.73	17,500	13.6	2.3	Yes	No	No
Sodium	690	NC	NC	382	No	No	No
Thallium	--	245	38	0.44	--	No	No
Vanadium	85.1	24,500	2,240	24.2	No	No	No
Zinc	67.8	1,050,000	5,970	36.8	No	No	No
General Chemistry (mg/kg)							
Chloride	100	NC	NC	12.3	No	No	No
Cyanide	--	70,000	0.80	ND	No	No	No
Fluoride	2.81	NC	16	3.7	Yes	NC	No
Nitrate (as nitrogen)	52	350,000	40	479	Yes	No	Yes
Nitrite (as nitrogen)	2.81	350,000	4	2.5	No	No	No
Phosphate	0.79	NC	NC	12	Yes	NC	NC
Sulfate	237	NC	1,000	139	No	No	No
Volatile Organics (µg/kg)							
Acetone	--	350,000	3,210	26	--	No	No
Methylene chloride	--	17,500	254	110	--	No	No
Toluene	--	700,000	7,270	13	--	No	No
Xylenes (total)	--	7,000,000	91,400	ND	--	No	No
Semi-volatile Organics (µg/kg)							
Aroclor-1254	--	70,000	990	770	--	No	No
Benzoic acid	--	Unlimited	257,000	160	--	No	No
Bis(2-ethyl-hexyl) phthalate	--	9,380,000	14,000	2,700	--	No	No
Butylbenzylphthalate	--	Unlimited	893,000	1,400	--	No	No
Chrysene	--	18,000	96	40	--	No	No
Diethyl ether	--	NC	NC	40	--	NC	NC
Di-n-butylphthalate	--	Unlimited	56,500	3,000	--	No	No
Di-n-octylphthalate	--	Unlimited	532,000,000	270	--	No	No

Table 3-5. 200-PW-5 Operable Unit Initial Screening. (3 Pages)

	Screening Levels			216-B-57 Crib			
Contaminants of Concern	Background	Direct Exposure Screening Level (WAC 173-340-745 or 15 mrem)[a]	Groundwater Protection Screening Level (WAC 173-340-747)[b]	Maximum Concentration	Exceeds Background[c]	Exceeds Direct Exposure Screening Level	Exceeds Groundwater Protection Screening Level
Pentachloro-phenol	--	109,000	115,000	93	--	No	No
Phenol	--	Unlimited	43,900	ND	--	No	No
Pyrene	--	Unlimited	655,000	49	--	No	No

[a] *Washington Administrative Code* 173-340-745 "Soil Cleanup Standards for Industrial Properties," Method C for nonradiological contaminants. For radionuclides, the screening level is the concentration of the radionuclide that would result in a 15 mrem/yr dose under an industrial exposure scenario; these values were calculated using RESRAD.

[b] WAC 173-340-747 "Deriving Soil Concentrations for Ground Water Protection." These standards are for nonradiological contaminants and are based on WAC 173-340-720, "Ground Water Cleanup Standards," Method B. Protection of groundwater for radionuclides is evaluated through the RESRAD and STOMP modeling as presented in Chapters 4.0 and 5.0

[c] Background from DOE/RL-92-24, *Hanford Site Soil Background*; DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background Values for Radioactive Analytes*; or Ecology Publication 94-115, 1994, *Natural Background Soil Metals Concentrations in Washington State*.

[d] Groundwater protection for radionuclides is determined through modeling using RESRAD and STOMP as discussed in Chapters 4.0 and 5.0.

[e] The groundwater protection standard is less than the background concentration; therefore, the background concentration becomes the screening level for groundwater protection.

-- = no background concentration available for the Hanford Site or from the Washington State Department of Ecology (see footnote "c" above).

NA = not analyzed

NC = no criterion available

ND = not detected.

Table 3-6. Comparison of the 216-B-46 and 216-B-49 Cribs.

Site	Total Uranium (kg)	Total Plutonium (g)	Americium-241 (Ci)	Cesium-137 (Ci)	Strontium-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)	Effluent Volume (m^3)
216-B-46	1.90E+02	2.00E+01	-	8.89E+01	6.31E+02	4,000	1,200,000	6700
216-B-49	3.20E+02	1.50E+01	-	1.82E+02	1.14E+03	4,000	1,500,000	6700

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4.0 VADOSE ZONE CONTAMINANT FATE AND TRANSPORT MODELING

4.1 INTRODUCTION AND PURPOSE

The 200 Areas Remediation Project conducted vadose zone modeling to determine the fate and transport of contaminants identified for representative sites of the 200-TW-1 and 200-TW-2 OUs. The representative waste sites modeled in the 200-TW-1 were the 216-T-26 and 216-B-46 Cribs. The representative waste sites modeled in the 200-TW-2 OU were the 216-B-7A Crib and the 216-B-38 Trench. The 216-B-57 Crib in the 200-PW-5 OU was not modeled because this site was extensively evaluated in the 200-BP-1 OU RI/FS process and because a Hanford barrier has been constructed over the site. The 216-B-5 Reverse Well was not modeled because contaminants were injected directly into the aquifer and into the vadose zone near the aquifer.

The modeling was conducted to identify those contaminants identified during the RI that pose future risk to groundwater. The modeling evaluates whether the contaminants migrating from the waste sites will reach groundwater before decaying or attenuating, and estimates potential future concentrations in groundwater. The modeling results also may assist in determining the remediation strategy and establishing criteria for cleanup.

4.2 MODELING METHODOLOGY

The modeling effort used the STOMP version 2.0 finite difference code developed by PNNL to conduct the simulations. Description of the STOMP code is found in PNNL-11217, *STOMP Subsurface Transport Over Multiple Phases Theory Guide*; PNNL-12034, *STOMP Subsurface Transport Over Multiple Phases User's Guide*; and PNNL-11216, *STOMP Subsurface Transport Over Multiple Phases Application Guide*. Quantitative predictions of hydrogeologic flow and contaminant transport are generated from the numerical solution of nonlinear partial differential equations that describe subsurface environment flow and transport phenomena. The STOMP code capabilities include (among others) the simulation of saturated and unsaturated flow regimes, transport of radioactive elements and nondecaying contaminants, and transport of aqueous phase and nonaqueous phase organic compounds. A complete description of STOMP capabilities and the actual equations and the partial differential approximations are contained within the Theory Guide (PNNL-11217) and the User's Guide (PNNL-12034).

The models constructed to simulate the 200-TW-1 and 200-TW-2 OU representative waste sites are two-dimensional vertical cross-section representations of the actual physical systems. For the 216-B-38 Trench, the horizontal grid consisted of 65 nonuniform cells with increasing resolution toward the center of the domain. The vertical grid consisted of 131 0.6 and 0.7 m (2 and 2.3 ft) cells. For the 216-B-46 Crib, the horizontal grid consisted of 30 uniform cells 3 m (10 ft) in length. The vertical grid consisted of 103 0.6 and 0.7 m (2 and 2.3 ft) cells. For the 216-B-7A Crib, the horizontal grid consisted of 50 uniform cells 2 m (6.6 ft) in length. The vertical grid consisted of 93 0.7 and 0.8 m (2.3 and 2.6 ft) cells with three additional cells of 1.4, 2.1, and 5.8 m (4.6, 6.9, and 19 ft) deeper in the aquifer. For the 216-T-26 Crib, the horizontal grid consisted of 70 uniform cells of 3 m (10 ft) in length. The vertical grid consisted of 110 uniform 0.6 m (2 ft) cells, with two additional cells of 1.2 and 5.8 m (3.9 and 19 ft) deeper in the aquifer.

Model conceptualizations and input parameters were developed on the basis of historical information and data collected during the RI. The representative waste sites located in the 200 East Area possess simple horizontal hydrogeologic layers. The geology observed in the characterization boreholes installed within the waste sites did not indicate the presence of significant impermeable layers or fine-grained units that would result in greatly enhanced lateral spreading of the contaminants. The silty Hanford formation/Plio-Pleistocene (?) unit is present beneath the 216-B-7A Crib. However, hydraulic testing of soil samples indicated that its vertical hydraulic conductivity is on the same order of magnitude as that of the other geologic units present in the vadose zone. Therefore, for this analysis, assuming contaminant transport occurs primarily vertically provides an adequate estimation of the contaminant fate and transport and impact to the aquifer. In the 200 West Area, several fine units, as well as the caliche layer associated with the Plio-Pleistocene unit, slope southward in the vadose zone. Therefore, the 216-T-26 Crib model includes the effects of the sloping layers on lateral spreading in the evaluation.

Once the conceptual contaminant distribution models had been translated into numerical form, the model domains were established in hydraulic steady state to provide initial conditions for the onset of waste site operations. Hydraulic steady state refers to the condition that soil moisture content and soil moisture movement remain constant through time. Conducting the steady-state modeling provides initial conditions for the transient simulations.

A period representing the operational life of the facility to the present was simulated to provide initial hydraulic conditions and contaminant distributions for the fate and transport modeling. The volume of wastewater discharged into the facilities created artificially high moisture contents and elevated water tables below the facilities. Including the operational history of the facilities allowed the model to account for the enhanced drainage and recharge expected to occur even after wastewater disposal to the facilities ceased.

Including the operational history of the facilities also allowed the models to consider the contaminant concentration data collected during the RI phase in a manner compatible with the mathematics of the numerical model. The mobile contaminants (i.e., those with low distribution coefficients [k_ds]) would be expected to reach groundwater shortly after discharge began and to remain more widespread, whereas those adsorbing to the soil (i.e., those with high k_ds) should be retained in the vadose zone above the water table. To determine the spatial distribution of the contaminants in the vadose zone, the contaminants were input to the model as unit inventories. The resulting distribution of contaminants from the model of the operational period then was scaled to match the sampling results collected during the remedial investigation. The sampling results provided the magnitude of the concentrations in the vadose zone, and the model results provided the basis for the spatial distribution. The models then simulated the movement and concentration of these contaminants for 1,000 yr into the future. Figures showing the comparison of the model input contaminant distributions and the measured data are presented in Appendix D.

The scaling of the modeled concentration results also provides a basis for estimating the inventory of contaminants discharged at the facilities. The transport and distribution of mobile contaminants is not as affected by adsorption in the vadose zone. The modeled results scaled to the sampling data provide a reasonable estimate of the pore water concentrations, and hence the source concentration necessary to create them. The inventory estimates for the contaminants with greater adsorbing characteristics become more problematic. The quantity of contaminants

and the magnitude of the concentrations remaining in the vadose zone are highly dependent on the contaminant adsorption characteristics. The model uses a constant linear representation (the contaminant k_d) to describe the adsorption characteristics. In the actual vadose zone, the contaminant distribution coefficient may vary spatially and temporally because of changing chemical conditions. Therefore, while the inventory estimates for the mobile constituents may be somewhat reliable, those for the adsorbing contaminants may not be reliable.

4.3 REPRESENTATIVE SITE INFORMATION AND HYDRAULIC PROPERTIES GEOLOGY

Boreholes installed during the RI and boreholes and wells installed during the operational life of the facilities provided information to identify the geologic units present and to construct the cross-sections at each representative waste site. The geologic units and formations identified at the 216-B-46 Crib, the 216-T-26 Crib, the 216-B-7A Crib, and the 216-B-38 Trench are discussed in detail in Chapter 3.0. Figures 3-2 through 3-6 show the vertical cross sections developed to describe the geology near these waste sites and serve as the framework for the model.

4.4 SOIL HYDRAULIC PROPERTIES AND CONTAMINANT SOIL INTERACTION CHARACTERISTICS

Soil hydraulic properties for the different geologic units were developed from the existing database of moisture retention and unsaturated hydraulic conductivity data available at the Hanford Site (WHC-EP-0883, *Variability and Scaling of Hydraulic Properties for 200 Area Soils, Hanford Site*). In general, soil hydraulic properties describe the amount of water that the soil is capable of containing, the capillary pressure at which the soil retains a certain quantity of water, and the rate at which water is capable of moving through the soil. Capillary pressure refers to the suction exerted by the soil to hold water in place. Measurable properties of interest are the soil bulk density, soil saturated moisture content (or porosity), moisture content as a function of capillary pressure, and hydraulic conductivity as a function of soil moisture.

Moisture retention characteristic curves may be derived that describe the data in terms of an analytical equation. The characteristic curves allow the relationship to be expressed for the entire continuum of values, which is a necessity of modeling. Moisture content often is expressed in terms of the saturation, which is the amount of water contained by the soil relative to the amount that the soil could contain:

$$S_w = \left[\frac{\Theta_w - \Theta_r}{\Theta_s - \Theta_r}\right]$$

where:

S_w = degree of water saturation of the porous media (dimensionless)
Θ_w = moisture content of the soil (dimensionless)
Θ_s = saturated moisture content of the soil (dimensionless)
Θ_r = residual moisture content of the soil (dimensionless).

The residual moisture content refers to the absolute minimum amount of water retained by the soil regardless of the amount of applied pressure. The residual moisture content is not really measurable, but is determined through the curve-fitting process.

The van Genuchten equation frequently is applied to express the saturation in terms of the soil capillary pressure and three fitted variables:

$$S_w = \{1 + (\alpha[\frac{P_g - P_w}{\rho_w g}])^n\}^{-m} \quad for\ P_g - P_w > 0 \quad i.e.,\ unsaturated\ conditions$$

$$S_w = 1 \quad for\ P_g - P_w \leq 0 \quad i.e.,\ saturated\ conditions$$

where:

P_g = absolute pressure of the gas phase present (Pa, usually atmospheric pressure when the gas phase is air)

P_w = absolute pressure of the water phase present (Pa)

$P_g - P_w$ = capillary pressure of the soil on the water phase present (Pa)

ρ_w = density of water (kg/m^3)

g = acceleration of gravity (m/s^2)

α (1/m), n, and m are curve fit parameters, m = 1 - 1/n

S_w is defined as before.

The Mualem equation describes hydraulic conductivity as a function of saturation:

$$k_{rw} = (S_w)^{1/2}\{1 - (1 - [S_w]^{1/m})^m\}^2$$

and

$$K = k_{rw} * K_{sat}$$

where:

K = soil permeability (cm^2) or hydraulic conductivity (cm/s)
k_{rw} = relative permeability or hydraulic conductivity
K_{sat} = saturated permeability (cm^2) or saturated hydraulic conductivity (cm/s)
S_w and m are defined as before.

The characterization effort conducted at the 200-TW-1 and 200-TW-2 OU representative sites produced detailed descriptions of the local geology (BHI-01606, BHI-01607) (Figures 3-4, 3-5 and 3-6). Unsaturated hydraulic data were collected for much of the Hanford Site; these data are summarized in WHC-EP-0883. WHC-EP-0883 included the development of statistical distributions for six general soil types. The characterization effort conducted at the 200-TW-1 and 200-TW-2 OU representative sites identified more than the six soil types described by WHC-EP-0883, so the statistical distributions served as the basis for determining the hydraulic properties used in this report. Soil hydraulic properties used in the models were kept within two standard deviations of the mean presented in WHC-EP-0883, unless an appropriate soil type match was not available. In those cases, properties were determined from the closest soil type available and were extrapolated according to the expected characteristics of the soil type.

Table 4-1 presents the soil hydraulic properties and fitted curve parameters for the geologic units identified at the 200-TW-1 and 200-TW-2 OU representative sites.

4.5 CONTAMINANTS

Contaminant data collected from the investigation boreholes provided information identifying the contaminants present and describing the distribution of the contaminants at the waste sites. The contaminants modeled at the 200-TW-1 OU representative sites include americium-241, europium-154/155, cesium-137, cobalt-60, cyanide, nitrate, nitrite, plutonium-238/239/240, radium-226, strontium-90, sulfate, technetium-99, tritium, and uranium-233/234/235/238. The contaminants modeled at the 200-TW-2 OU representative sites include americium-241, carbon-14, cesium-137, cobalt-60, europium-154, fluoride, nitrate, plutonium-238/239/240, potassium-40, radium-228, strontium-90, technetium-99, tritium, and uranium-233/234/235/238. Figures 3-10, 3-14, 3-23, and 3-27 contain one-dimensional contaminant distribution profiles summarizing the findings of the investigations for the 216-B-46 Crib, the 216-T-26 Crib, the 216-B-7A Crib, and the 216-B-38 Trench, respectively.

Distribution coefficient estimates for the contaminants initially were derived from the "Best Estimate" lists in PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, for Zone G Category for the 200-TW-1 OU representative sites and for Zone E Category for the 200-TW-2 OU representative sites. Zone G represents tank waste-type liquids with organic chelating or complexing agents, located near the disposal facility inlet or ground surface where the liquid phase is greatly affected by the chemical composition of the contaminant liquid source. Zone E represents tank waste-type liquids and waste associated with small tanks, lines, pits, and boxes, located away from the disposal facility where the excessive acidic or basic nature of the waste has been neutralized by the buffering capacity of the soil. In addition to the waste type and chemistry, distribution coefficient values are affected by the characteristics of the contaminant and how they interact with the subsurface environment. To account for these varying characteristics that are difficult to quantify, the modeling included a simulation period representing the time from waste disposal to the RI/FS data collection effort. Contaminant curves produced by the modeling were compared to the data collected during the remedial investigation. In those cases where the "Best Estimate" distribution coefficient resulted in a contaminant distribution profile inconsistent with the data, the distribution coefficient was revised to be more consistent with the data. Distribution coefficients used in the modeling are shown in Table 4-2.

4.6 RESULTS OF FATE AND TRANSPORT MODELING

4.6.1 216-T-26 Crib

The results of the fate and transport modeling of unsaturated zone contamination during the period representing 1955 to 2000 show the effects of the sloping fine-grained geologic units on the lateral transport of the contaminants (Figure 4-1). The contaminants extend substantially in the direction of the slope of the geologic units of the vadose zone, but the highest concentrations still appear to occur directly beneath the facility. The greatest amount of transport occurs beneath the facility, because as the contaminants move laterally away from the facility, the

hydraulic pressure head lessens, thus lessening the downward hydraulic gradient. The actual downward path of the contaminants may be deflected by the geologic layering, and the lateral transport certainly affects the location and the extent of contamination in the vadose zone. However, using the vertical cross-sectional model to evaluate the impacts to groundwater appears to provide an adequate prediction of the expected maximum concentrations in groundwater in the future.

Based on the results of the 216-T-26 Crib modeling, cyanide, nitrate, nitrite, technetium-99, and uranium-233/234/238 are predicted to reach the groundwater with concentrations exceeding their respective maximum contaminant levels (MCL). Tritium reaches the groundwater, but at concentrations below the MCL. None of the other contaminants reach the groundwater at measurable concentrations during the 1,000-yr simulation period. Figures 4-2 through 4-4 present breakthrough curves for the mobile contaminants. The other radionuclide contaminants are rather immobile in the environment, so none travel much beyond their current location. Cesium-137, the europium isotopes, plutonium-238, and strontium-90 have relatively short half-lives and decay below detectable limits before they would be expected to reach the water table at measurable concentrations. They are not expected to be present anywhere in the vadose zone in appreciable quantity in 1,000 yr. Americium-241 and plutonium-239/240 are expected to remain in the environment, but these radionuclides tend to bind to soil particles and remain fixed, even though their relatively long half-lives result in long residency in the vadose zone.

Cyanide, nitrate, nitrite, and technetium-99 are predicted to reach the groundwater at concentrations exceeding their MCLs within about 150 yr from the present (yr 2000). The concentrations of the mobile contaminants attenuate below the MCLs within 200 yr, except cyanide, which attenuates below its MCL in about 250 yr. In fact, the modeling results representing the operational period of the facility to the present indicate that high concentrations of the mobile contaminants would have arrived in the groundwater shortly after discharge began at that facility and would remain fairly evenly distributed throughout the vadose zone. However, the sampling results showed nitrate (as nitrate) at concentrations below 10 mg/kg from 50 to 60 m (164 to 197 ft) bgs, compared to 660 mg/kg at a depth of 45 m (148 ft) and 3,070 mg/kg at a depth of about 30 m (98 ft) bgs. Elevated levels of nitrate have been measured in the groundwater around this facility for several years. On the basis of the modeling, the vadose zone sampling data, and the long-term groundwater monitoring data, the nitrate in the vadose zone now is not expected to increase the concentrations currently observed in groundwater, but may be an artifact of the nitrate that caused the high concentrations currently observed.

The uranium isotopes peak in concentration after about 600 yr. The concentrations of the uranium-233/234 and uranium-238 isotopes remain above the MCLs after 1,000 yr, but the concentrations are decreasing at the end of the simulation period. The plutonium-239 concentration exceeds the MCL in about 800 yr, and the concentration is increasing at the end of the simulation period.

4.6.2 216-B-46 Crib

The results of the 216-B-46 Crib modeling indicate that all of the mobile contaminants, except tritium and nitrite, are expected to reach the groundwater with concentrations exceeding their MCLs. The list of mobile contaminants at the 216-B-46 Crib includes uranium-238, cobalt-60, and radium-226, which usually experience some sorption during transport in the environment. The maximum predicted concentrations of cyanide and nitrite (as nitrite) (0.0.54 and 0.35 mg/L,

respectively) are either close to or below the MCLs for those contaminants (0.2 and 1.6 mg/L as nitrogen [7.1 mg/L as nitrate], respectively). The other less mobile contaminants (cesium-137, strontium-90, plutonium-239, and uranium-238) also reach the groundwater, but at concentrations that are essentially undetectable (less than 1.0 E-06 pCi/L). None of the other contaminants of concern reach the groundwater with concentrations exceeding their MCLs during the 1,000-yr simulation period. Uranium-238 appears to first break through almost immediately, although the peak concentration does not occur until the end of the simulation period, when the concentration appears to be stabilizing. Figures 4-5 through 4-8 present breakthrough curves for the mobile contaminants. Cesium-137, plutonium-238, and strontium-90 have relatively short half-lives and decay below detectable limits before they would be expected to reach the water table in any appreciable quantity. They are not expected to be present anywhere in the vadose zone in appreciable quantity in 1,000 yr. Americium-241 is expected to remain in the environment, but is not expected to travel much beyond its current location. This radionuclide tends to bind to soil particles and remain fixed, even though its relatively long half-life results in long residency in the vadose zone. Except for the contaminants known to be mobile in the environment, none of the contaminants associated with the 216-B-46 Crib discharges have been detected in the groundwater. Part of the reason for the high resulting concentrations in groundwater is that the aquifer is thin around the 216-B-46 Crib, and the water table is declining. The saturated thickness observed in this area may not be naturally occurring, but may be a consequence of the past liquid discharges. As the water table continues to decline, contaminants may be stranded in the vadose zone where the artificial aquifer used to be, and may not actually pose a threat to groundwater during the 1,000-yr simulation time.

Cyanide, cobalt-60, nitrate, and technetium-99 are predicted to reach the groundwater with concentrations exceeding their MCLs almost immediately. In fact, the modeling results representing the operational period of the facility to the present indicate that high concentrations of cyanide, cobalt-60, nitrate, and technetium-99 would have arrived in the groundwater shortly after discharge began at that facility and would remain throughout the vadose zone. The contaminant concentrations attenuate below the MCLs within 200 yr. The sampling results showed cyanide occurring at levels mostly below the detection limit, with only two results above the detection limit (3.18 and 1.5 mg/kg). Elevated levels of nitrate (generally greater than 3,000 mg/kg as nitrate) and technetium-99 (generally greater than 100 pCi/g) were measured consistently and continually from about 8 m (26 ft) bgs to the water table. Elevated levels of cyanide, nitrate, and technetium-99 have been measured in the groundwater around this facility for several years. The cyanide, cobalt-60, nitrate, and technetium-99 in the vadose zone now are not expected to increase the concentrations currently observed in groundwater, but appear to be an artifact of the discharges that caused the high concentrations currently observed.

4.6.3 216-B-7A Crib

Based on the results of the 216-B-7A Crib modeling, fluoride, nitrate, and uranium-233/234/238 are predicted to reach the groundwater with concentrations exceeding their MCLs. The maximum predicted concentration of technetium-99 (230 pCi/L) is below the MCL (900 pCi/L). Tritium is predicted to reach the groundwater, but at a resulting concentration below the MCL. None of the other contaminants reach the groundwater at measurable concentrations during the 1,000-yr simulation period. Figures 4-9 through 4-12 present breakthrough curves for the mobile contaminants. The other radionuclide contaminants are rather immobile in the environment, so

none travel much beyond their current location. Cesium-137, europium-154, and plutonium-238 have relatively short half-lives and decay to below detectable limits long before they would be expected to reach the water table. They are not expected to be present anywhere in the vadose zone in appreciable quantities in 1,000 yr. Americium-241, potassium-40, and plutonium-239/240 are expected to remain in the environment, but are not expected to travel much beyond their current location. The concentrations predicted to occur in groundwater are below detection. These radionuclides tend to bind to soil particles and remain fixed, even though their relatively long half-lives result in long residency in the vadose zone. Except for the contaminants known to be mobile in the environment, strontium-90, and the uranium isotopes, which tend to be somewhat variable in their mobility, none of the contaminants associated with the 216-B-7A Crib discharges have been detected in the groundwater. None of these contaminants are expected to pose a threat to groundwater during the 1,000-yr simulation time.

Nitrate and technetium-99 reach the groundwater with concentrations exceeding their MCLs almost immediately, while the uranium isotopes (uranium-233/234/238) require more than 100 yr to reach the water table. The modeling results representing the operational period of the facility to the present indicate that high concentrations of nitrate and technetium-99 would have arrived in the groundwater shortly after discharge began at that facility and would remain throughout the vadose zone. Relatively low levels of nitrate (generally less than 150 mg/kg as nitrate) were measured consistently from just below ground surface to a depth of 30 m (98 ft) bgs. The two deepest soil samples collected (46 and 68 m [151 and 223 ft] bgs) exhibited the highest concentrations (493 and 263 mg/kg, respectively. The sampling results showed technetium-99 occurring at levels mostly below the detection limit, with only three results above the detection limit (32.9, 4.27, and 1.56 pCi/g), collected between 5.5 and 8.4 m (18 and 27.5 ft) bgs. The elevated levels of the uranium isotopes (117 pCi/g of uranium-233/234 and 108 pCi/g of uranium-238) appear to be contained at about 9 to 10 m (29.5 to 33 ft) bgs. The model results predict the peak strontium-90 groundwater concentration to occur about 270 yr into the future, but then to decay below the drinking water standard in about 480 yr. The stronium-90 soil concentration data showed almost all of the strontium-90 contained within the top 18 m (59 ft) of the vadose zone, so the exceptionally low distribution coefficient necessary to result in strontium-90 reaching the groundwater does not appear to be applicable to this waste site. Elevated levels of nitrate, technetium-99, and uranium have been measured in the groundwater around this facility for several years. The amounts of nitrate and technetium-99 in the vadose zone now are not expected to increase the concentrations currently observed in groundwater, but may be an artifact of the discharges that caused the high concentrations currently observed.

4.6.4 216-B-38 Trench

Based on the results of the 216-B-38 Trench modeling, nitrate, nitrite, and uranium-233/234/238 are predicted to reach the groundwater with concentrations exceeding their MCLs. The other mobile contaminants (fluoride, technetium-99, and tritium) are predicted to reach the groundwater, but at resulting concentrations below their respective MCLs. Potassium-40 and strontium-90 are not predicted to reach the groundwater. None of the other contaminants are predicted to reach the groundwater at measurable concentrations during the 1,000-yr simulation period. Figures 4-13 through 4-15 present breakthrough curves for the mobile contaminants. The other radionuclide contaminants are rather immobile in the environment, so none travel much beyond their current location. Cesium-137 and plutonium-238 have relatively short

half-lives and decay below detectable limits before they would be expected to reach the water table. They are not expected to be present anywhere in the vadose zone in appreciable quantities within 1,000 yr. Americium-241 and potassium-40 are expected to remain in the environment, but are not expected to travel much beyond their current location. These radionuclides tend to bind to soil particles and remain fixed, even though their relatively long half-lives result in long residency in the vadose zone. Except for the contaminants known to be mobile in the environment and the uranium isotopes, which tend to be somewhat variable in their mobility, none of the contaminants associated with the 216- B-38 Trench discharges have been detected in the groundwater. None of these contaminants are expected to pose a threat to groundwater during the 1,000-yr simulation time.

In the model simulation, nitrate and nitrite reach the groundwater with concentrations exceeding their MCLs almost immediately. The modeling results representing the operational period of the facility to the present indicate that high concentrations of nitrate and nitrite would have arrived in the groundwater shortly after discharge began at that facility and would remain throughout the vadose zone. Elevated levels of nitrate (generally greater than 2,000 mg/kg as nitrate) were measured between 15 and 46 m (49 and 151 ft) bgs, with the concentration decreasing to 58 and 1.5 mg/kg as nitrate in the two deepest samples (60 and 81 m [197 and 266 ft] bgs, respectively). The soil sampling results showed technetium-99 occurring at levels mostly below the detection limit. Only three results were above the detection limit, and all three of those measured less than 2 pCi/g. Elevated levels of nitrate and technetium-99 have been measured in the groundwater around this facility for several years. The amounts of nitrate, nitrite, and technetium-99 in the vadose zone now are not expected to increase the concentrations currently observed in groundwater. The nitrate and nitrite appear to be artifacts of the discharges that caused the high concentrations currently observed, but the technetium-99 levels do not appear to be indicative of the levels necessary to cause the plume currently observed.

Additional vadose zone modeling pertinent to the 216-B-38 Trench evaluated the effectiveness of surface barriers in reducing the risk from previous tank farm leaks. That modeling included nitrate, technetium-99, and uranium-238 in evaluating the possible effects of tank leakage and water line leaks intermingling with the contaminants disposed of to the trench. The vadose zone models are similar in construction, but include some differences because of different approaches and purposes for the RI/FS evaluation of the 200 Areas Remediation Project. The representative waste site approach resulted in the collection of precise site-specific hydrogeologic and contaminant data at the waste sites to be included in the models. The purpose of the RI/FS modeling is to establish or evaluate the need for remedial measures at all of the waste sites within the 200-TW-1 and 200-TW-2 OUs by evaluating the impacts of the representative waste sites on the aquifer.

The results of both modeling efforts indicated similar conclusions: nitrate and technetium-99 would appear in the aquifer soon after discharge to the trench began, and the uranium isotopes would not arrive at the water table for several hundred years, if at all. PNNL-13949, *2002 Initial Assessments for B-BX-BY Field Investigation Report (FIR): Numerical Simulations*, modeling indicated that the nitrate and technetium-99 concentrations would peak around 2020 to 2030. The results of the RI/FS model show the peaks occurring somewhat sooner; the differences are attributable to different recharge assumptions and surface barrier effects. PNNL-13949 modeling indicated that the uranium isotopes would not reach the water table during the 1,000-yr simulation period, which is different from the results of this model. However, that modeling

included the effects of a surface barrier installed in either 2010 or 2040 that reduced infiltration to 0.1 mm/yr for 5,000 yr and to 3.5 mm/yr, thereafter. The current modeling included no barrier and a recharge rate of 14.4 mm/yr, which is considered representative of stabilized backfill at the surface. The modeling conducted for this RI report is meant to describe existing conditions. Additional modeling to evaluate the effectiveness of potential remedial actions will be considered in the FS.

4.7 CONCLUSIONS

The results of the modeling indicate that the known mobile contaminants (cyanide, cobalt-60, nitrate, nitrite, sulfate, technetium-99, and uranium isotopes) already observed in the groundwater are expected to continue to impact groundwater, but are not expected to increase concentrations already observed in the aquifer. The effects of the mobile contaminants remaining in the vadose zone are not expected to exacerbate existing groundwater conditions, but appear to be artifacts of the discharges that caused the existing groundwater plumes.

The modeling indicates that certain of the other long-lived contaminants (plutonium-239 and radium-226) also may reach the groundwater at concentrations exceeding their MCLs in the future. The soil concentration data showed almost all of the low-mobility but long-lived contaminants contained near the bottom of the waste sites and within the top 18 m (59 ft) of the vadose zone. The soil sampling data collected at the 216-B-46 Crib, the only representative waste site where radium-226 was identified as a contaminant of concern, indicated the presence of radium to a depth of almost 30 m (98 ft), but at a concentration of less than 1 pCi/g. One pCi/g is very close to Hanford Site background levels, and radium-226 has not been detected in groundwater monitoring wells located within 200 m (656 ft) of the crib.

The Tank Waste Remediation System and the Immobilized Low-Activity Waste programs assigned distribution coefficients of 10 mL/g and 40 mL/g, respectively, to the plutonium isotopes (PNNL-11800). The model and soil contaminant distribution match indicated that a distribution coefficient greater than the Category G "Best Estimate" of 3 mL/g and greater than the 5 mL/g used in the current model appears to be more representative of the contaminant mobility. The exceptionally low distribution coefficients ("Best Estimate" Category G) for the low-mobility but long-lived contaminants necessary to result in their reaching the groundwater do not appear to be applicable to the waste site modeling. Contaminants with distribution coefficients consistent with their actual distribution near the bottom of the waste sites are more likely to remain in place as they decay rather than travel to the groundwater.

Figure 4-1. Cross Section Contaminant Distribution Representing the Spread of a Contaminant in the Vadose Zone with a Distribution Coefficient of 1 mL/g.

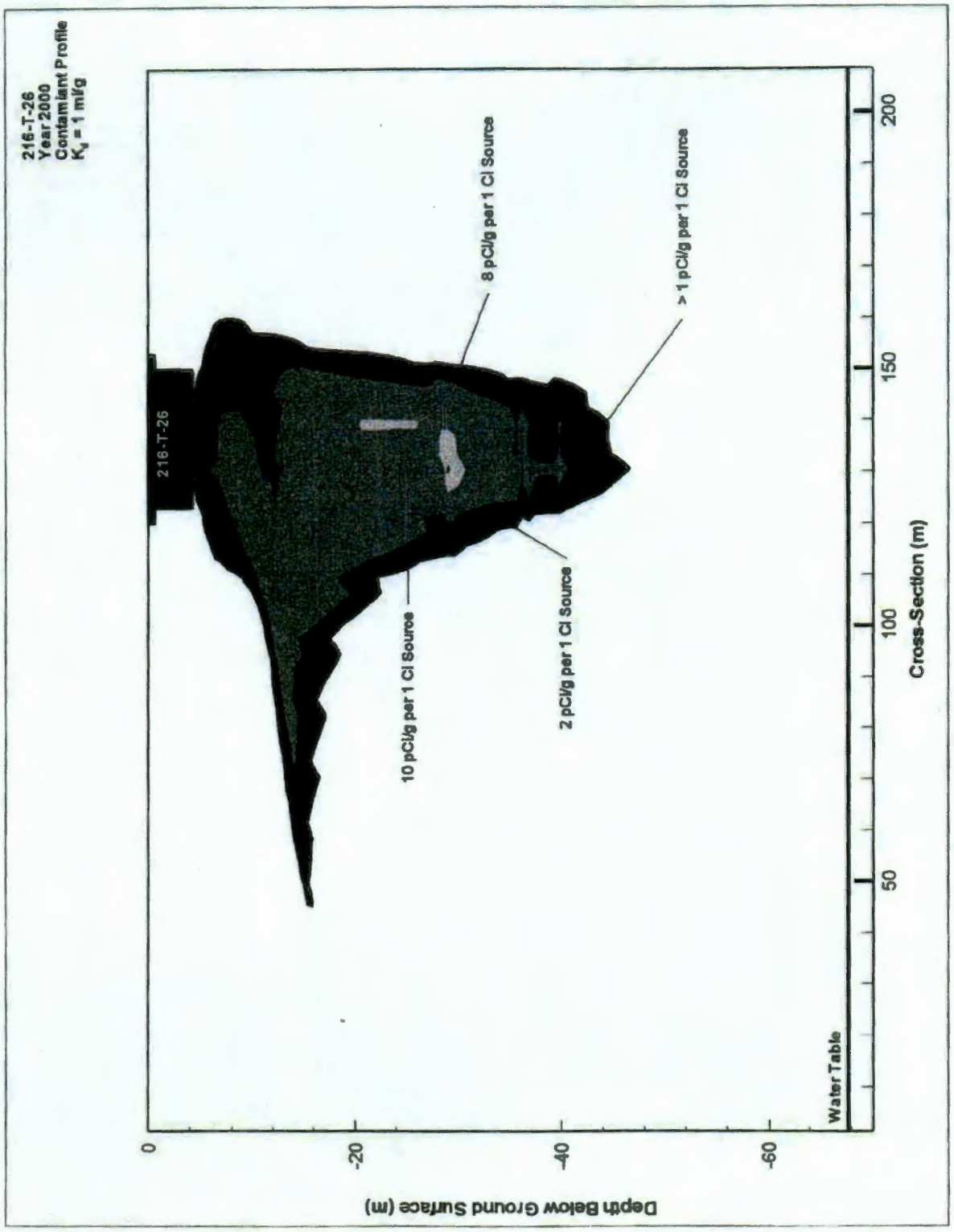

Figure 4-2. Contaminant Breakthrough Curves in Groundwater for Hydrogen-3 and Technetium-99 at the 216-T-26 Crib.

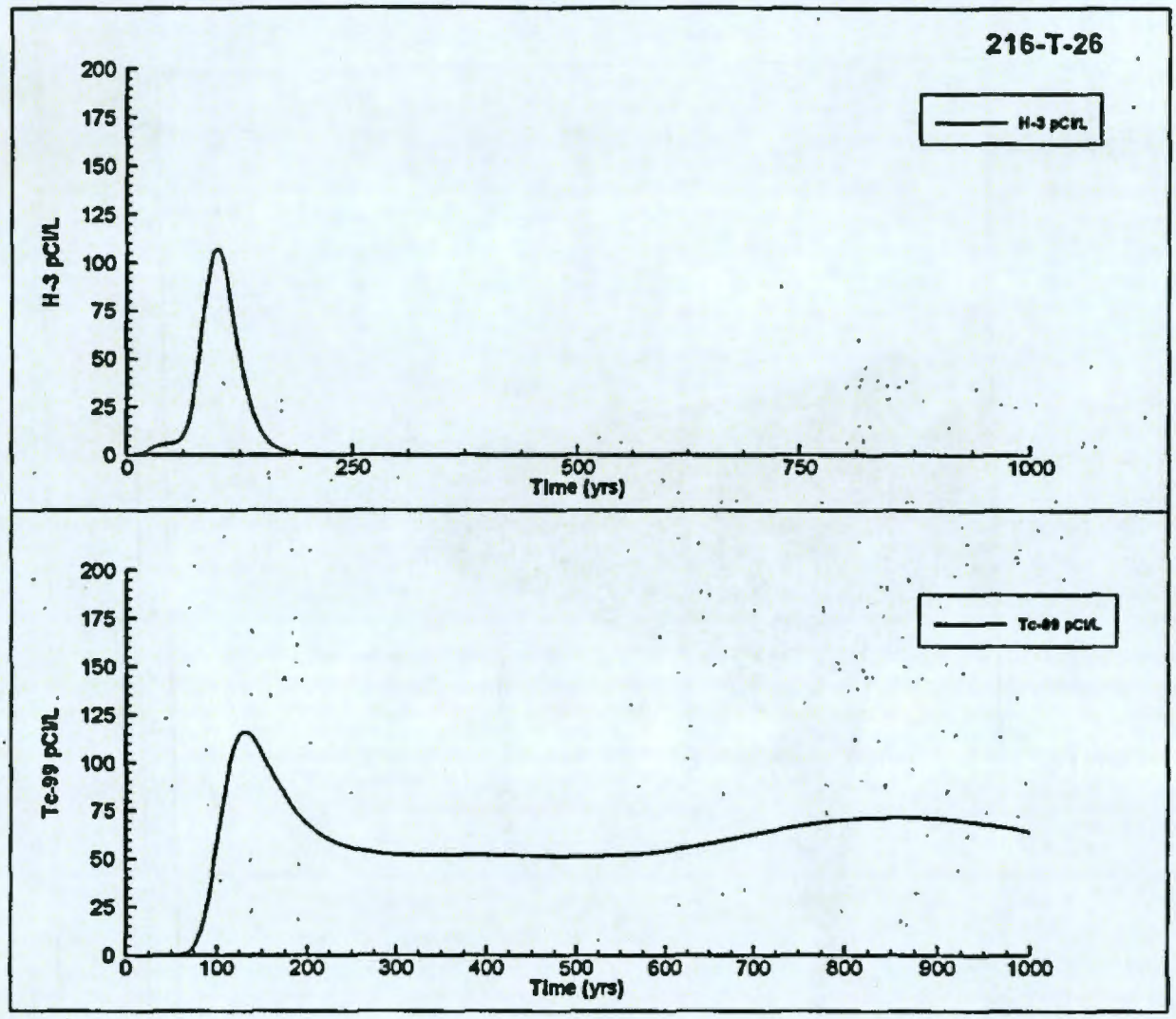

Figure 4-3. Contaminant Breakthrough Curves in Groundwater for Uranium-233/234, Uranium-235, and Uranium-238 at the 216-T-26 Crib.

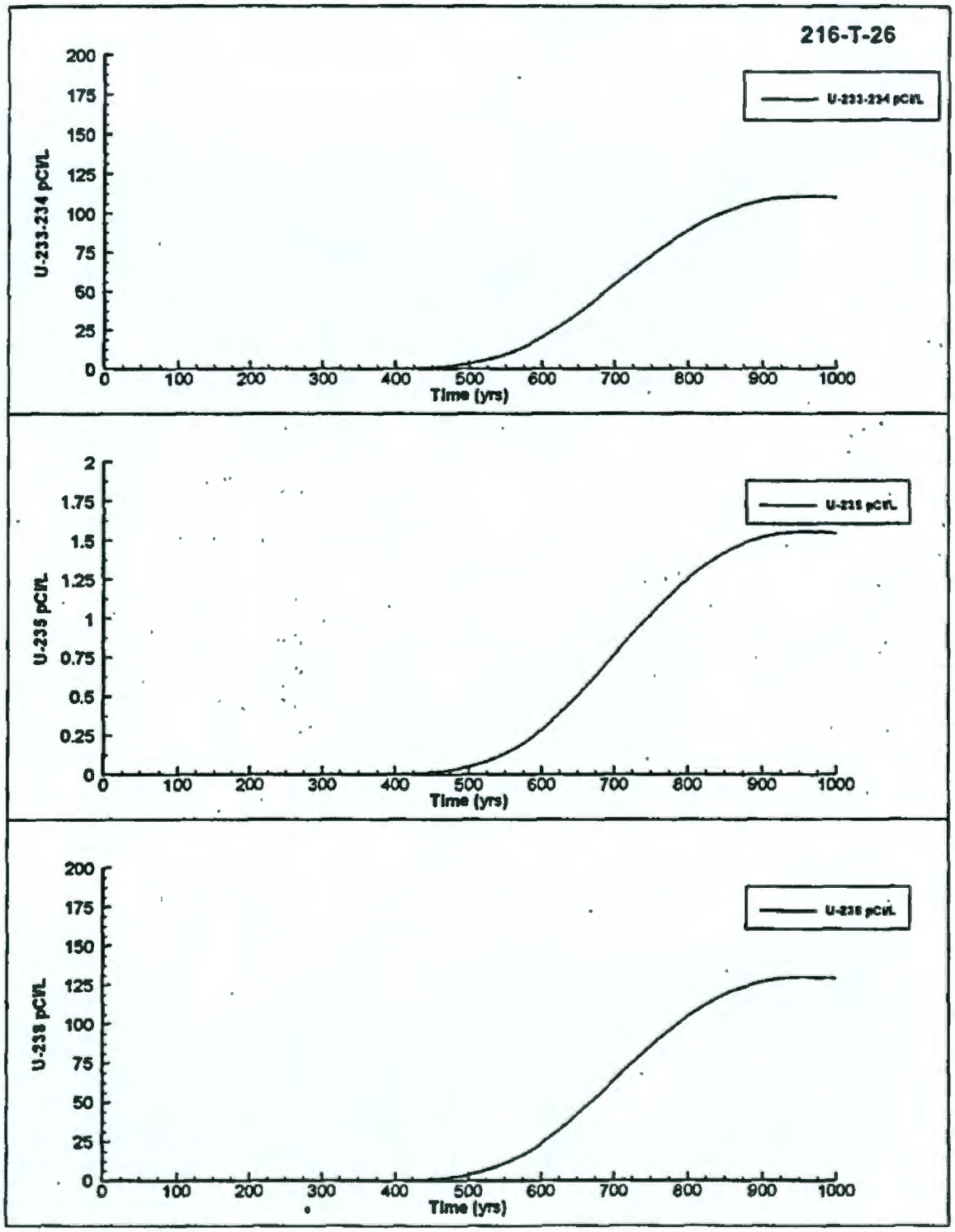

Figure 4-4. Contaminant Breakthrough Curves in Groundwater for Nitrate, Nitrite, and Cyanide at the 216-T-26 Crib.

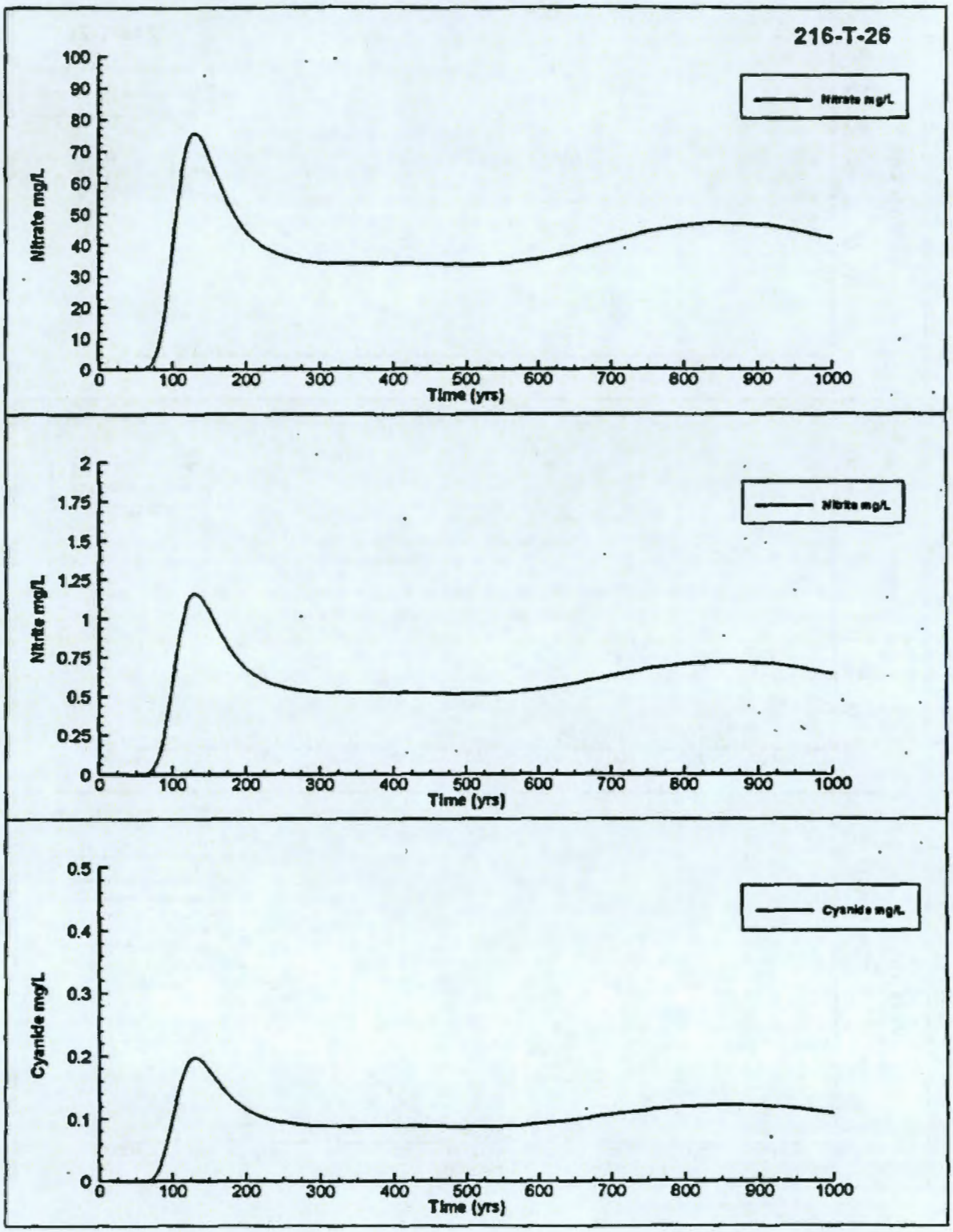

Figure 4-5. Contaminant Breakthrough Curves in Groundwater for Nitrate, Nitrite, and Sulfate at the 216-B-46 Crib.

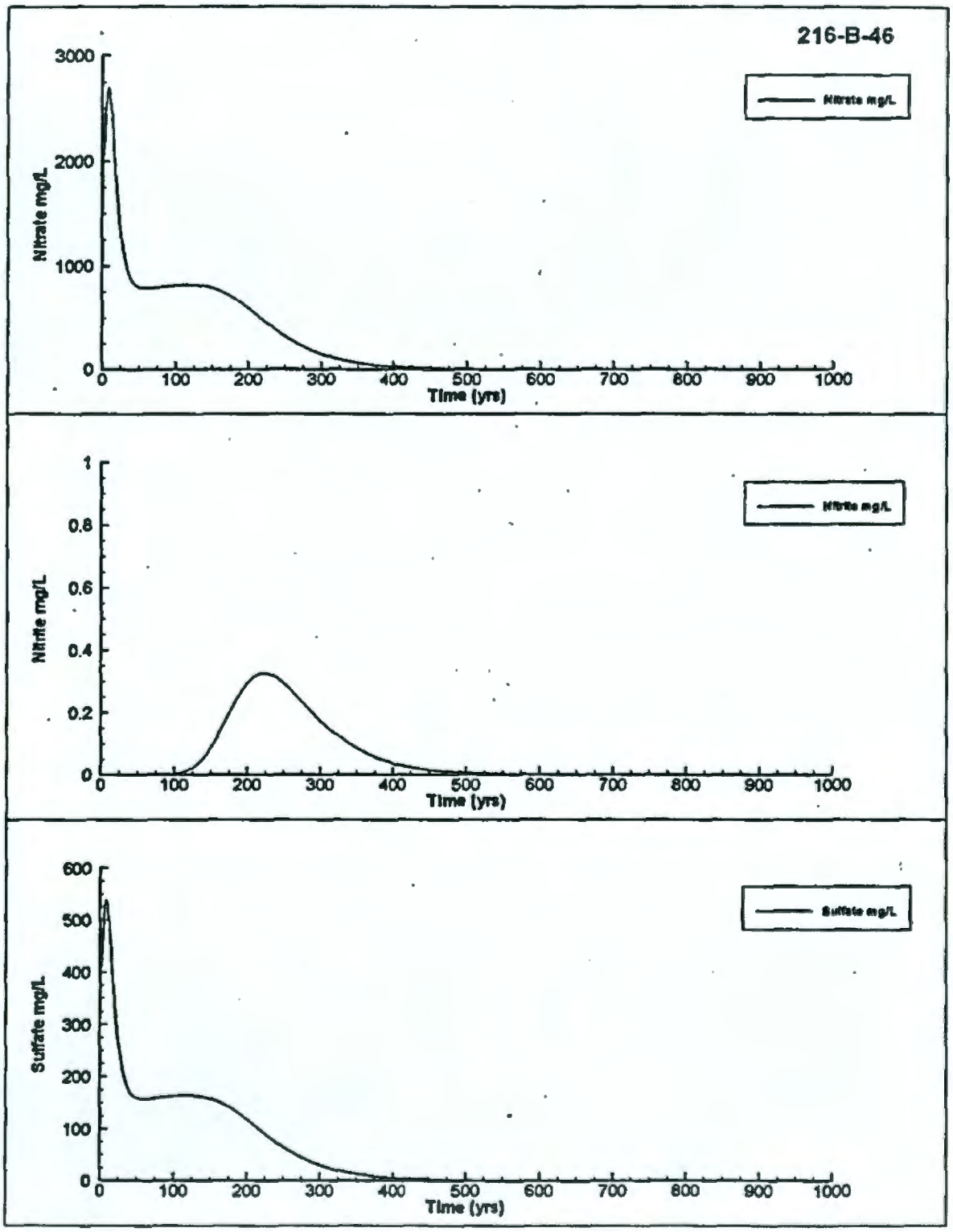

Figure 4-6. Contaminant Breakthrough Curves in Groundwater for Cyanide, Hydrogen-3, and Technetium-99 at the 216-B-46 Crib.

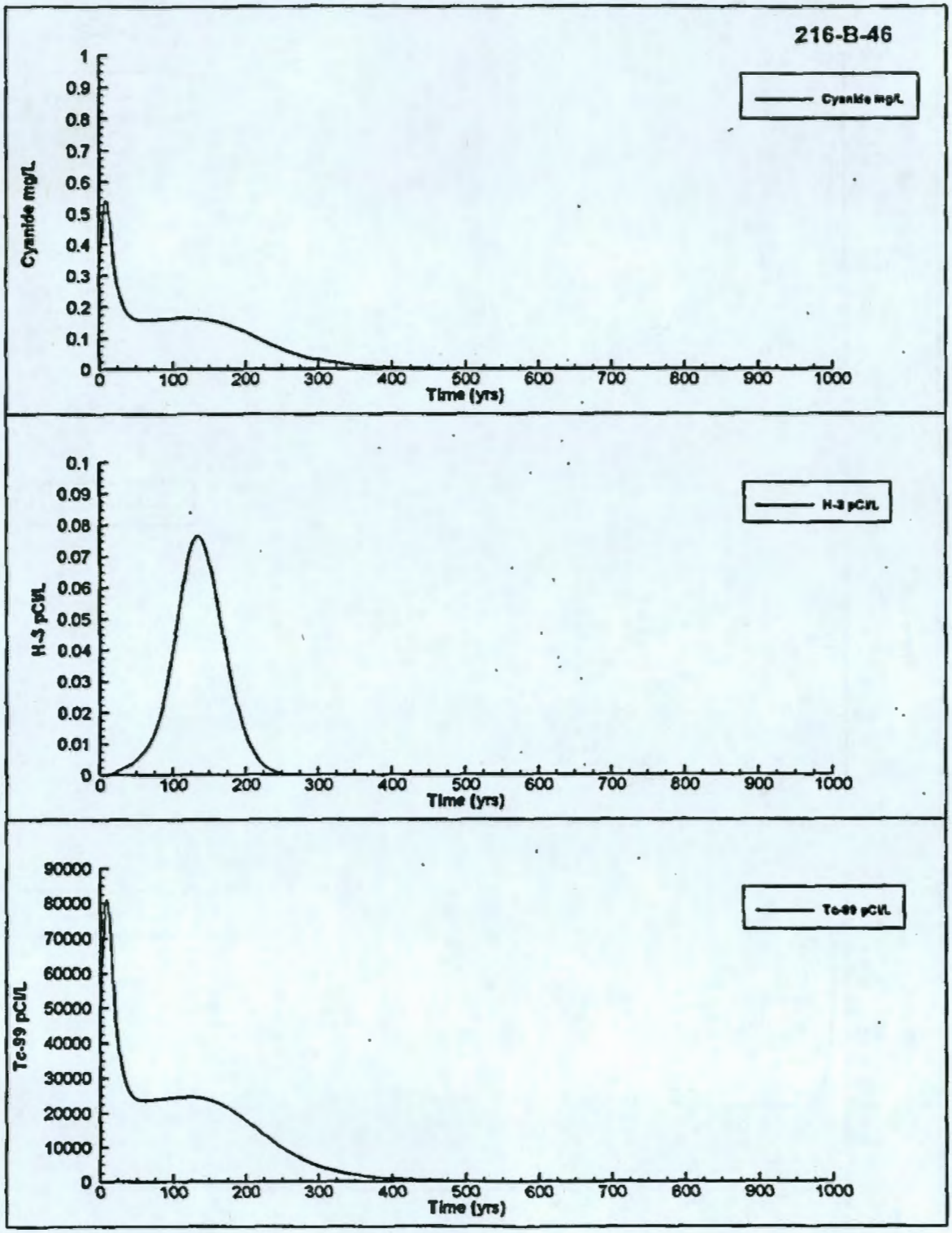

Figure 4-7. Contaminant Breakthrough Curves in Groundwater for Plutonium-238, Plutonium-239/240, and Radium-226 at the 216-B-46 Crib.

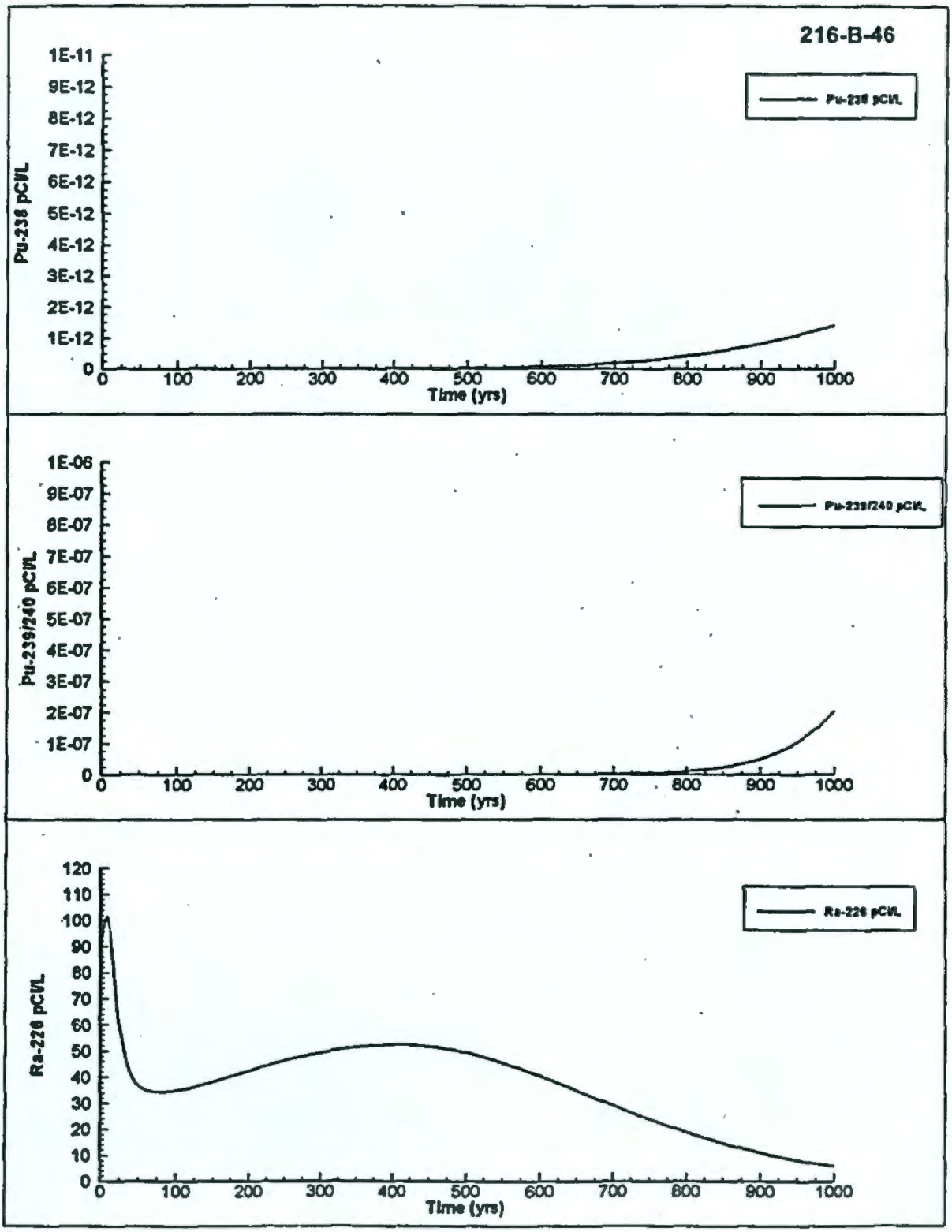

Figure 4-8. Contaminant Breakthrough Curves in Groundwater for Cobalt-60, Uranium-238, and Cesium-137 at the 216-B-46 Crib.

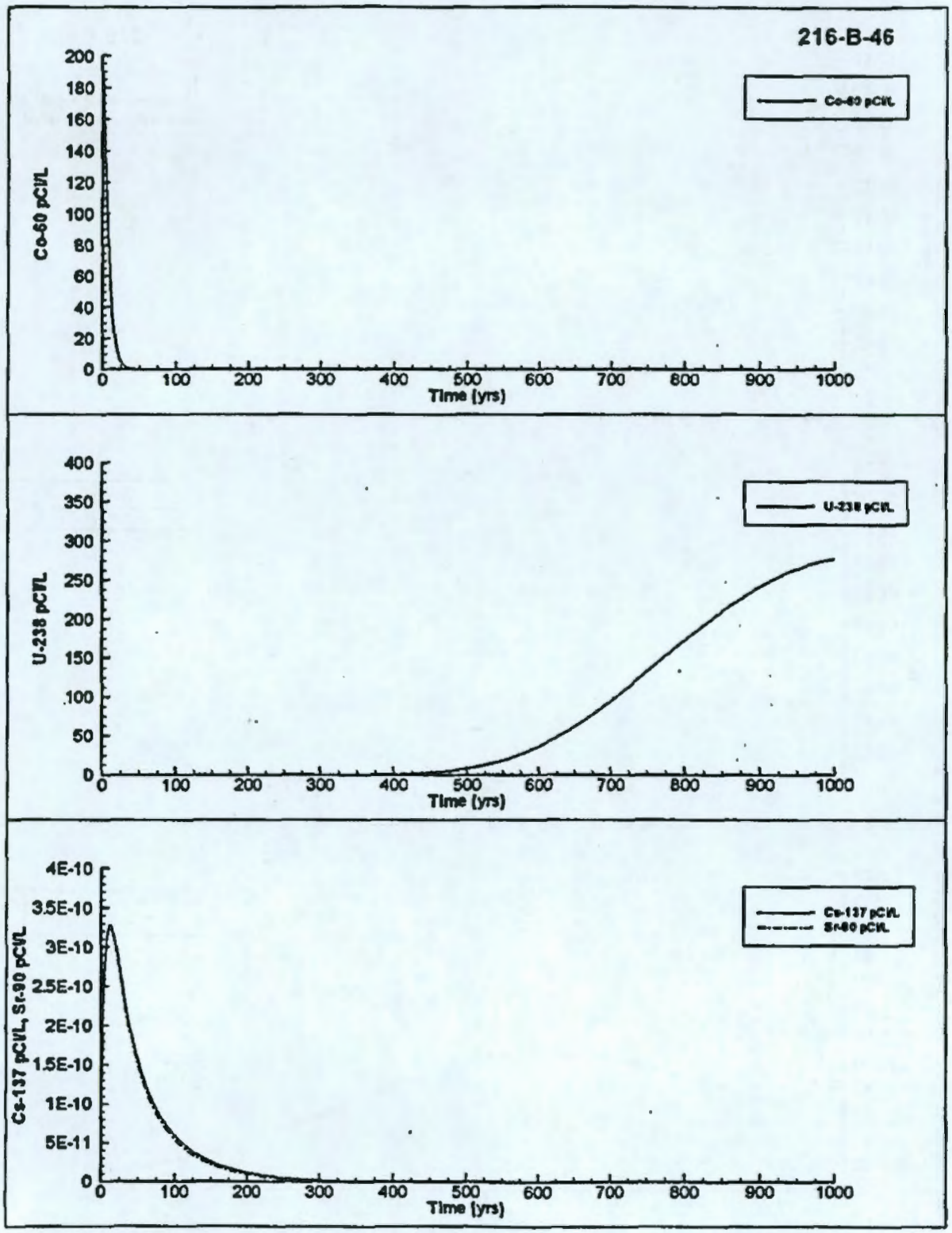

Figure 4-9. Contaminant Breakthrough Curves in Groundwater for Hydrogen-3, Technetium-99, and Potassium-40 at the 216-B-7A Crib.

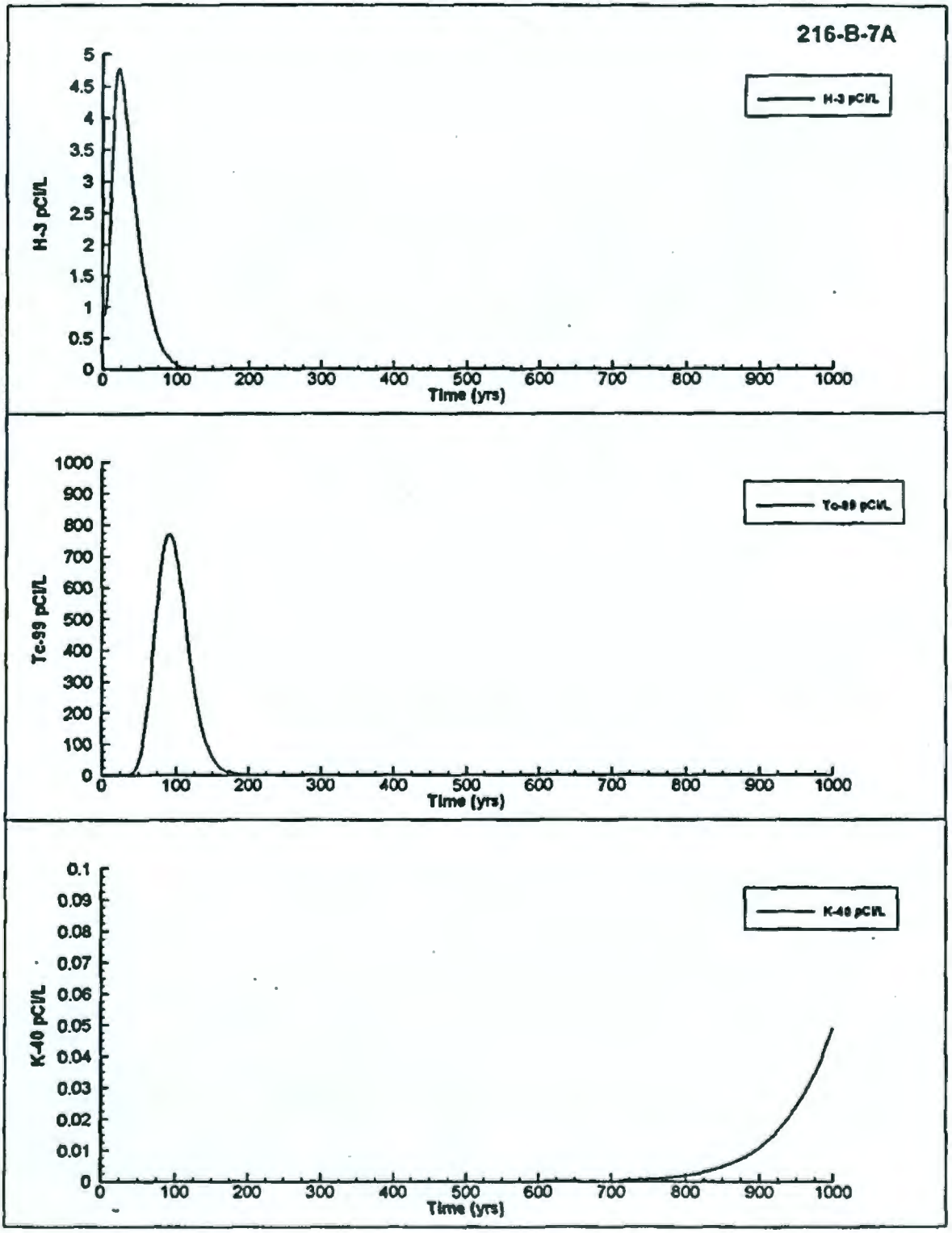

Figure 4-10. Contaminant Breakthrough Curves in Groundwater for Nitrate, Fluoride, and Plutonium-239/240 at the 216-B-7A Crib.

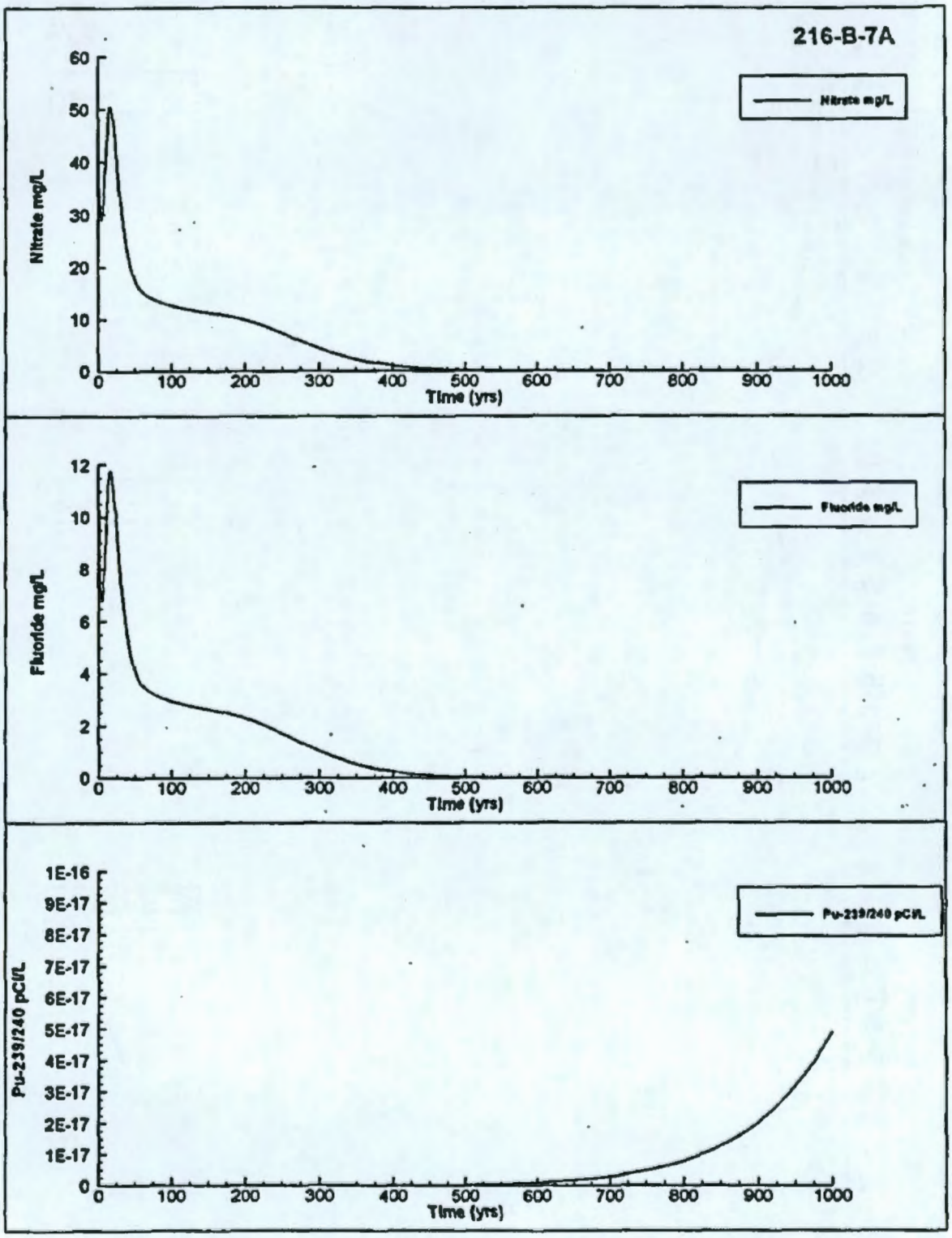

Figure 4-11. Contaminant Breakthrough Curves in Groundwater for Uranium-233/234, Uranium-235, and Uranium-238 at the 216-B-7A Crib.

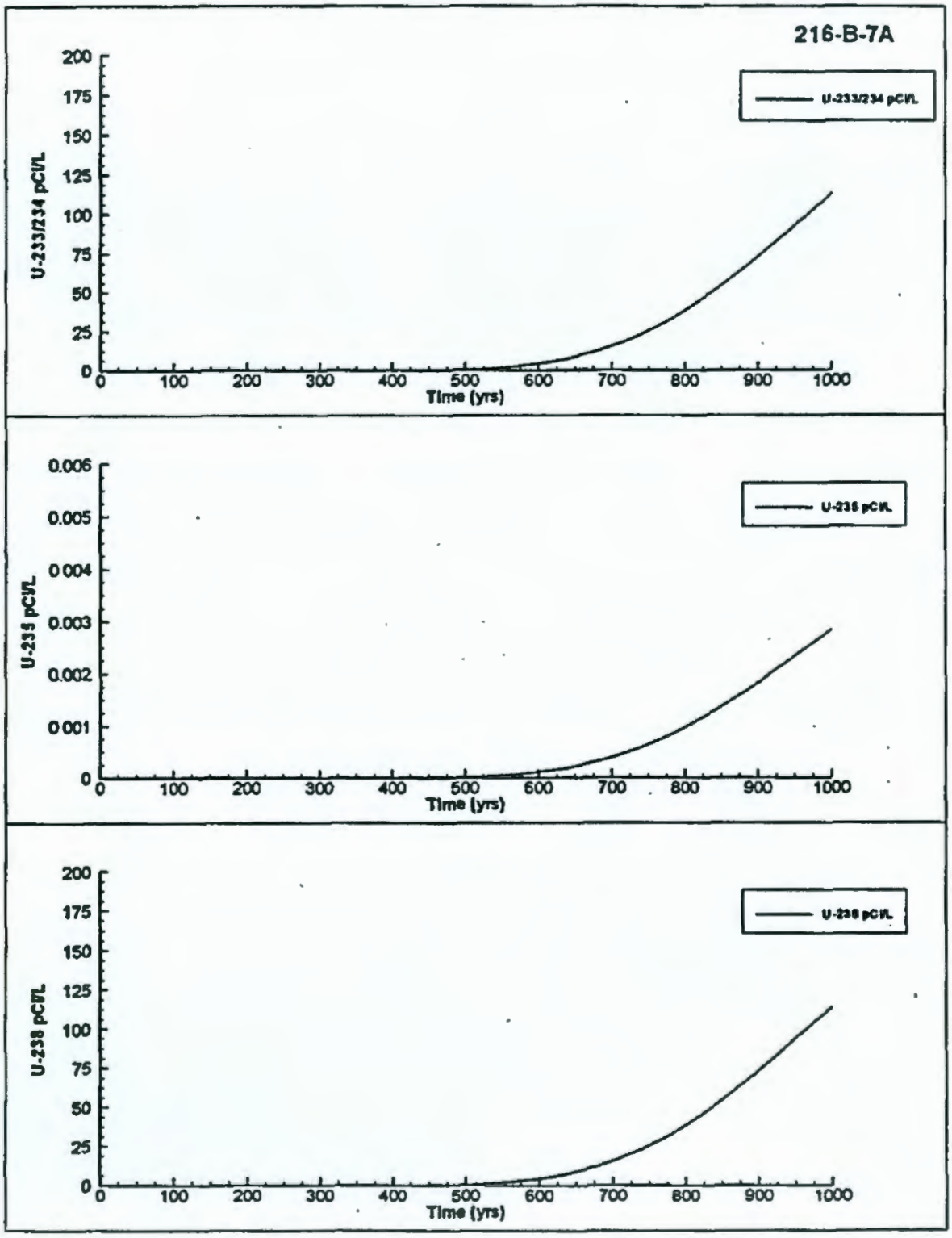

Figure 4-12. Contaminant Breakthrough Curves in Groundwater for Plutonium-238, Plutonium-239/240, and Strontium-90 at the 216-B-7A Crib.

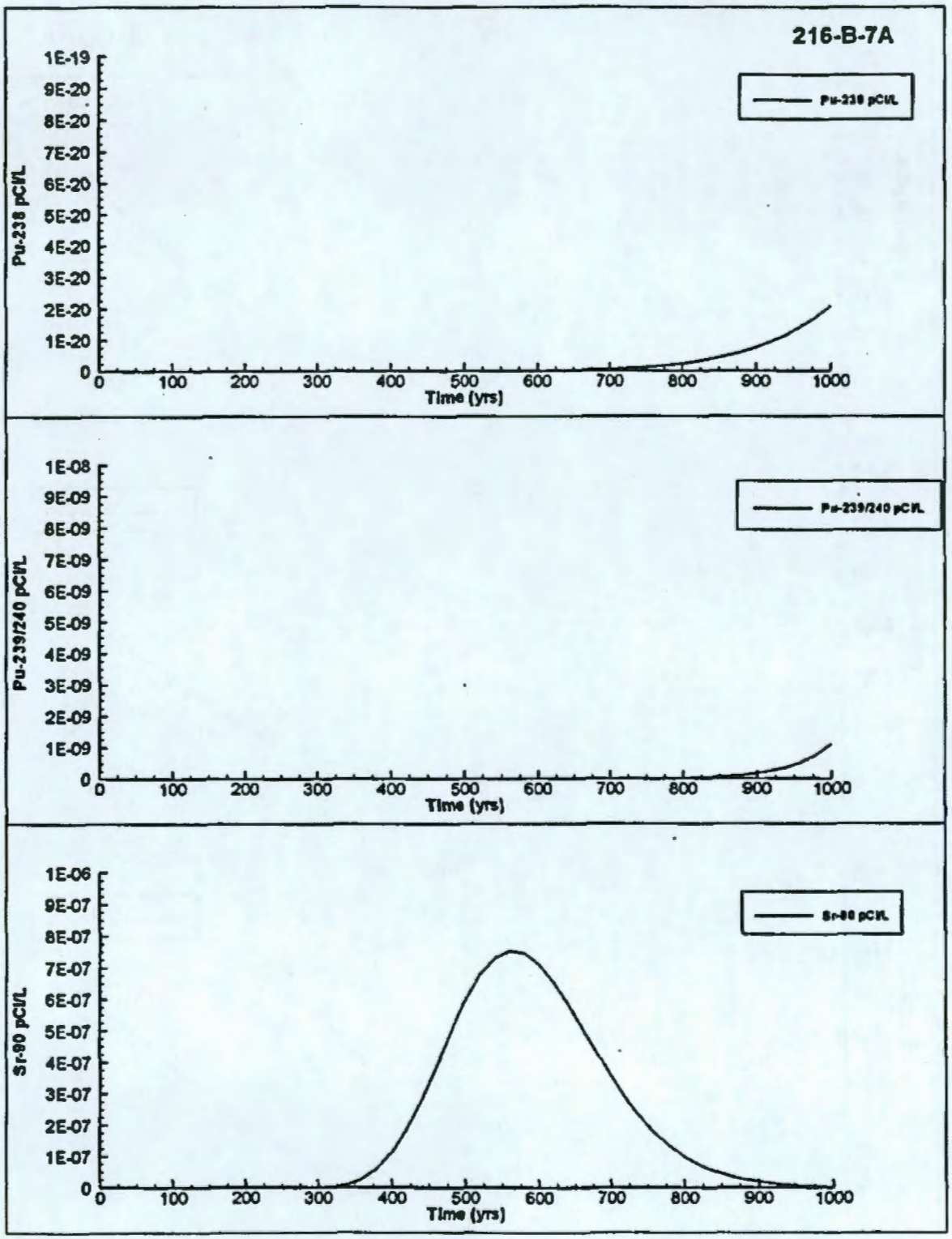

Figure 4-13. Contaminant Breakthrough Curves in Groundwater for Hydrogen-3, Technetium-99, Uranium-233/234, and Uranium-238 at the 216-B-38 Trench.

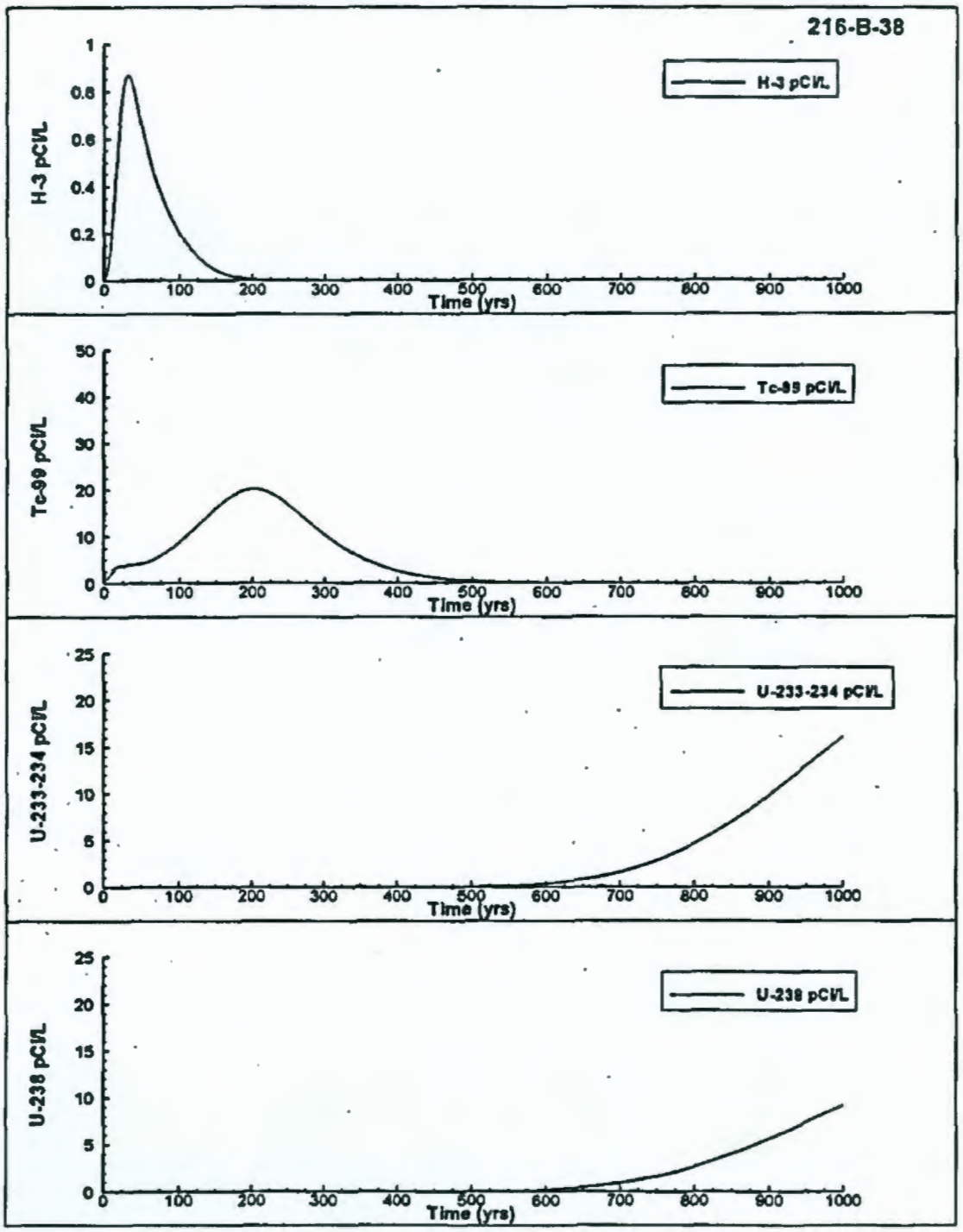

Figure 4-14. Contaminant Breakthrough Curves in Groundwater for Nitrate, Nitrite, and Fluoride at the 216-B-38 Trench.

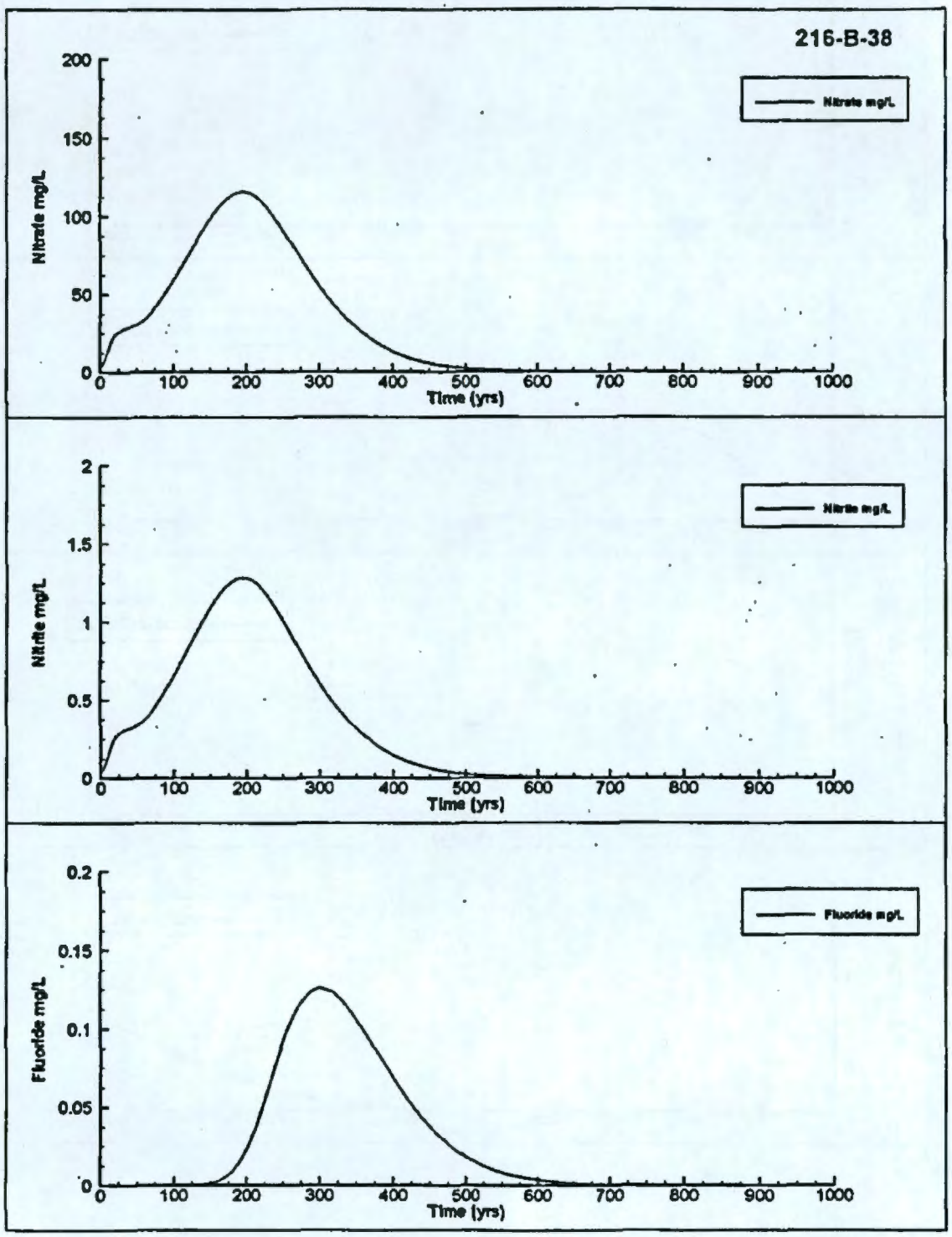

Figure 4-15. Contaminant Breakthrough Curves in Groundwater for Uranium-233/234, Uranium-238, and Stronium-90 at the 216-B-38 Trench.

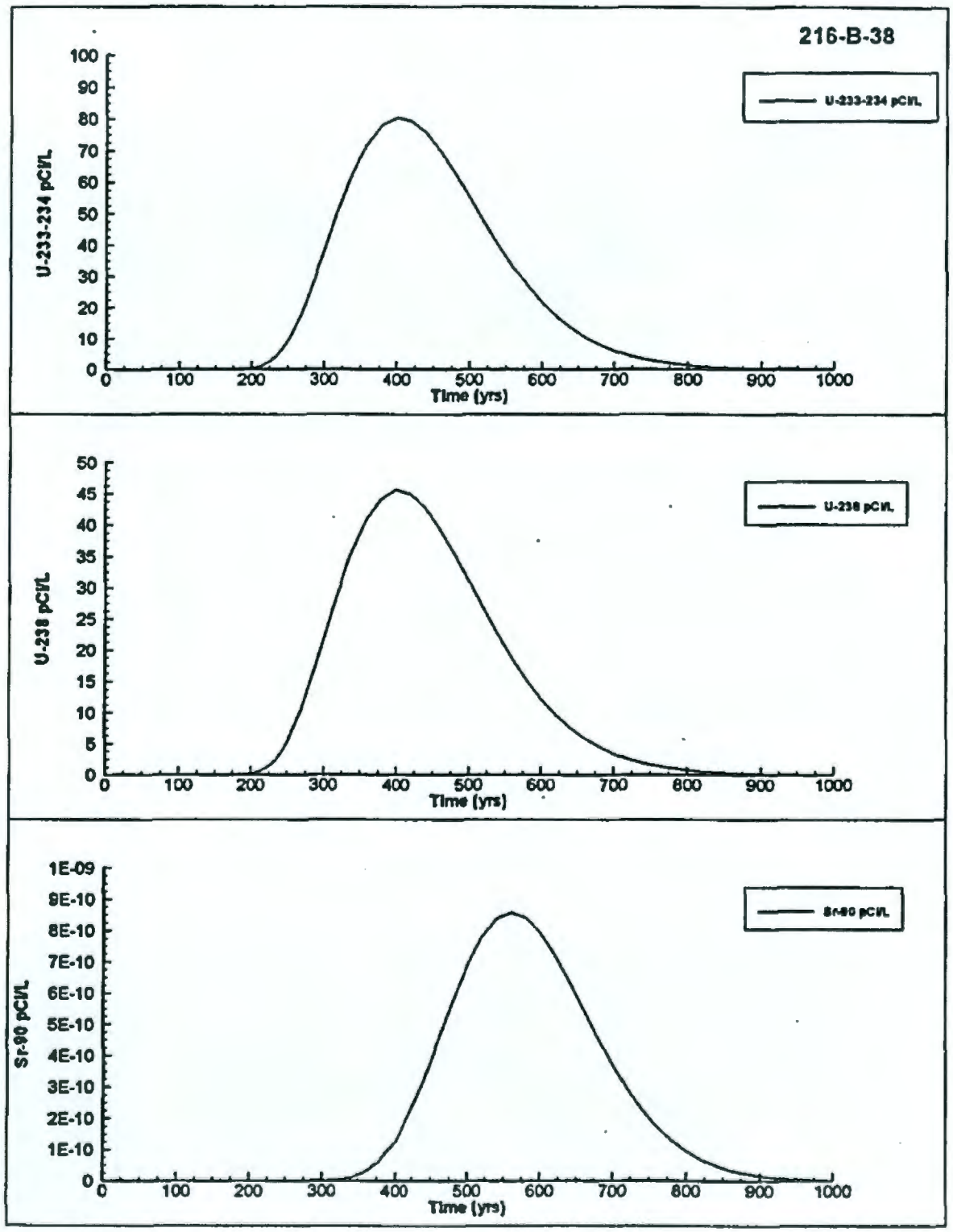

Table 4-1. Modeling Soil Properties. (2 pages)

Material Description	Alpha (1/cm)	n	m	Moisture Content (Saturated)	Moisture Content (Residual)	Vertical Saturated Hydraulic Conductivity (cm/s)	Vertical Saturated Hydraulic Conductivity (m/day)	Horizontal Saturated Hydraulic Conductivity (m/day)
PPU Sandy Gravel	0.020	1.419	0.295	0.269	0.015	1.87E-01	1.62E+02	1.62E+03
Ringold/PPU Silty Sand	0.009	1.851	0.460	0.435	0.067	2.40E-04	2.07E-01	2.07E+00
Backfill (B-38)	0.021	1.374	0.272	0.138	0.010	5.60E-04	4.84E-01	4.84E+00
Silt	0.005	2.067	0.516	0.424	0.041	1.50E-05	1.30E-02	1.30E-01
Cobble Gravel	0.118	2.440	0.590	0.249	0.000	2.13E+01	1.84E+04	1.84E+05
Hanford Sandy Gravel	0.083	1.660	0.398	0.166	0.023	1.25E-01	1.08E+02	1.08E+03
Hanford Silty Sandy to Sandy Gravel	0.065	1.726	0.426	0.236	0.037	4.00E-02	3.46E+01	3.46E+02
Hanford Silty Sandy Gravel	0.047	1.791	0.455	0.307	0.050	1.25E-02	1.08E+01	1.08E+02
Hanford Silty Gravel	0.035	1.835	0.474	0.354	0.060	5.00E-03	4.32E+00	4.32E+01
Hanford Sandy Gravel to Gravelly Sand	0.055	1.827	0.448	0.219	0.032	2.00E-02	1.73E+01	1.73E+02
Backfill Gravelly Sand to Silty Sandy Gravel	0.032	1.400	0.507	0.262	0.030	7.50E-03	6.48E+00	6.48E+01
Hanford Gravelly Sand	0.027	1.994	0.498	0.272	0.040	3.00E-03	2.59E+00	2.59E+01
Hanford Slightly Gravelly Sand	0.076	1.907	0.544	0.320	0.023	2.25E-03	1.94E+00	1.94E+01
Hanford/Backfill Slightly Silty Gravelly Sand	0.024	1.982	0.501	0.301	0.046	2.08E-03	1.79E+00	1.79E+01
Hanford Gravelly Silty Sand	0.019	1.958	0.505	0.360	0.059	2.25E-04	1.94E-01	1.94E+00
Hanford Sand	0.104	2.150	0.575	0.346	0.027	1.25E-03	1.08E+00	1.08E+01
Hanford Slightly Silty Sand	0.073	2.074	0.479	0.380	0.044	1.00E-03	8.64E-01	8.64E+00
Silty to Slightly Silty Sand	0.042	1.999	0.440	0.414	0.061	6.75E-04	5.83E-01	5.83E+00
Hanford Silty Sand	0.011	1.923	0.286	0.448	0.078	3.50E-04	3.02E-01	3.02E+00
Hanford Sandy Silt to Silty Sand	0.009	1.971	0.363	0.440	0.066	1.25E-04	1.08E-01	1.08E+00
Cemented Sand	0.017	1.771	0.575	0.320	0.079	6.25E-05	5.40E-02	5.40E-01
Hanford Sandy Silt	0.008	1.995	0.401	0.436	0.059	3.75E-05	3.24E-02	3.24E-01
Ringold Sandy Gravel	0.009	1.621	0.516	0.077	0.010	3.50E-03	3.02E+00	3.02E+01

Table 4-1. Modeling Soil Properties. (2 pages)

Material Description	Alpha (1/cm)	n	m	Moisture Content (Saturated)	Moisture Content (Residual)	Vertical Saturated Hydraulic Conductivity (cm/s)	Vertical Saturated Hydraulic Conductivity (m/day)	Horizontal Saturated Hydraulic Conductivity (m/day)
Ringold Silty Sandy Gravel	0.010	1.772	0.514	0.262	0.044	1.75E-03	1.51E+00	1.51E+01
Ringold Silty Gravel	0.010	1.822	0.513	0.324	0.055	8.75E-04	7.56E-01	7.56E+00
Ringold Gravelly Sand to Sand	0.021	1.845	0.556	0.304	0.066	2.50E-04	2.16E-01	2.16E+00
Ringold Gravelly Silt to Gravelly Sandy Silt	0.012	2.043	0.514	0.373	0.041	7.00E-05	6.05E-02	6.05E-01
Clastic Dike	0.008	1.995	0.401	0.436	0.059	1.44E-03	1.24E+00	1.24E-01

PPU = Plio-Pleistocene unit.

Table 4-2. Comparisons of Modeled K_d Values to Published Values. (3 pages)

216-T-26 Crib			
Contaminant	**Zone G Category Best Estimate**	**Model Match to Soil Contaminant Data**	**Value Used in Model**
	Distribution Coefficient (mL/g)		
Am-241	3	10*	10
Cs-137	10	10*	10
Eu-154	3	10*	10
Eu-155	3	10*	10
H-3	0	1	0
Pu-238	3	10*	10
Pu-239/240	3	10*	10
Sr-90	5	5	5
Tc-99	0	1	0
U-233/234	0.4	2	0.6
U-235	0.4	2	0.6
U-238	0.4	2	0.6
Cyanide	0	1	0
Nitrate	0	1	0
Nitrite	0	1	0
*10 mL/g was the largest distribution coefficient value used to match contaminant data at 216-T-26 Crib.			
216-B-46 Crib			
Contaminant	**Zone G Category Best Estimate**	**Model Match to Soil Contaminant Data**	**Value Used in Model**
	Distribution Coefficient (mL/g)		
Cs-137	10	5*	5
Co-60	0	0.4	0.4
H-3	0	5*	0
Pu-238	3	5*	5
Pu-239/240	3	5*	5
Ra-226	5	0.4	0.4
Sr-90	5	5*	5
Tc-99	0	0.4	0
U (total)	0.4	5*	0.6
Cyanide	0	0.4	0
Nitrate	0	0.4	0
Nitrite	0	5*	0
Sulfate		0.4	0
*5 mL/g was the greatest distribution coefficient value used to match contaminant data at 216-B-46 Crib.			

Table 4-2. Comparisons of Modeled K_d Values to Published Values. (3 pages)

216-B-7A Crib			
Contaminant	**Zone F Category Best Estimate**	**Model Match to Soil Contaminant Data**	**Value Used in Model**
	Distribution Coefficient (mL/g)		
Am-241	300	20	20
C-14	N/A	150*	6
Cs-137	500	20	20
Eu-154	350	20	20
H-3	0	3	0
K-40	N/A	20	5.5
Pu-238	20	20	20
Pu-239/240	20	20	20
Sr-90	0.5	150*	5.5
Tc-99	0	20	0
U-233/234	0.3	20	0.6
U-235	0.3	20	0.6
U-238	0.3	20	0.6
Fluoride	0	1	0
Nitrate	0	1	0
*150 mL/g was the greatest distribution coefficient value used to match contaminant data at 216-B-7A Crib.			
216-B-38 Trench			
Contaminant	**Zone F Category Best Estimate**	**Model Match to Soil Contaminant Data**	**Value Used in Model**
	Distribution Coefficient (mL/g)		
Am-241	300	5.5*	5.5
Cs-137	500	5.5*	5.5
H-3	0	0.5	0
K-40	N/A	5.5*	5.5
Pu-238	20	5.5*	5.5
Sr-90	0.5	5.5*	5.5
Tc-99	0	0.25	0
U-233/234	0.3	2	0.6
U-238	0.3	2	0.6
Fluoride	0	5.5*	0
Nitrate	0	0.25	0
Nitrite	0	0.25	0
*5.5 mL/g was the greatest distribution coefficient value used to match contaminant data at 216-B-38 Trench.			

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5.0 RISK EVALUATION

5.1 INTRODUCTION

This chapter provides the results of the human health baseline risk assessment, which includes the human health risk assessment for nonradionuclides and the RESRAD modeling for radionuclides (ANL/EAD-4, *User's Manual for RESRAD, Version 6*). This evaluation consists of a discussion of the conceptual site model (Section 5.2), human health risk assessment for nonradionuclide contaminants (Section 5.3), RESRAD modeling to assess the dose and risk from radionuclides (Section 5.4), and a conclusion of the results (Section 5.5). The risk evaluation was prepared in accordance with Section 5.0 of the HSRAM (DOE/RL-91-45) and provides a characterization of site risks to determine if remedial actions are warranted and to support evaluation of remedial alternatives in the FS.

This chapter also includes the ecological risk screening of the 200-TW-1, 200-TW-2, and 200-PW-5 OU contaminants against screening concentrations in WAC 173-340-900, Table 749-3, for nonradionuclides and in DOE-STD-1153–2002 for radionuclides. This latter document was prepared for the DOE by the Biota Dose Assessment Committee (BDAC) and presents screening levels (BCG) for radionuclides as well as a methodology for conducting ecological risk assessments for radionuclides. DOE/RL-2001-54 contains additional details on the BDAC document.

5.2 CONCEPTUAL SITE MODEL

This conceptual site model provides a current understanding of the sources of contamination, physical and ecological setting, and current and future land use and identifies potentially complete human and ecological exposure pathways for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. Information generated during the development of the RI/FS has been incorporated into this conceptual site model to identify potential exposure scenarios.

5.2.1 Physical Setting

The topography and hydrogeologic framework are described in Chapter 3.0. Meteorology is describe in this subsection. Additional discussions are provided in PNNL-13788; PNNL-13910, *Hanford Site Environmental Report for Calendar Year 2001*; and PNNL-6415, *Hanford Site National Environmental Policy Act (NEPA) Characterization*.

The Hanford Site lies east of the Cascade Mountains and has a semiarid climate created by the rainshadow effect of the mountains. Climatological data are monitored at the Hanford Meteorological Station and other locations throughout the Hanford Site. From 1945 through 2001, the recorded maximum temperature was 45 °C (113 °F), and the recorded minimum temperature was –30.6 °C (-23 °F) (PNNL-6415). The two extremes occurred during the months of August and February, respectively. The monthly average temperature ranged from a low of –0.24 °C (31.7 °F) in January to a high of 24.6 °C (76.3 °F) in July. The annual average relative humidity is 54 percent (PNNL-6415).

Most precipitation occurs during late autumn and winter with more than half of the annual amount occurring from November through February (PNNL-6415). Normal annual precipitation

is 17.7 cm (6.98 in.). For this reason, the Hanford Site is considered to be an arid land/desert because it typically receives less than 25.5 cm (10 in.) of precipitation a year.

The prevailing wind direction is from the northwest during all months of the year at the Hanford Monitoring Station (PNNL-6415). Monthly average wind speeds are lowest during the winter months and average about 3 m/s (6 to 7 mi/h). The highest average wind occurs during the summer and is about 4 m/s (8 to 9 mi/h). The record wind gust was 35.7 m/s (80 mi/h) in 1972.

Sources of contamination are the waste sites that received 200 Areas scavenged and tank wastes. The waste sites are described in greater detail in Chapters 1.0 and 3.0

5.2.2 Ecological Setting

This section describes the ecological setting of the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. The ecological setting encompasses the terrestrial habitats and wildlife in the OUs. The availability and quality of habitats determines the wildlife types that may be present in the OUs.

Environmental monitoring has been an ongoing activity since the early days of the Hanford Site. The monitoring efforts continue today, and a significant body of information exists about the ecology of the Central Plateau. The latest data collection efforts that focused on the Central Plateau and the 200 Areas were conducted in 2000 and 2001. Information about the ecological setting is presented in more detail in DOE/RL-2001-54.

5.2.2.1 Terrestrial Habitat

The Central Plateau is characterized by native shrub-steppe habitat interspersed with large areas of disturbed ground, dominated by annual grasses and herbaceous plants, especially in the industrialized 200 Areas and outlying waste sites. Baseline vegetation surveys identify three simplified habitat associations: sagebrush/shrub-steppe, grass and herbaceous plants, and disturbed. A detailed discussion of the survey results that support the information presented in this section is provided in DOE/RL-2001-54. Figures showing location and relative abundance of plant and animal species are provided in DOE/RL-2001-54.

5.2.2.1.1 Sagebrush/Shrub-Steppe Group

In the native shrub-steppe, the most prevalent shrub is big sagebrush (sagebrush) (*Artemisia tridentata*); the understory is dominated by the native perennial, Sandberg's bluegrass (*Poa sandbergii*), and the introduced annual, cheatgrass (*Bromus tectorum*). Other shrubs present in the 200 Areas include rabbitbrush (*Chrysothamnus* spp.), spiny hopsage (*Grayia spinosa*), and antelope bitterbrush (*Purshia tridentata*).

Sagebrush/shrub-steppe habitat associations are dominant outside the fenceline, covering about two-thirds of the Central Plateau. Patches of big sagebrush habitat are located within the 200 East Area and 200 West Area fencelines.

5.2.2.1.2 Grasses and Herbaceous Plants Group

Native bunchgrasses present include Indian ricegrass (*Oryzopsis hymenoides*), sand dropseed (*Sporobolus cryptandrus*), and needle-and-thread grass (*Stipa comata*). Common herbaceous species include turpentine cymopteris (*Cymopteris terebinthinus*), globemallow (*Sphaeralcea munroana*), balsamroot (*Balsamorhiza careyana*), milkvetch (*Astragalus* spp.), yarrow (*Achillea millefolium*), and daisy (*Erigeron* spp.). These habitats often are associated with disturbed areas and represent a lower quality habitat than the sagebrush/shrub-steppe.

5.2.2.1.3 Disturbed Areas Group

Large areas of disturbed ground dominated by annual grasses and herbaceous plants are present in the 200 East and 200 West Areas. Disturbed and nonvegetated (gravel or asphalt) areas in the 200 Areas have minimal vegetative cover (<10 percent) (WHC-SD-EN-TI-216, *Vegetation Communities Associated with the 100-Area and 200-Area Facilities on the Hanford Site*) and are primarily the result of either mechanical disturbance (e.g., from road clearing or facility construction) or range fire. At the Hanford Site, the ground surface is covered with a fragile thin crust (cryptogamic crust), consisting of mosses, lichen, algae, and bacteria, that protects the soil beneath. By preventing erosion, the cryptogamic crust helps to build the soil below and retains moisture and provides nutrients. This aspect of the soil is crucial to the existence of desert life. Once disturbed, decades (or centuries if the soil has been removed) may pass before a plant community returns to a state comparable to its original condition. The principal colonizers of disturbed sites are non-native annual species such as Russian thistle (*Salsola kali*), Jim Hill mustard (*Sisymbrium altissimum*), and cheatgrass.

Mechanical disturbance typically entails a loss of soil structure and disruption of nutrient cycling, which have a significant effect on the plant species that recolonize a site. Many waste sites have been backfilled with clean soil and planted with crested (*Agropyron cristatum*) or Siberian wheatgrass (*Agropyron sibericum*) to stabilize the surface soil, control soil moisture, or displace more invasive deep-rooted species like Russian thistle (PNNL-6415, *Hanford Site National Environmental Policy Act [NEPA] Characterization*). Most waste sites are treated, as necessary, with herbicide to prevent the uptake of underground contamination by deep-rooted plants. There are varying levels of disturbance at these sites. Some waste sites are highly disturbed and have only a gravel cover, while other sites have light vegetative cover of grasses and herbaceous plants, yet other sites have had vegetation present for some time and are supporting the growth of shrubs. Fire is a major source of disturbed habitat at the Hanford Site; although the 200-CW-5 OU waste sites have not recently been impacted by fire.

5.2.2.2 Wildlife

The largest mammal frequenting the Central Plateau is the mule deer (*Odocoileus hemionus*). While mule deer are much more common along the Columbia River, the few that forage throughout the Central Plateau comprise a distinct group called the Central Population (PNNL-11472, *Hanford Site Environmental Report for Calendar Year 1996*). A large elk herd (*Cervus canadensis*) currently resides on the Fitzner-Eberhardt Arid Lands Ecology Reserve. Occasionally a few elk have been seen just south of the 200 Areas; recently the herd on the Reserve has been thinned, thus the elk currently are not expected to continue expanding their range.

Other mammals common to the Central Plateau are badgers (*Taxidea taxus*), coyotes (*Canis latrans*), Great Basin pocket mice, northern pocket gophers, and deer mice. Jackrabbits (*Lepus californicus*) are present in low numbers. Pocket gophers and mice (especially Great Basin pocket mice and deer mice) are abundant in the Central Plateau and the 200 Areas, predominantly consume vegetation, and can excavate large amounts of soil as they construct their burrows (Hakonson et al. 1982). Mammals associated with buildings and facilities include Nuttall's cottontails (*Sylvilagus nuttallii*), house mice (*Mus musculus*), Norway rats (*Rattus norvegicus*), and various bat species.

Common bird species in the Central Plateau include western meadowlarks, horned larks, and western kingbirds (*Tyranus verticalis*). Species associated with the industrialized portions of the 200 Areas include rock doves (*Columba livia*), starlings (*Sturnus vulgaris*), black-billed magpies (*Pica pica*), and ravens (*Corvus corax*). Burrowing owls (*Athene cunicularia*) commonly nest in the Central Plateau in abandoned badger or coyote holes. Loggerhead shrikes (*Lanius ludovicianus*) and sage sparrows (*Amphispiza belli*) are common nesting species in habitats dominated by sagebrush. Long-billed curlews (*Numenius americanus*) have been observed nesting on inactive 200 Areas waste sites. More recent characterizations of the 200 Areas have identified western meadowlarks as being the most widely distributed bird species, followed by horned larks and mourning doves (*Zenaida macroura*). Other conspicuous birds include terrestrial game birds (e.g., California quail [*Callipepla californica*], chukar [*Alectoris chukar*], ring-necked pheasant [*Phasianus colchicus*]), passerine species, and raptors (e.g., red-tailed hawk [*Buteo jamaicensis*], northern harrier [*Circus cyaneus*]).

Reptiles found in the Central Plateau include gopher snakes (*Pituophis melanoleucus*) and side-blotched lizards (*Uta stansburiana*). Rattlesnakes (*Crotalus viridis*) also have been observed. Observations of reptiles were not widespread, with only 23 observations of side-blotched lizards at 316 sites surveyed in the 2001 survey (DOE/RL-2001-54).

Three of the most common groups of insects found at the Hanford Site include darkling beetles, grasshoppers, and ants. Darkling beetles are a dominant part of the insect community in the 200 Areas, where they occur with very little seasonal restriction but exhibit dramatic changes in abundance from year to year (PNL-2253, *Ecology of the 200 Area Plateau Waste Management Environs: A Status Report*). Grasshoppers are herbivorous insects common in the Central Plateau. Their abundance cycles from year to year, with increased population size from May to July.

5.2.2.3 Sensitive Habitat

Sensitive habitats include those identified by DOE/RL-96-32, *Hanford Site Biological Resources Management Plan*, as rare or wetlands (or riparian) habitat. Wetlands are protected by the Federal and state governments.

5.2.2.3.1 Rare Habitat in the Central Plateau -Basalt Outcrops

Rare habitats are those important for plant, fish, and wildlife species that have a low availability (DOE/RL-96-32). Within the Central Plateau, the only identified rare habitat areas (rated as Level IV in DOE/RL-96-32) are located in proximity to the basalt ridges of Gable Butte and Gable Mountain. These basalt outcrops have limited availability, are associated with rare plant communities, and are easily disturbed. There are no waste sites in close vicinity to these rare habitats.

Wildlife likely to occur in these habitats are birds, such as the prairie falcon, rock wren, poorwill, and chukar; small mammals, such as the yellow-bellied marmot and wood rat; and reptiles, such as rattlesnakes, gopher snakes, and horned lizards.

5.2.2.3.2 Wetlands (Riparian) Habitat in the Central Plateau

Wetlands, or riparian, habitat are transitional lands between terrestrial and aquatic ecosystems where the water table usually is close to the surface but not always. Wetlands offer water and protection for wildlife in an arid environment.

In 1995, all contaminated effluent discharges to liquid waste sites were ceased. Within the Central Plateau, manmade ponds and ditches, including the B Pond Complex located near the 200 East Area, once were present and were sources of riparian habitat. All riparian habitat within the fenceline have been eliminated with the exception of a small riparian area that was identified in the 200 East Area during the 2001 survey. This may be a seasonal wetland; the value of this small riparian area has not been evaluated. No wetland habitat was located in the 200 West Area.

Vernal pools, such as those on Gable Butte and Gable Mountain, are temporary and are considered seasonally flooded wetlands. Approximately 20 vernal pools were located on the eastern end of Umtanum Ridge, near the central part of Gable Butte, and on the eastern end of Gable Mountain. None of these pools are in close proximity to waste sites in the Central Plateau (TNC 1999).

5.2.2.4 Sensitive Species

Sensitive species include threatened and endangered species, which are protected by Federal and state laws. Washington State defines sensitive species as any wildlife species native to the State of Washington that is vulnerable or declining and is likely to become endangered or threatened throughout a significant portion of its range within the state without cooperative management or removal of threats (*Washington Administrative Code* WAC 232-12-297, "Endangered, Threatened, and Sensitive Wildlife Species Classification," Section 2.6).

5.2.2.4.1 Threatened and Endangered Species

Two Federally protected species have been observed at the Hanford Site, the Aleutian Canada Goose and the Bald Eagle (*Haliaeetus leucocephalus*). Both are dependent on the river corridor and rarely are seen in the Central Plateau. As migratory birds, these species are protected under the *Migratory Bird Treaty Act of 1918*.

No plants, invertebrates, amphibians, reptiles, or mammals on the Federal or State of Washington threatened and endangered species lists are known to exist in the Central Plateau.

5.2.2.4.2 Rare Plants

Rare plant species are vascular plant species listed by the Washington Natural Heritage Program (WNHP, 1998, *Washington Rare Plant Species by County*) as endangered, threatened, or sensitive in the State of Washington. The Nature Conservancy survey discovered 112 populations of 28 rare plant taxa on the Hanford Site (TNC 1999). Although rare plants were found dispersed throughout the Site, the highest densities occurred on the east end of Umtanum Ridge, the basalt-derived sands near Gable Mountain, the White Bluffs, Rattlesnake Mountain, and the Yakima Ridge.

5.2.2.4.3 Mammals of Concern

The state has classified the pygmy rabbit (*Brachylagus idahoensis*) as a candidate endangered species. None have been observed to date in the Central Plateau. The pygmy rabbit is dependent

on sagebrush, primarily big sagebrush *(Artemisia tridentata)*, and usually is found in areas where big sagebrush grows in very dense stands.

5.2.2.5 New-to-Science Species

The Nature Conservancy conducted a biodiversity survey of plants, mammals, reptiles and amphibians, birds, and insects at the Hanford Site between 1994 and 1998 (TNC 1999). This survey found two species and one variety of plants and 41 species and two subspecies of insects that had not been known to science. A listing of the new plant and insect species may be viewed at http://www.pnl.gov/ecology/ecosystem/Species/Species.html.

U.S. Fish and Wildlife and the State of Washington have not yet determined the protective status of these new-to-science species (i.e., are they considered threatened or endangered). The habitat-based management plan at the Hanford Site will offer protection to most of these species.

Eriogonum codium (Umtanum desert buckwheat). The only known population of *Eriogonum codium* consists of approximately 5,200 plants on Umtanum Ridge in Benton County at the western edge of the Site.

Lesquerella tuplashensis (White Bluffs bladderpod). *Lesquerella tuplashensis* is a short-lived perennial that grows on the upper edge of the White Bluffs of the Columbia River in Franklin County.

Astragalus conjunctus var.*rickardii* (Basalt milkvetch). Basalt milkvetch typically is associated with bunchgrass areas within big sagebrush-steppe communities. It has been found on the top and north end of Rattlesnake Mountain at the Hanford Site (TNC 1999). The other known population of A. *conjunctus* var. *rickardii* in Benton County is a small population from the Chandler Butte portion of the Horse Heaven Hills.

Insects were dispersed throughout the Hanford Site, with the new species found in shrub-steppe, areas around the basalt talus, springs, and upland areas. The size, diversity, and relatively undisturbed nature of the Hanford Site shrub-steppe habitat has provided for a large and diverse insect population, of which the new-to-science species are a part. Habitat protection will be key to preserving the insect diversity at the Hanford Site.

With the exception of some of the insects, none of these new-to-science species is expected to be located near the 200-TW-1, 200-TW-2, or 200-PW-5 OU waste sites. The presence of the insects near the waste sites is limited because of the disturbed habitat associated with the waste sites.

5.2.2.6 Summary

Through ecological monitoring and sampling activities that have been conducted on the Hanford Site, a very comprehensive set of information is available on the habitat and species that currently exist in the Central Plateau. Given the current understanding of the habitat and wildlife in the Central Plateau, the following three concerns are important for consideration when making decisions on the remediation of waste sites in the Central Plateau.

- The shrub-steppe habitat at the Hanford Site is one of the largest pieces of shrub-steppe in a region where this habitat is declining. Protection of shrub-steppe habitat at the Hanford Site is critical for the regional ecology. The shrub-steppe habitat also provides for the most diverse community of plants and animals in the upland arid environment. More diverse communities have greater stability and productivity (Tilman et al. 1996,

"Productivity and Sustainability Influenced by Biodiversity in Grassland Ecosystems,"and Tilman 1999, "The Ecological Consequences of Changes in Biodiversity: A Search for General Principles"). It follows that more stable and productive ecosystems would be better able to cope with environment stresses, such as contamination. Also, reducing the area of any ecosystem reduces the number of species in that system (Wilson 1989, "Threats to Biodiversity").

- Individual species whose populations are limited and are designated as sensitive species must be protected. New-to-science species should be afforded similar protection until further study can be performed.
- The waste sites are disturbed habitats covered with gravel, or grasses, and other small plants. Two aspects of the disturbed habitat must be kept in mind: plant succession is slow in the arid environment; and disturbed areas, such as the waste sites, offer little habitat for animals.

The disturbed areas of the waste sites and fire-damaged terrain offer a lower quality habitat and have less community diversity. The most common organisms are ants, beetles, and mice. Ants tunnel underground and will move soil up to the surface.

5.2.3 Characterization of Land Use

As discussed in Section 1.3, the land-use boundary around the 200 East and 200 West Areas has been designated as industrial-exclusive in the CLUP EIS (DOE/EIS-0222-F). All of the waste sites associated with the 200-TW-1, 200-TW-2, and 200-PW-5 OUs are located within this industrial-exclusive land-use boundary.

Based on DOE/EIS-0222-F and the associated 65 FR 61615, industrial-exclusive land use is defined as "preserving DOE control of the continuing remediation activities and use of the existing compatible infrastructure required to support activities such as dangerous waste, radioactive waste, and mixed waste treatment, storage, and disposal facilities" (DOE/EIS-0222-F). The waste sites meet the definition of an industrial property under WAC 173-340-200, "Definitions," by meeting the following criteria:

1. The 200-TW-1, 200-TW-2, and 200-PW-5 OUs do not serve as current residential areas.
2. The OUs have no potential to serve as future residential areas.
3. Access to the industrial property by the general public is not allowed or is greatly limited and controlled for safety or security considerations.
4. Food is not grown or raised on the property.

5.2.4 Conceptual Exposure Model for Human Exposure

An exposure pathway is the means by which a contaminant moves from a source to a receptor (a potentially exposed individual or organism). A complete exposure pathway has the following five elements:

- A contaminant source
- A mechanism for contaminant release

- An environmental transport medium
- An exposure point (i.e., a location where people or wildlife can come into contact with the contaminants)
- A feasible route of exposure (e.g., ingestion, dermal contact, direct exposure, or inhalation).

Exposure can occur when contaminants migrate from their source to an exposure point or when a receptor moves into direct contact with contaminants or contaminated media close to the source. An exposure pathway is complete if a means is available for the receptor to be exposed through ingestion, inhalation, direct exposure, or dermal absorption at a location where site-related contaminants are present. No exposure (and therefore no risk) exists unless the exposure pathway is complete. This is an important determination in the risk assessment process.

The conceptual exposure model for potential current and future human exposures is presented in Figure 5-1. The conceptual site exposure model has been formulated according to EPA guidance, WAC 173-340 guidance, and the HSRAM (DOE/RL-91-45). Using this guidance, professional judgment, and current understanding of site conditions, the conceptual model identified contaminant sources, release mechanisms, routes of migration, potential exposure points, potential routes of exposure, and potential population groups associated with the 200-TW-1, 200-TW-2, and 200-PW-5 OUs.

5.2.5 Potential Human Exposure Pathways

On the basis of the current understanding of land-use conditions, the most plausible exposure settings considered for characterizing human health risks are described in this section.

As shown in Figure 5-1, surface and subsurface liquid discharge from the 200 East and 200 West Area facilities (primarily B, T, and U Plants and the Reduction-Oxidation Plant [REDOX] [or S Plant]) are the primary source and release mechanisms at the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. Liquid effluents (i.e., first- and second-cycle waste effluents from the tank farms, effluents from the tributyl phosphate processes and from the URP process, and other process condensates) from the 200 East and 200 West Area source facilities were distributed to the waste sites via pipes or trucks. Populations that are potentially exposed to shallow-zone soils 0 to 4.6 m (0 to 15 ft) bgs from the waste sites, under reasonably anticipated site use conditions, include current and future industrial workers. Potential routes of human exposure associated with shallow-zone soil include direct-contact routes (incidental soil ingestion, direct exposure, and dermal contact), and inhalation of dust and VOCs during excavation activities.

Soil samples collected from the 216-B-46 and 216-T-26 Cribs were evaluated for the 216-TW-1 OU; soil samples collected from 216-B-7B Crib and 216-B-38 Trench were evaluated for the 216-TW-2 OU; and soil samples collected from the 216-B-57 Crib were evaluated for the 216-PW-5 OU. The point of compliance for shallow-zone soils is evaluated using samples collected at depths between 0 and 4.6 m (0 and 15 ft) bgs. These depths represent a reasonable estimate of the depth of soil that could be excavated and distributed in the shallow zone as a result of development activities [WAC 173-340-740(6)(d)].

Local groundwater is not a current source of drinking water at the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. In addition, local groundwater is not anticipated to become a future source of drinking water. Under current conditions, no complete human exposure pathways to

groundwater exist for these OUs. Risks associated with current contamination in the groundwater were not evaluated in this RI. The risks for the Central Plateau are discussed in PNNL-13788 and will continue to be evaluated through the ongoing groundwater program at the Hanford Site for the groundwater OUs. The potential for contaminants to migrate from the soil to groundwater was evaluated for the representative sites in the 200-TW-1 and 200-TW-2 OUs and for the 216-B-57 Crib by comparing soil concentrations to the WAC 173-340-747 groundwater protection standards for the nonradiological constituents, followed by fate and transport modeling for selected sites and contaminants. For radiological constituents, fate and transport modeling were used to evaluate this potential (see Chapter 4.0).

5.3 HUMAN HEALTH EVALUATION FOR NONRADIOLOGICAL CONSTITUENTS

The human health risk assessment for nonradiological constituents consists of the following components:

- **Human Health Risk Assessment Guidance.** Lists the guidance documents used
- **Contaminants of Potential Concern for Human Health.** Identifies the nonradiological contaminants considered to be most important to the evaluation of human health risk
- **Human Exposure Assessment.** Identifies the pathways by which potential human exposures could occur; describes how they are evaluated; and evaluates the magnitude, frequency, and duration of these exposures
- **Toxicity Assessment for Human Health.** Summarizes the toxicity of the selected contaminants and the relationship between magnitude of exposure and the occurrence of adverse health effects
- **Human Health Risk Characterization.** Integrates information from the exposure and toxicity assessments to characterize the risks to human health from potential exposure to contaminants in environmental media
- **Identification of Major Uncertainties and Assumptions.** Summarizes the basic assumptions used in the risk assessment, as well as limitations of data and methodology.

5.3.1 Human Health Guidance

The procedures used for the human health evaluation are consistent with those described in the following guidance documents:

- DOE/RL-91-45, *Hanford Site Risk Assessment Methodology*
- EPA/540/1-89/002, *Risk Assessment Guidance for Superfund (RAGS), Volume I -- Human Health Evaluation Manual, Part A (Interim Final)*
- OSWER Directive 9285.6-03, *Risk Assessment Guidance for Superfund, Vol. I Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, (Interim Final)*
- EPA/600/P-95/002Fa, *Exposure Factors Handbook*

- EPA/540/R/99/005, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim*
- EPA/600/P-92/003C, *Proposed Guidelines for Carcinogen Risk Assessment*
- EPA PB-963373, *Supplemental Guidance to RAGS: Calculating the Concentration Term.*

5.3.2 Contaminants of Potential Concern for Human Health

Contaminants of potential concern are those contaminants that should be carried through the human health risk quantification process. An initial screening of COPCs was conducted for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs during the DQO process (BHI-01356).

5.3.2.1 Data Used for Contaminants of Potential Concern Selection. Data evaluated for this risk assessment include shallow-zone soil samples collected from the 200-TW-1 OU area during 1991 and 2001 RI activities, from the 200-TW-2 OU area during the 2001 RI activities, and from the 200-PW-5 OU area during 1991 RI activities. Table 5-1 summarizes the soil samples, depth intervals, and sample collection dates.

All nonradiological constituents detected at least once were included in the risk assessment. The following summarizes the major attributes of data included in the risk assessment.

- Estimated values flagged with a "B" (inorganics only) or "J" qualifier were treated as detected concentrations.
- Data qualified as rejected (flagged "R") were not used in the risk assessment.
- Only the parent sample result was included in the analysis when field duplicate or split samples were collected.

Maximum concentrations in the 0 to 4.6 m (0- to 15-ft) zone were used as the estimated exposure point concentrations for calculating risks associated with direct exposure to contaminants. All nonradiological contaminants were detected in surface soil samples from each exposure area at least once, and their summary statistics are presented in Table 5-2. Thirty-five nonradiological and 10 radiological constituents were detected in shallow-zone soil at least once from the 216-B-46 Crib (200-TW-1 OU). Ten nonradiological and nine radiological constituents were detected in shallow-zone soil at least once from the 216-T-26 Crib (200-TW-1 OU). Twenty-four nonradiological and 14 radiological constituents were detected in shallow-zone soil at least once from the 216-B-38 Trench (200-TW-2 OU). Fourteen nonradiological and 13 radiological constituents were detected in shallow-zone soil at least once from the 216-B-7A Crib (200-TW-2 OU). Twenty-eight nonradiological and eight radiological constituents were detected in shallow-zone soil at least once from the 216-B-57 Crib (200-PW-5 OU).

During the RI activities, soil samples were analyzed for general chemical parameters. Although measurable concentrations of these constituents were reported, some will not be evaluated in this risk assessment. General contaminant parameters not included are chloride, pH, phosphate, sulfide, and total organic carbon.

These parameters are discussed in Section 3.2.1.4 and are evaluated for protection of groundwater in Tables 3-3 through 3-5.

5.3.2.2 Criteria for Selection of Nonradiological Contaminants of Potential Concern in Shallow-Zone Soil Samples. Criteria considered in identifying COPCs for shallow-zone soil from the 216-B-46 Crib, 216-T-26 Crib, 216-B-7A Crib, 216-B-38 Trench, and 216-B-57 Crib are as follows:

- Essential nutrients
- Background screening
- Comparison to WAC 173-340-745 Method C cleanup levels
- Availability of toxicity factors for use in calculating health risks.

A flowchart of the screening process used for the nonradioactive contaminants is presented in Figure 5-2.

5.3.2.3 Essential Nutrients. Essential nutrients are those contaminants considered essential for human nutrition. Recommended daily allowances are developed for essential nutrients to estimate safe and adequate daily dietary intakes (NAS 1989, *Recommended Daily Allowances*). Because calcium, magnesium, potassium, and sodium are considered to be essential nutrients and have no available toxicity factors, they were excluded from further consideration as COPCs.

5.3.2.4 Background Screening. The first criterion for identifying a contaminant as being of potential concern was its presence at a concentration higher than naturally occurring levels. Sitewide soil background levels for metals have been established for the Hanford Site. The statewide soil background level was used as the background level for cadmium. Sitewide and statewide soil background levels are not available for antimony, bismuth, boron, selenium, thallium, and uranium; if these metals were detected, they were compared to the WAC 173-340-745 Method C soil cleanup values. Because background criteria have not been developed for VOCs and semivolatile organic compounds (SVOC) in soils at the Hanford Site, any constituent detected in these fractions was carried forward into the next step of the screening evaluation.

Shallow-Zone Soil. Shallow-zone soil sample results 0 to 4.6 m (0 to 15 ft) bgs from each area of interest (i.e., 216-B-46 Crib, 216-T-26 Crib, 216-B-7A Crib, 216-B-38 Trench, and 216-B-57 Crib) were aggregated, and the maximum concentration of each metal detected in shallow-zone soil was compared to the 90th percentile background value. Summaries of metals compared to background values for each area of interest are presented in Table 5-3.

- For the 216-B-46 Crib, the following metals did not have available background levels or exceeded the 90th percentile background values: antimony, thallium, and uranium.
- For the 216-T-26 Crib and 216-B-38 Trench, uranium did not have an available background level.
- For the 216-B-7A Crib, the following metals did not have available background levels or exceeded the 90th percentile background values: lead and uranium.
- For the 216-B-57 Crib, silver exceeded the background level.

5.3.2.5 Comparison to *Washington Administrative Code* 173-340-745 Method C Soil Cleanup Values. The next criterion for identifying a contaminant as one of potential concern

was its presence at a concentration higher than WAC 173-340-745 cleanup levels. This comparison was performed in accordance with WAC 173-340-745.

Soil samples collected from these OUs meet the industrial classification; therefore, contaminant concentrations in shallow-zone soil are compared to the WAC 173-340-745 Method C direct exposure cleanup levels. Method C cleanup levels are developed assuming industrial-site use, which assumes that the primary exposure is to adult workers. Contaminants in shallow-zone soil that exceed the WAC-173-340-745 Method C soil cleanup levels for direct exposure were carried forward into the risk assessment.

Method C Comparison. Maximum shallow-zone soil sample results from each of the representative waste sites were compared to the Method C cleanup levels for direct contact exposure. This comparison is presented in Table 5-4. None of the constituents were present at concentrations greater than the Method C soil cleanup levels; therefore, no nonradiological contaminants were carried forward into the risk assessment.

5.4 RESRAD MODELING

The RESRAD modeling (ANL/EAD-4) was performed to evaluate the potential impacts from direct contact to current and future industrial workers from radiological constituents present in the shallow-zone of the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. The results of the modeling are discussed in Section 5.4.4. This qualitative assessment provides information to support decision making for the OU through the RI/FS process.

To determine the cumulative radionuclide doses, RESRAD Version 6.1 analysis was performed for the site-specific exposure pathways. The following exposure pathways are explained in the conceptual exposure model provided in Section 5.2 of this report:

- Direct exposure from external gamma radiation
- Inhalation
- Soil ingestion.

The RESRAD model allows the use of site-specific parameters that were gathered during the RI activities. Site-specific data from the RI used as input parameters include, but are not limited to, depth of contamination, geological layers, soil density, and volumetric moisture. A detailed discussion of the site-specific input parameters is provided in Section 5.4.2.

5.4.1 Criteria for Selection of Radiological Contaminants of Potential Concern in Shallow-Zone Soil Samples

Data evaluated include shallow-zone soil samples collected from the 200-TW-1 and 200-TW-2 OU representative sites and 2001 RI activities and surface soil samples from the 200-PW-5 OU representative site collected during the 1991 200-BP-1 OU RI. The soil samples included in the 200-TW-1, 200-TW-2, and 200-PW-5 OUs, depth interval, and sample collection date are summarized in Table 5-1.

All radiological constituents detected at least once were included in the RESRAD modeling analysis. As discussed previously, analytical data from the shallow zone (0 to 4.6 m [0 to 15 ft] bgs) were considered in the RESRAD model. The following major data attributes are included in the radiological evaluation.

- Estimated values flagged with a "J" qualifier were treated as detected concentrations.
- Data qualified as rejected (flagged "R") were not used in the risk assessment.
- Only the parent sample result was included in the analysis when field duplicate or split samples were collected.

Maximum concentrations of detected radionuclides in the 0 to 4.6 m (0- to 15-ft) depth range were used as estimated exposure point concentrations. All radiological constituents were detected in shallow-zone soil samples from each exposure area at least once, and their summary statistics are presented in Table 5-5.

5.4.2 RESidual RADioactivity Assumptions and Input Parameters

Site-specific data were used where available as input parameters to the RESRAD model (ANL/EAD-4). In addition, exposure assumptions from WAC 173-340-745 Method C and default RESRAD assumptions were used as inputs to the model. The input parameters, rationale for use, and reference for the source of the information are presented in Table 5-6. The conditions established to run the RESRAD models simulate the current conditions found at the waste sites based on the results of the RI activities. Radionuclides that were detected above background were used in the RESRAD models without subtracting out background concentrations. Radionuclides that were not detected above background were not included in the RESRAD runs.

An industrial-exposure scenario was used for the waste sites located inside the 200 Areas exclusive land-use boundary (as defined in the CLUP EIS [DOE/EIS-0222-F]). The industrial scenario assumes that no groundwater from the waste site will be used for drinking or irrigation purposes.

For the 216-B-46 and 216-B-57 Cribs, a single scenario was modeled, using the radiological exposure point concentrations provided in Table 5-5. Only minor contamination was located in the 0 to 4.6 m (0 o 15 ft) zone at these sites. The major zones of contamination are lower because of the depth of the cribs. For the 216-T-26 Crib, no RESRAD model was run because no contamination exists in the 0 to 4.6 m (0 to 15 ft) bgs.

For the 200-TW-2 OU, a no-cover scenario was considered to represent the worst case conditions. In addition, a scenario was run that included a layer of clean cover over the contaminated zone. Two waste sites were considered, the 216-B-7A Crib and the 216-B-38 Trench. The cover was assumed to be made up of backfill and stabilization material with physical properties similar to those of the contaminated zone. The two sites were modeled with cover thicknesses of 0.3 to 3 m (1 and 10 ft), respectively. An unplanned release was consolidated on top of the 216-B-7A Crib. Therefore, a minor zone of contamination exists about 0.3 m (1 ft) bgs. The major zone of contamination is greater than 4.6 m (15 ft) bgs.

5.4.3 Screening of Radiological Constituents

Criteria considered in identifying COPCs for shallow-zone soil from the 216-B-46 Crib, 216-T-26 Crib, 216-B-7A Crib, 216-B-38 Trench, and 216-B-57 Crib are as follows.

- Maximum detected concentrations of radiological constituents from each exposure area were compared to naturally occurring levels.
- Sitewide soil background levels for some radiological isotopes have been established for the Hanford Site.
- Sitewide soil background levels are not available for americium-241, carbon-14, radium-226, radium-228, thorium-228, and thorium-230. Therefore, if these isotopes were detected, they were included in the RESRAD evaluation.
- Gross alpha and gross beta were not included in the RESRAD evaluation.

Summaries of concentrations of each isotope compared to background values for each area of interest are presented in Table 5-7.

- For the 216-B-46 Crib, the following isotopes did not have available background levels or exceeded the 90th percentile background values: plutonium-238, radium-226, strontium-228, and thorium-228.
- For the 216-T-26 Crib, no isotopes exceeded the 90th percentile background values in the 0 to 4.6 m (0- to 15-ft) zone.
- For the 216-B-38 Trench, the following isotopes did not have available background levels or exceeded the 90th percentile background values: americium-241, cesium-137, plutonium-238, plutonium-239/240, and total beta radiostrontium.
- For the 216-B-7A Crib, the following isotopes did not have available background levels or exceeded the 90th percentile background values: carbon-14, cesium-137, and total beta radiostrontium.
- For the 216-B-57 Crib, the following isotopes did not have available background levels or exceeded the 90th percentile background values: cesium-137, plutonium-238, radium-226, and strontium-90.

5.4.4 RESidual RADioactivityResults

Each waste site except the 216-T-26 Crib was modeled separately, and calculation times were carried out to 1,000 yr. The 216-T-26 Crib did not have any radionuclides in the 0 to 4.6 m (0- to 15-ft) zone that exceeded background. The RESRAD modeling results are summarized in Tables 5-8 through 5-15 and are shown in Figures 5-3 through 5-16. In all cases, the primary pathway associated with the total dose and risk was from direct exposure to the shallow-zone soils.

5.4.4.1 200-TW-1 Operable Unit

216-B-46 Crib. The results of the RESRAD dose estimate for the shallow-zone soil with no cover are presented in Table 5-8 and Figure 5-3. The maximum total dose of 1.9 mrem/yr occurs at year 0; the dose at 150 yr is 1.7 mrem/yr; and the dose decreases to 0.9 mrem/yr at 1,000 yr. The total dose from this exposure area does not exceed the target dose level of 15 mrem/yr for

the industrial scenario. The primary radionuclide associated with total dose is radium-226 during the 1,000-yr period.

The results of the RESRAD risk estimate for the shallow-zone soil with no cover are presented in Table 5-9 and Figure 5-4. The maximum risk of 4.3×10^{-5} occurs at year 0; the risk at 150 yr is 3.8×10^{-5}; and the risk decreases to 2.0×10^{-6} at 1,000 yr. The primary risk contributor is radium-226 during the 1,000-yr period.

5.4.4.2 200-TW-2 Operable Unit

216-B-7A Crib – No Cover. The results of the RESRAD dose estimate for the shallow-zone soil with no cover are presented in Table 5-10 and Figure 5-7. The maximum total dose of 15.1 mrem/yr occurs at year 0; the dose at 150 yr is 0.5 mrem/yr; and the dose decreases to 0 mrem/yr at 1,000 yr. The total dose from this exposure area does not exceed the target dose level of 15 mrem/yr for the industrial scenario except at year 0. The primary radionuclide associated with total dose is cesium-137.

The results of the RESRAD risk estimates for the shallow-zone soil with no cover are presented in Table 5-11 and Figure 5-8. The maximum risk of 2.5×10^{-4} occurs at year 0; the risk at 150 yr is 7.7×10^{-6}; and the risk decreases to 2.3×10^{-14} at 1,000 yr. The primary risk contributor is cesium-137.

216-B-7A Crib – With Cover. The results of the RESRAD dose estimate for the shallow-zone soil with 0.3 m (1 ft) of cover are presented in Table 5-10 and Figure 5-9. The total dose is 0.08 mrem/yr at year 0; the dose at 150 yr is 0.04 mrem/yr; and the dose decreases to 0 mrem/yr at 1,000 yr. The total dose from this exposure area does not exceed the target dose level of 15 mrem/yr for the industrial scenario at any time. The primary radionuclide associated with total dose is cesium-137.

The results of the RESRAD risk estimate for the shallow-zone soil with 0.3 m (1 ft) of cover are presented in Table 5-11 and Figure 5-10. The total risk is 1.6×10^{-6} at year 0; the risk at 150 yr is 8.3×10^{-7}; and the risk decreases to 2.3×10^{-14} at yr 1,000. The primary risk contributor is cesium-137.

216-B-38 Trench – No Cover. The results of the RESRAD dose estimate for the shallow-zone soil with no cover are presented in Table 5-12 and Figure 5-11. The maximum total dose of 128,300 mrem/yr occurs at year 0; the dose at 150 yr is 4,009 mrem/yr; and the dose decreases to 1.2 mrem/yr at 1,000 yr. The total dose from this exposure area exceeds the target dose level of 15 mrem/yr for the industrial scenario until after 300 yr have passed. The primary radionuclide associated with the total dose is cesium-137.

The results of the RESRAD risk estimate for the shallow-zone soil with no cover are presented in Table 5-13 and Figure 5-12. The maximum risk is greater than 1×10^{-2} from 0 to past 150 yr. The risk decreases to 3.99×10^{-6} at 1,000 yr. The primary risk contributor is cesium-137 for past 500 yr; plutonium-238 is the primary risk contributor at 1,000 yr.

216-B-38 Trench – With Cover. The results of the RESRAD dose estimate for the shallow-zone soil with 10 ft of cover are presented in Table 5-12 and Figure 5-13. The total dose decreases from 3.45×10^{-13} mrem/yr at year 0 to 6.3×10^{-17} mrem/yr at 1,000 yr. The total dose from this exposure area does not exceed the target dose level of 15 mrem/yr for the industrial scenario at any time. The primary radionuclide associated with the total dose is cesium-137, except at 1,000 yr, where plutonium-238 is the primary risk contributor.

The results of the RESRAD risk estimate for the shallow-zone soil with 10 ft of cover are presented in Table 5-13 and Figure 5-14. The total risk decreases from 6.73×10^{-18} at year 0 to 1.57×10^{-21} at yr 1,000. The primary risk contributor is cesium-137, except at 1,000 yr, where plutonium-238 is the primary risk contributor.

5.4.4.3 200-PW-5 Operable Unit

216-B-57 Crib – No Cover. The results of the RESRAD dose estimate for the shallow-zone soil with no cover are presented in Table 5-14 and Figure 5-15. The maximum total dose of 26.1 mrem/yr occurs at year 0; the dose at 150 yr is 2.73 mrem/yr; and the dose decreases to 1.04 mrem/yr at 1,000 yr. The total dose from this exposure area exceeds the target dose level of 15 mrem/yr for the industrial scenario until after 30 yr have passed. The primary radionuclide associated with the total dose is cesium-137 to 150 yr, and then the primary risk contributor becomes radium-226.

The results of the RESRAD risk estimate for the shallow-zone soil with no cover are presented in Table 5-15 and Figure 5-16. The total risk decreases from a maximum of 4.41×10^{-4} at year 0 to a minimum of 2.31×10^{-5} at 1,000 yr. The primary risk contributor is cesium-137 to 30 yr, and then radium-226 becomes the primary risk contributor.

5.4.5 Protection of Groundwater Modeling

The RESRAD model also was used to obtain risk and dose estimates for protection of the groundwater pathway. The results obtained from the RESRAD model for the groundwater protection model are limited to screening purposes only. Additional modeling for the protection of groundwater evaluation was conducted using the STOMP code (PNNL-12034) as described in Chapter 4.0.

The concentrations used in the RESRAD modeling for protection of groundwater are listed in Table 5-16. The other inputs used in the model are listed in Table 5-6. The results of the RESRAD dose estimates and risk estimates for the groundwater protection pathway for the 200-TW-1 OU are presented in Tables 5-17 and 5-18, respectively. The results of the RESRAD dose estimates and risk estimates for the 200-TW-2 OU are presented in Tables 5-19 and 5-20, respectively. As shown, no radiological constituents at the 200-TW-1 OU representative sites impact the groundwater pathway during the 1,000-yr evaluation period. For the 200-TW-2 OU representative sites, technetium-99 reaches groundwater in the later years; however, concentrations do not exceed acceptable risk and dose levels.

5.4.6 Uncertainty Analysis

Several sources of uncertainty affect the overall estimates of excess lifetime cancer risk and noncancer hazard as presented in this risk assessment. The sources generally are associated with sampling and analysis, exposure assumptions, toxicity values, and risk characterization, and are summarized in Table 5-21.

5.4.6.1 Uncertainty Associated with Sampling and Analysis

Uncertainties associated with sampling and analysis include the inherent variability (standard error) in the analysis, representativeness of the samples, sampling errors, and heterogeneity of the sample matrix. While the quality assurance/quality control program used in conducting the

sampling and analysis serves to reduce errors, it cannot eliminate all errors associated with sampling and analysis.

5.4.6.2 Uncertainty Associated with Exposure Assessment

Future soil exposure point concentrations (EPC) were assumed to be equal to existing soil concentrations. This assumption does not account for fate and transport processes likely to occur in the future; risk estimates are likely to be overestimated for future exposure scenarios.

The estimation of exposure requires many assumptions to describe potential exposure situations. There are uncertainties regarding the likelihood of exposure, frequency of contact with contaminated media, the concentration of contaminants at exposure points, and the time period of exposure. These tend to simplify and approximate actual site conditions. In general, these assumptions are intended to be conservative and yield an overestimate of the true risk or hazard.

The WAC 173-340-745 default exposure assumptions were conservatively used to estimate the future unrestricted land-use and current and future industrial land-use scenarios. It is unlikely that a worker will remain at the same job for a full work year over a 20-year exposure duration. The default exposure assumptions for the industrial land-use scenarios likely overestimate risk at the site.

5.4.6.3 Uncertainty Associated with Toxicity Assessment

The toxicological database also was a source of uncertainty. The EPA has outlined some of the sources of uncertainty in the risk assessment guidance for the Superfund (EPA/540/1-89/002). These sources may include or result from the extrapolation from high to low doses and from animals to humans; the species, gender, age, and strain differences in a toxin's uptake, metabolism, organ distribution, and target site susceptibility; and the human population's variability with respect to diet, environment, activity patterns, and cultural factors.

5.4.6.4 Uncertainty Associated with Risk Characterization

In the risk characterization, the assumption was made that the total risk of developing cancer from exposure to site contaminants is the sum of the risk attributed to each individual contaminant. This approach, in accordance with EPA guidance, did not account for the possibility that constituents act synergistically or antagonistically.

5.5 ECOLOGICAL RISK SCREENING

DOE/RL-2001-54 presents the screening-level ecological risk assessment for the Central Plateau. Tables 5-3, 5-4, and 5-7 provide the OU-specific screening of contaminants against ecological screening levels, including WAC 173-340-900, Table 749-3, and the BCGs from DOE/STD-1153-2002. For the nonradionuclides, only wildlife screening levels were considered, because the waste sites are in an industrial area.

DOE's graded approach for evaluating radiation doses to biota is a three-step process that is designed to guide a user from an initial, conservative general screening to a more rigorous analysis using site-specific information, if needed. The three-step process is as follows.

1. Assemble radionuclide concentration data and knowledge of sources, receptors, and routes of exposure for the area to be evaluated.

2. Apply an easy-to-use general screening methodology that provides limiting radionuclide concentration values (i.e., BCGs) in soil, sediment, and water.
3. If needed, conduct an analysis through site-specific screening, site-specific analysis, or an actual site-specific biota dose assessment conducted within an ecological risk framework, similar to that recommended by EPA/630/R-95/002F, *Guidelines for Ecological Risk Assessment*.

Any steps within the graded approach may be used at any time, but the general screening methodology usually will be the simplest, most cost-effective, and least time-consuming.

The BCGs contained in DOE/STD-1153-2002 are tabled soil concentrations judged to be protective of the most sensitive terrestrial organisms, assuming a dose of 0.1 rad/day.[1] Each radionuclide-specific BCG represents the limiting radionuclide concentration in environmental media that would not exceed DOE's established or recommended dose standards for biota. Therefore, soil concentrations less than the BCGs are not considered to pose a threat to terrestrial receptors.

The following summarizes the screening results and identifies contaminants that will be evaluated further for potential ecological impacts during the FS.

- For the 200-TW-1 OU, no contaminants were identified above the ecological screening levels for nonradionuclides or radionuclides.
- For the 200-TW-2 OU, cesium-137 and strontium-90 concentrations exceeded the screening levels. No nonradionuclide contaminants exceeded the screening levels.
- For the 200-PW-5 OU, cesium-137 and strontium-90 concentrations exceeded the screening levels. No nonradionuclide contaminants exceeded the screening levels.

[1] Terrestrial plant species are assumed to be protected at sites containing a dose of up to 1 rad/day (DOE/STD-1153-2002).

Figure 5-1. Conceptual Exposure Model for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units.

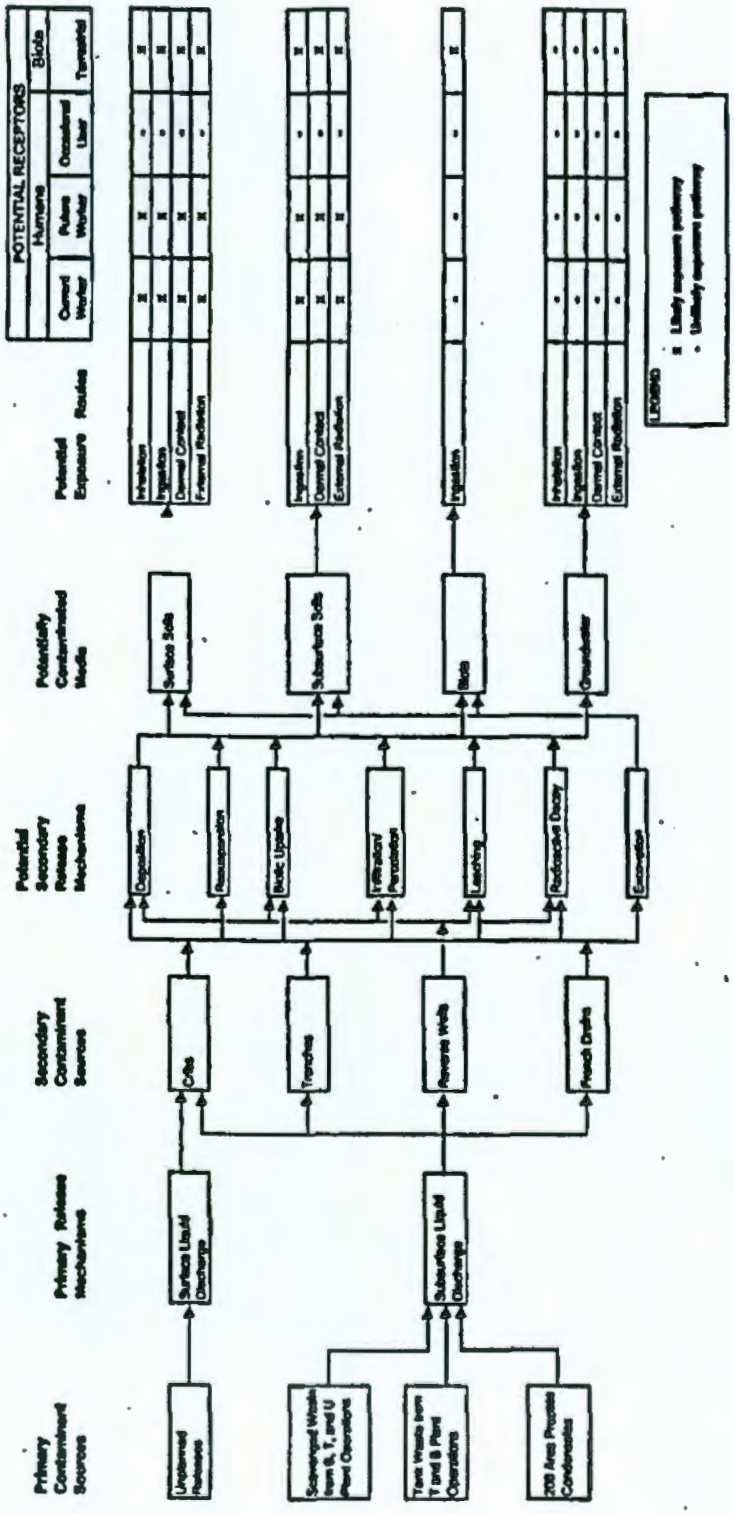


Figure 5-2. Data Evaluation Process for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Unit Remedial Investigations. (2 pages)

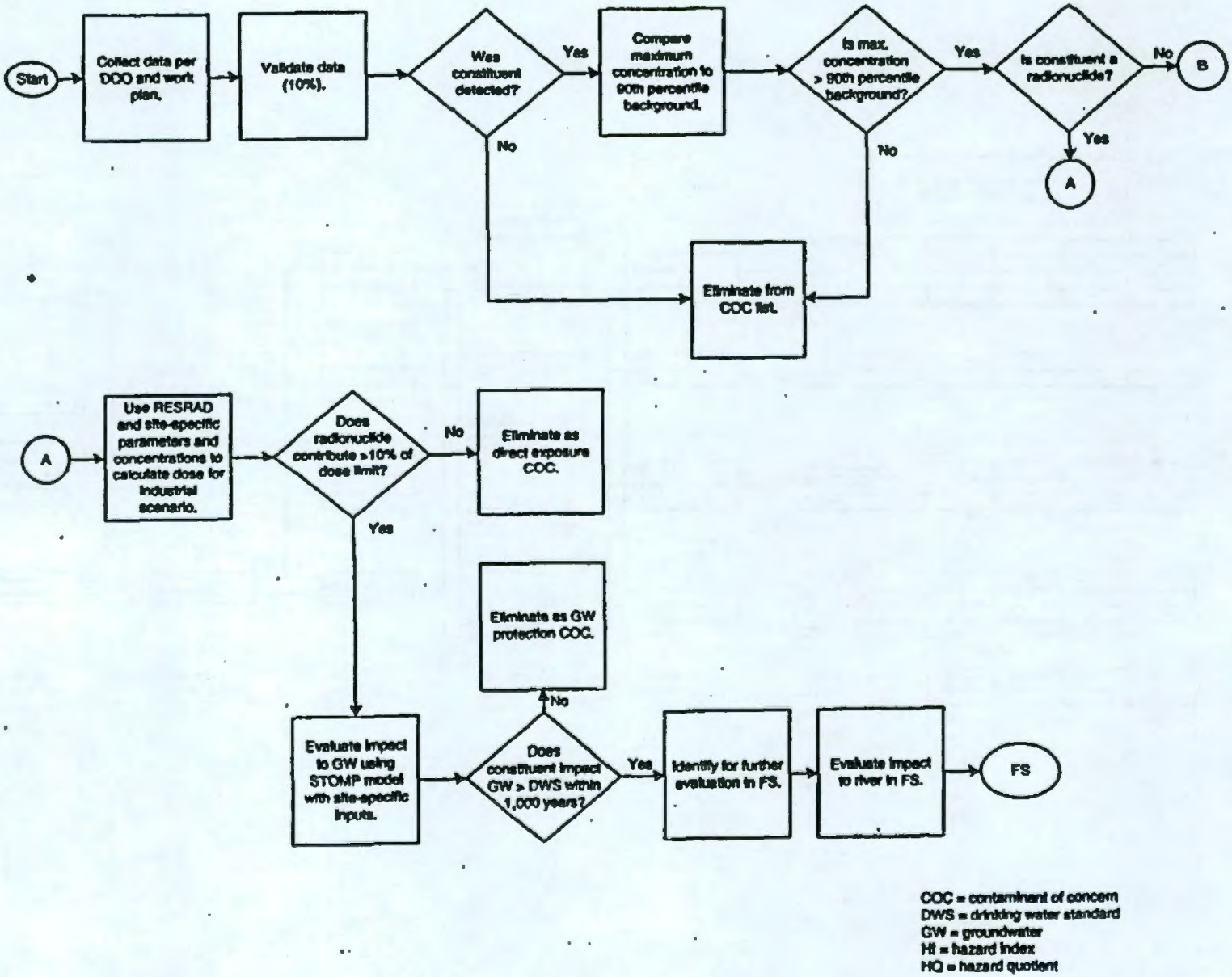


Figure 5-2. Data Evaluation Process for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Unit Remedial Investigations. (2 pages)

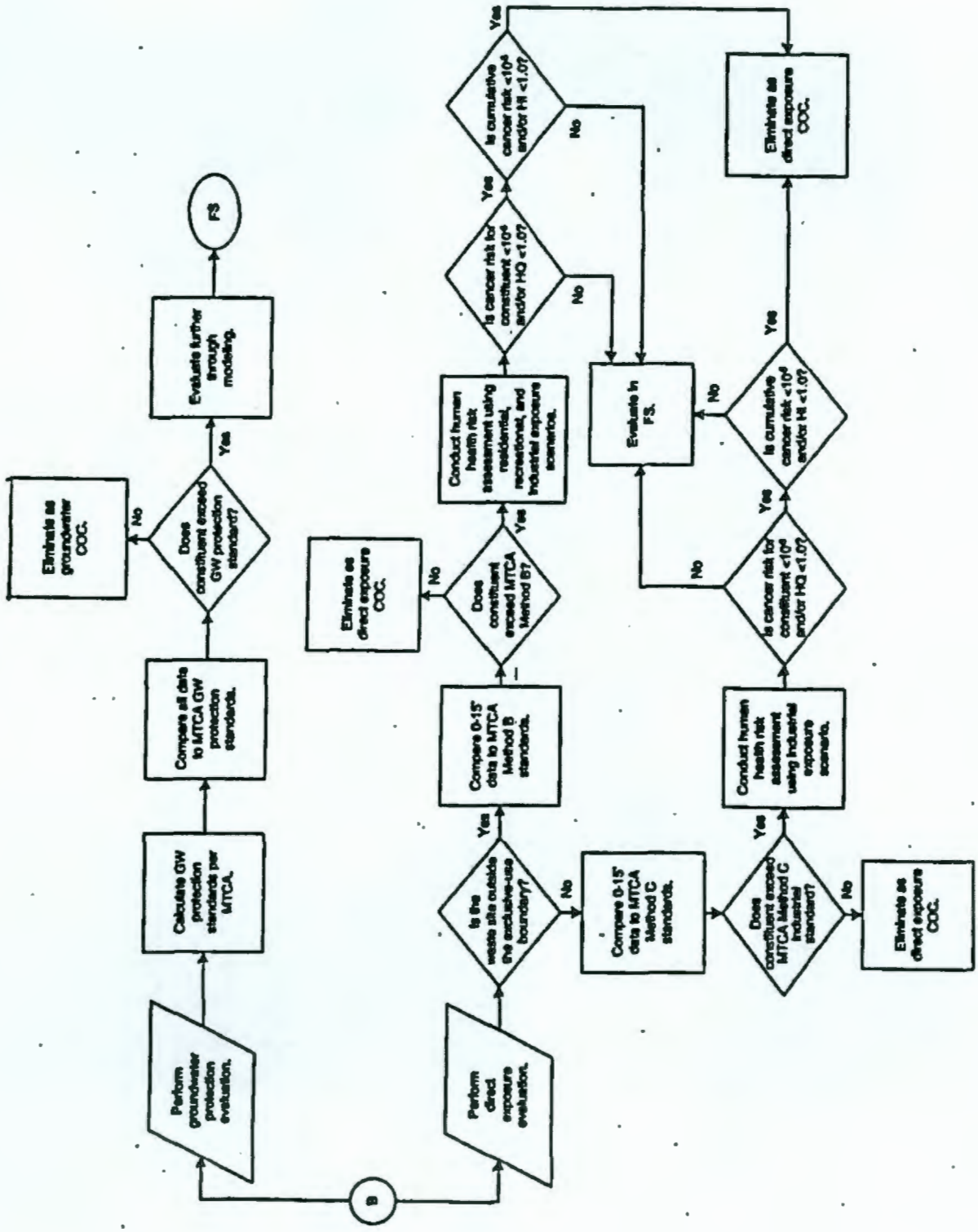
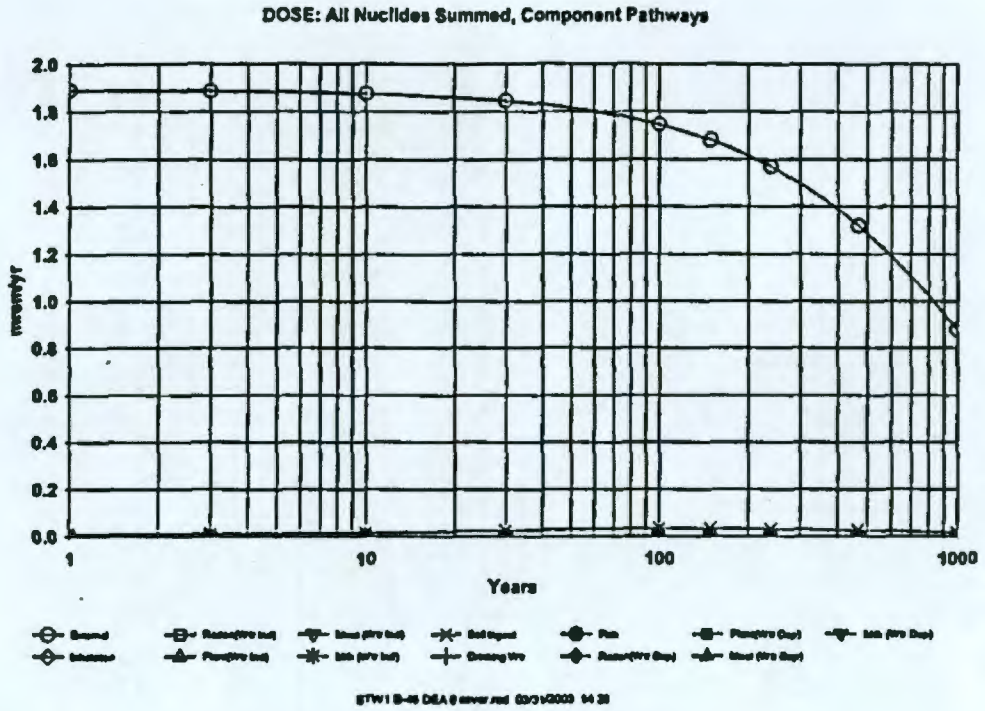


Figure 5-3. RESidual RADioactivity Analysis for the 200-TW-1 Operable Unit, 216-B-46 Crib – All Radionuclides, All Pathways Dose Estimate (No Cover, Direct Contact Scenario).



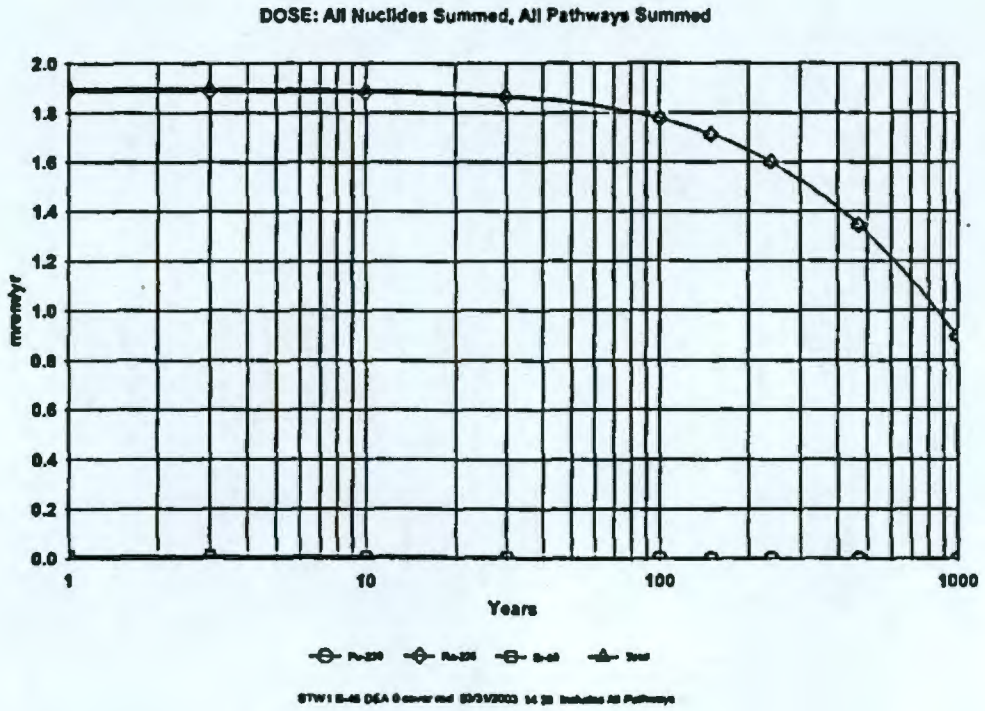
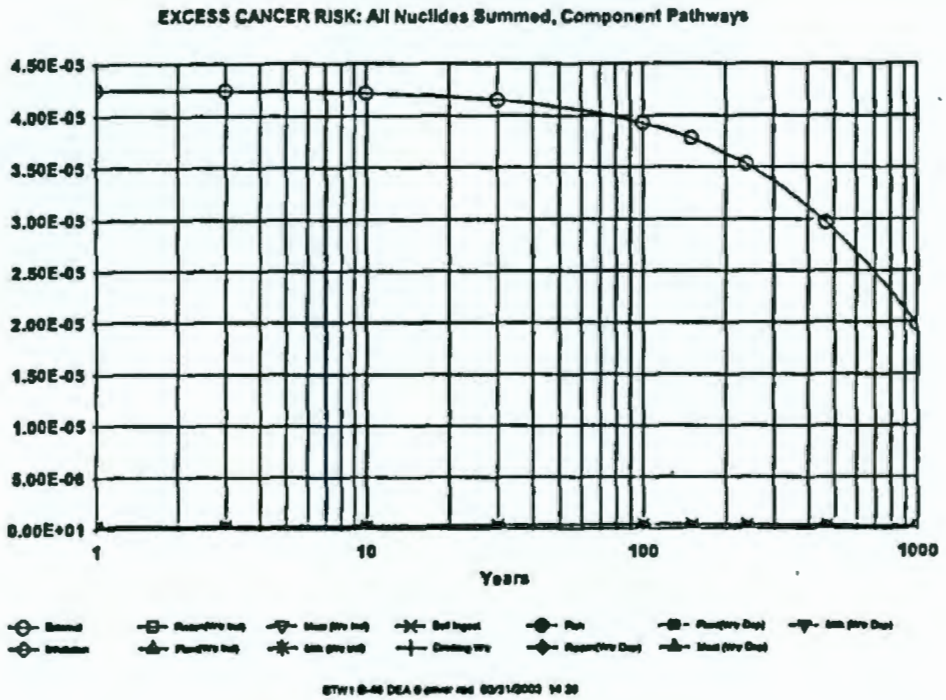


Figure 5-4. RESidual RADioactivity Analysis for the 210-TW-1 Operable Unit, 216-B-46 Crib – All Radionuclides, All Pathways Risk Estimate (No Cover, Direct Contact Scenario).



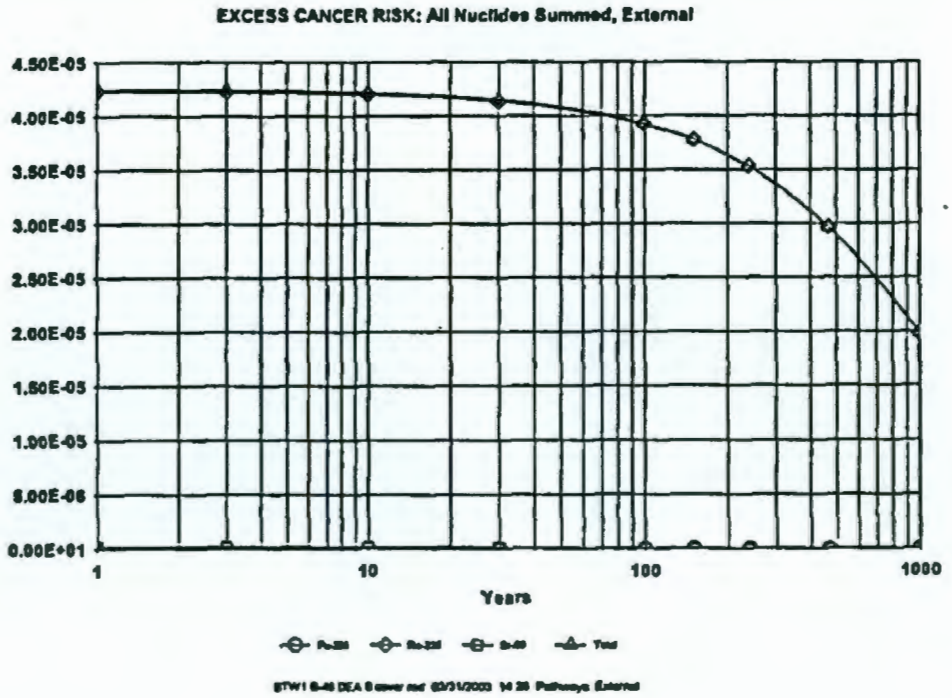
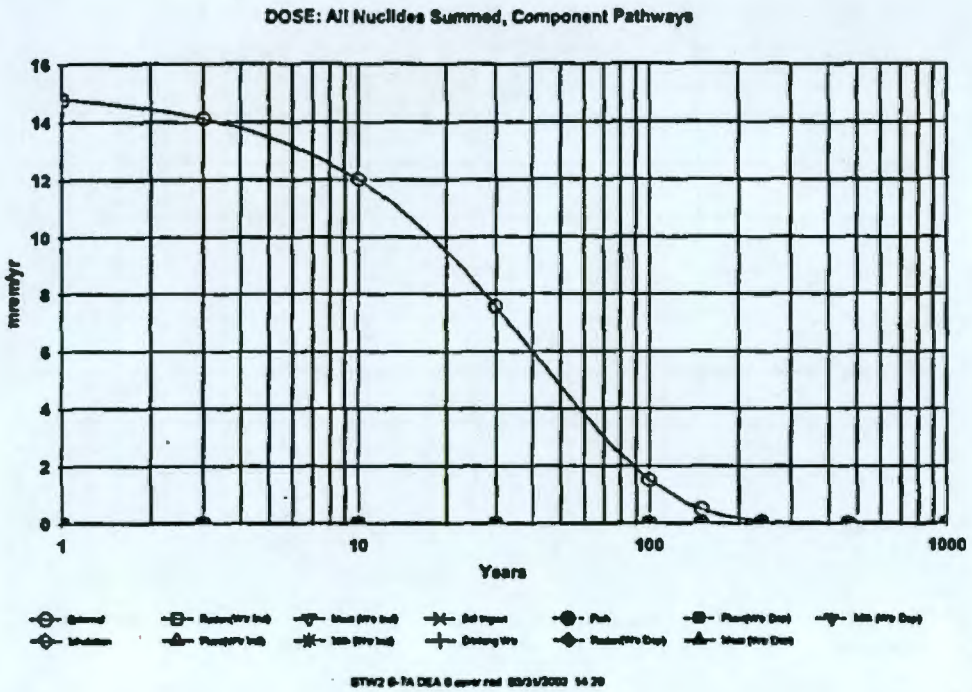


Figure 5-5. RESidual RADioactivity Analysis for the 200-TW-2 Operable Unit, 216-B-7A Crib – All Radionuclides, All Pathways Dose Estimate (No Cover, Direct Contact Scenario).



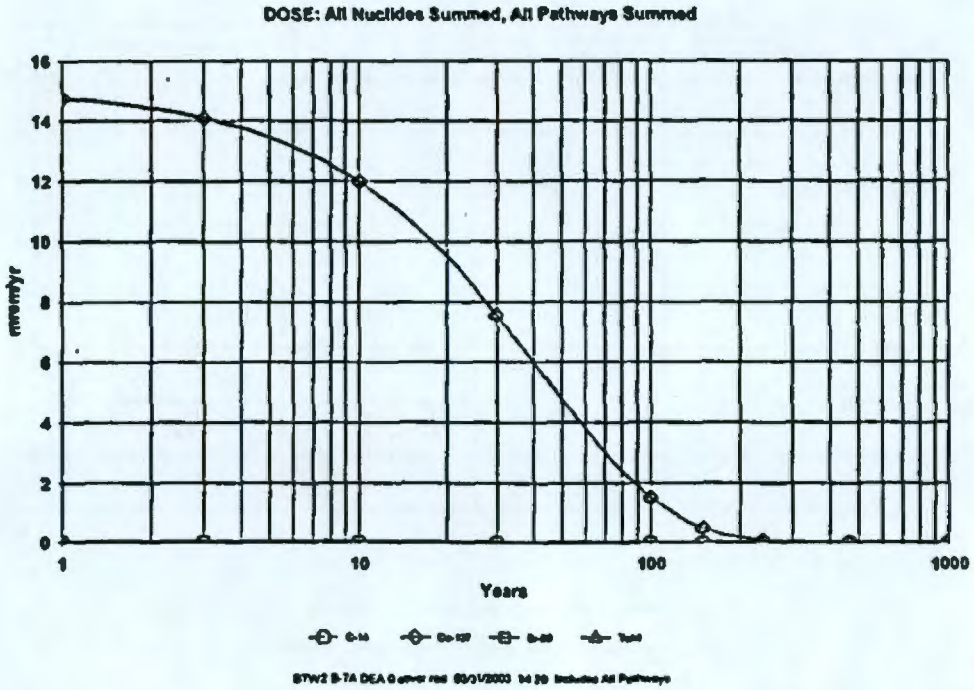
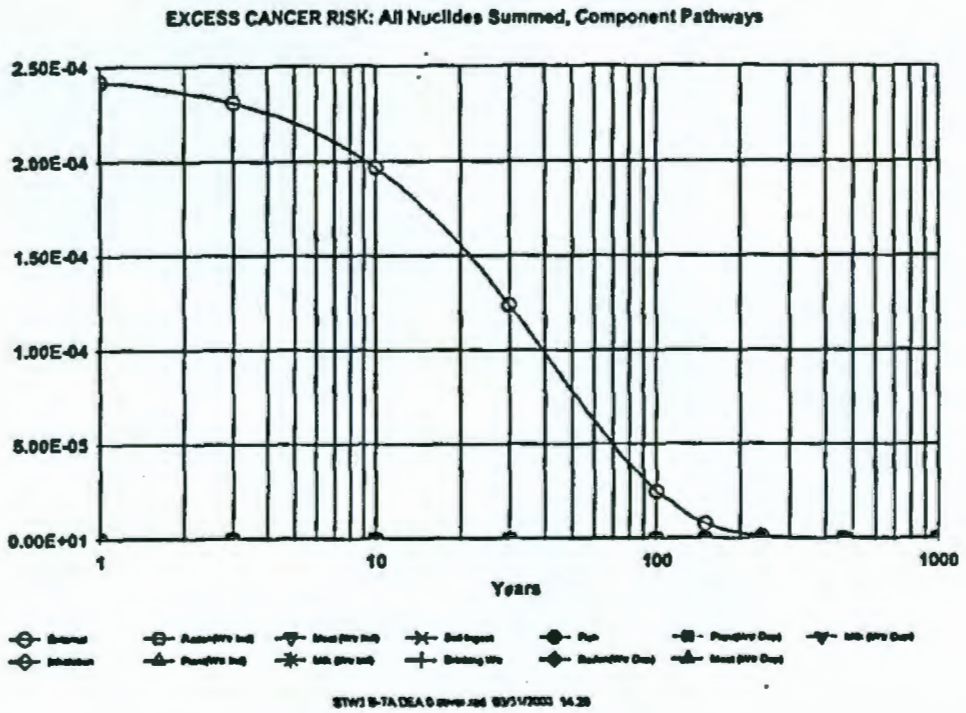


Figure 5-6. RESidual RADioactivity Analysis for the 200-TW-2 Operable Unit, 216-B-7A Crib – All Radionuclides, All Pathways Risk Estimate (No Cover, Direct Contact Scenario).



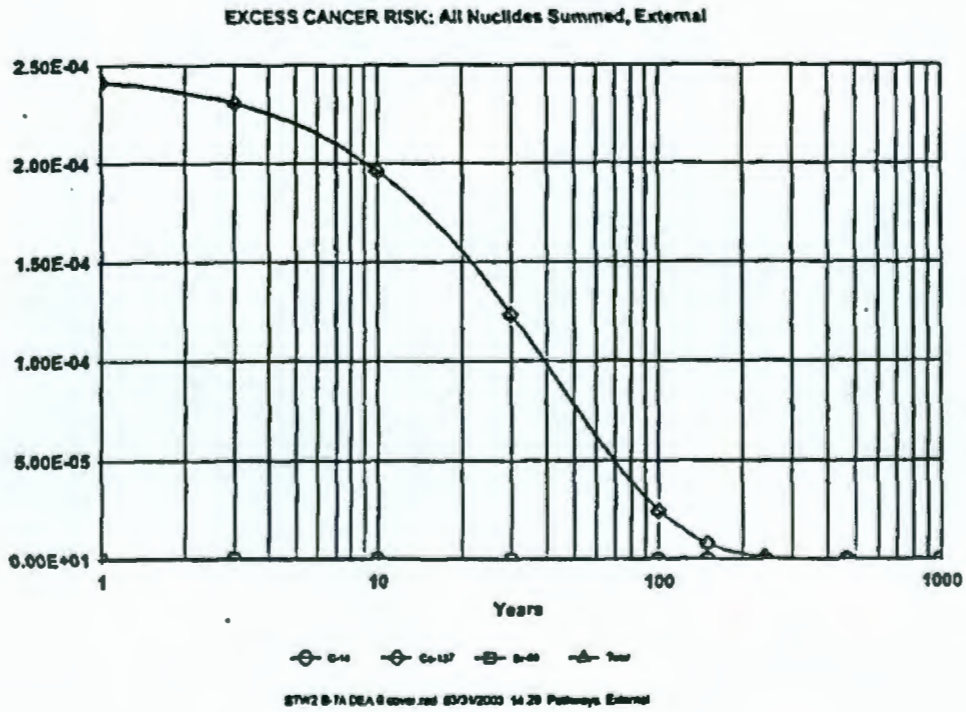
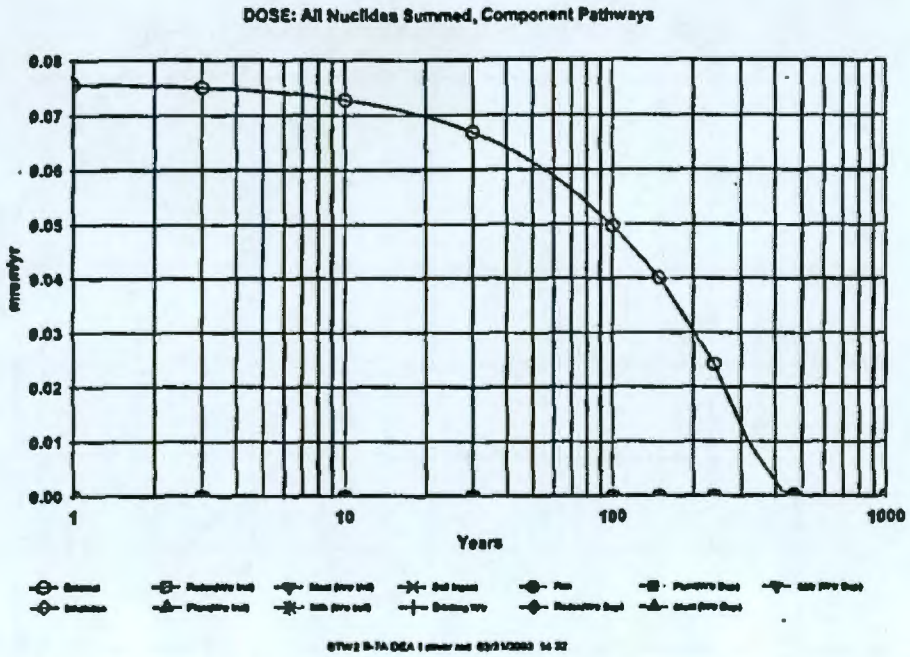


Figure 5-7. RESidual RADioactivity Analysis for the 200-TW-2 Operable Unit, 216-B-7A Crib – All Radionuclides, All Pathways Dose Estimate (1-ft Cover, Direct Contact Scenario).



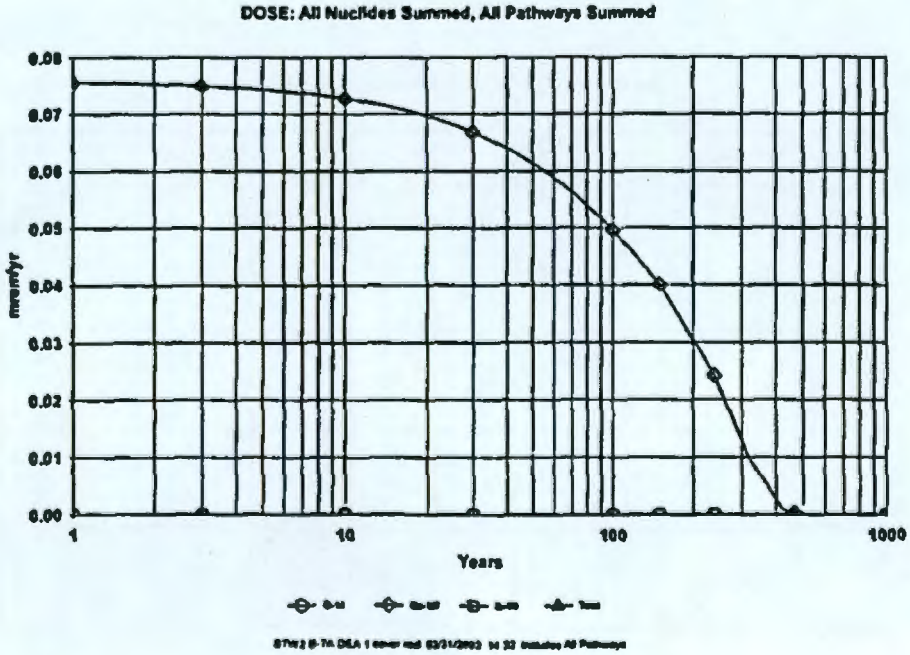
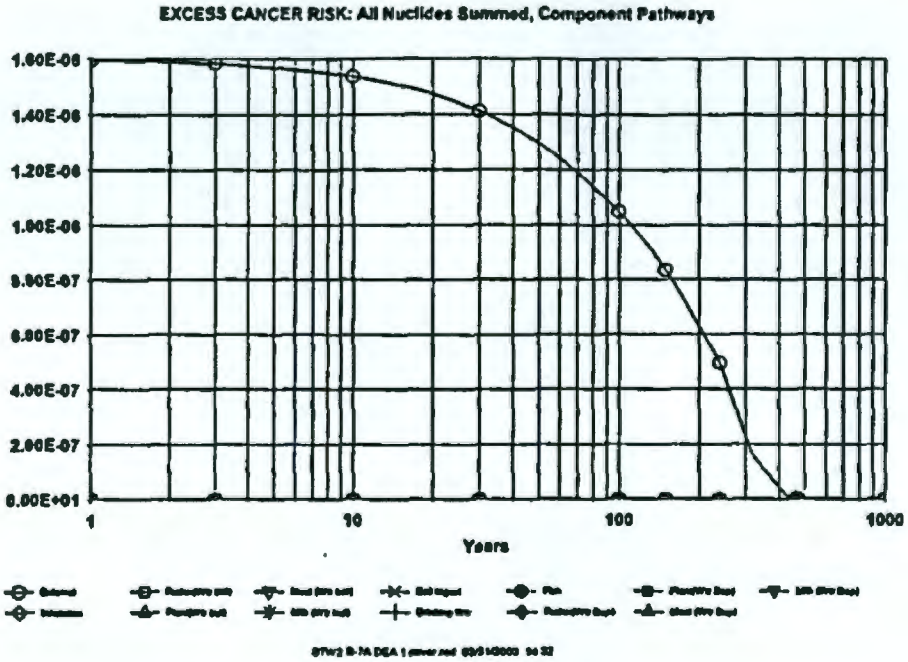


Figure 5-8. RESidual RADioactivity Analysis for the 200-TW-2 Operable Unit, 216-B-7A Crib – All Radionuclides, All Pathways Risk Estimate (1-ft Cover, Direct Contact Scenario).



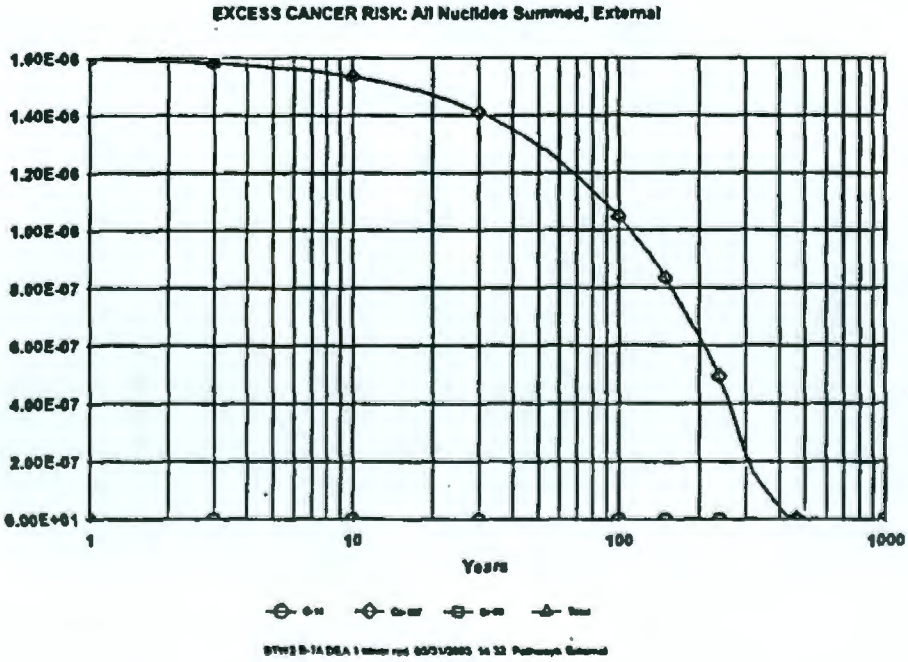
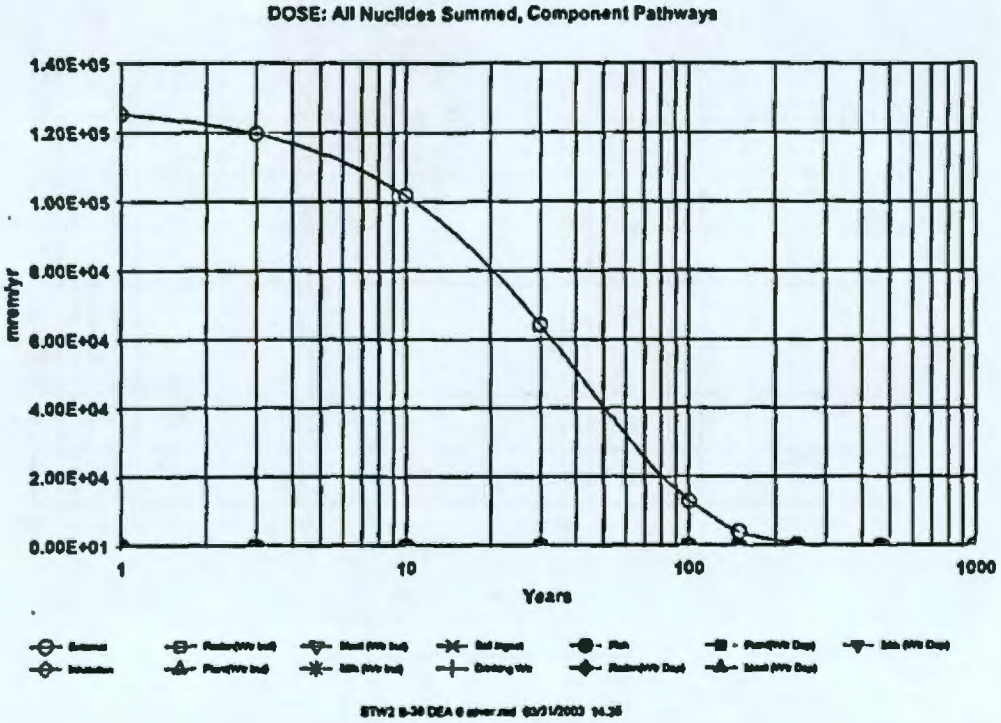


Figure 5-9. RESidual RADioactivity Analysis for the 200-TW-2 Operable Unit, 216-B-38 Trench – All Radionuclides, All Pathways Dose Estimate (No Cover, Direct Contact Scenario).



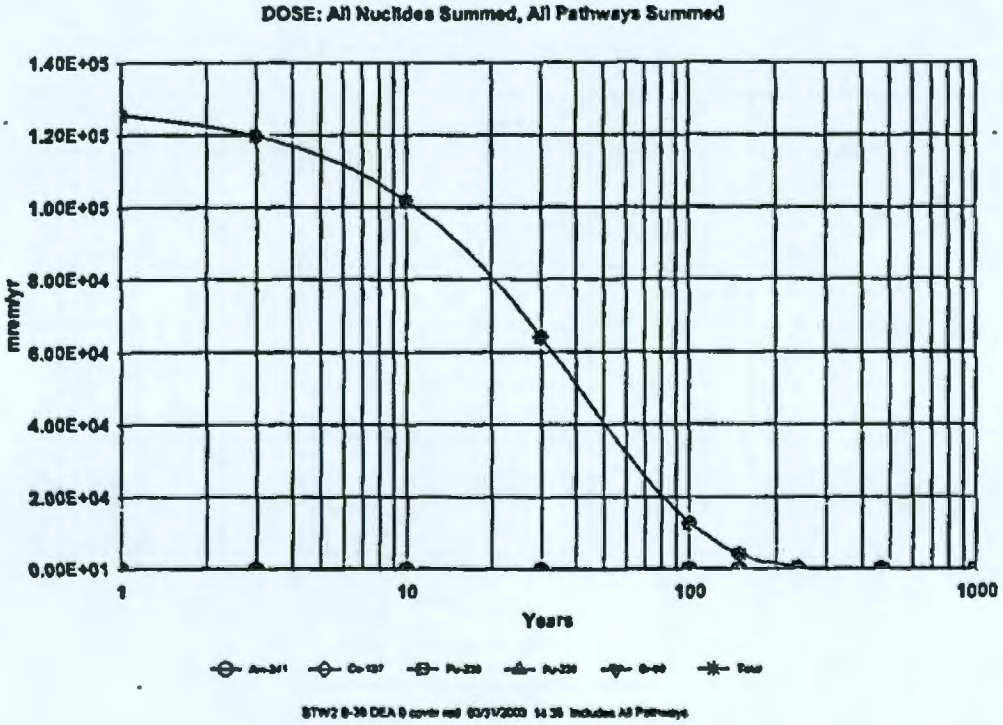
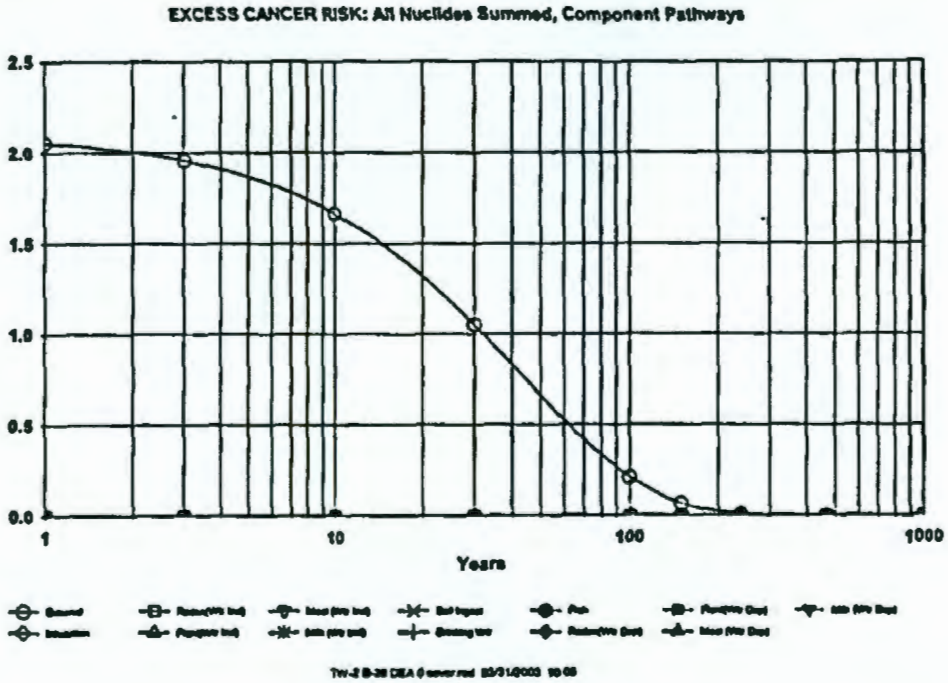


Figure 5-10. RESidual RADioactivity Analysis for the 200-TW-2 Operable Unit, 216-B-38 Trench – All Radionuclides, All Pathways Risk Estimate (No Cover, Direct Contact Scenario). (Note: Risks >1.0 are more correctly represented at >1 x 10^{-2})



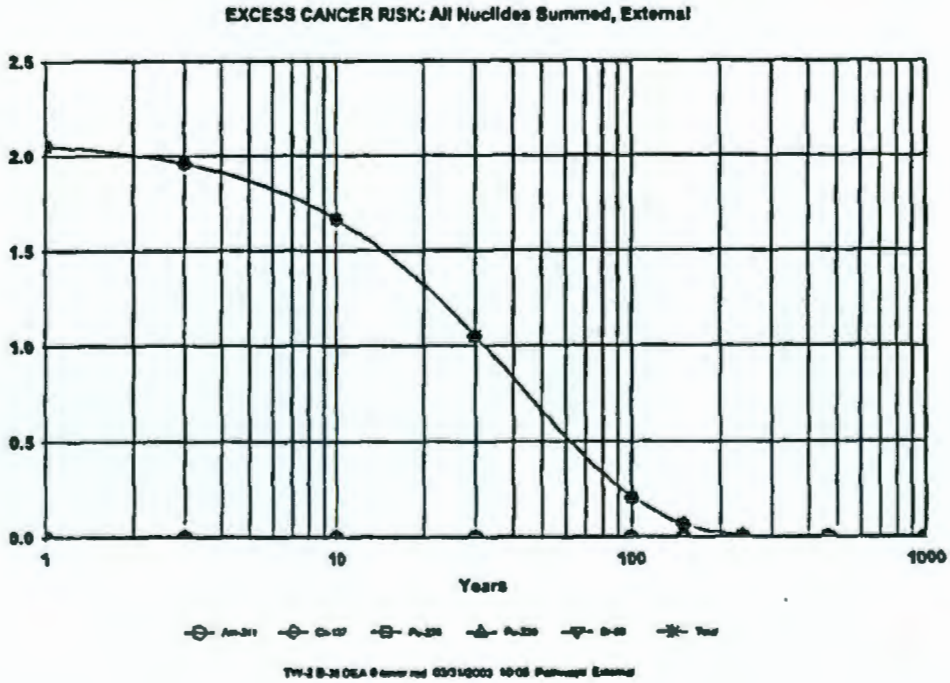


Figure 5-11. RESidual RADioactivity Analysis for the 200-TW-2 Operable Unit, 216-B-38 Trench – All Radionuclides, All Pathways Dose Estimate (10-ft Cover, Direct Contact Scenario).

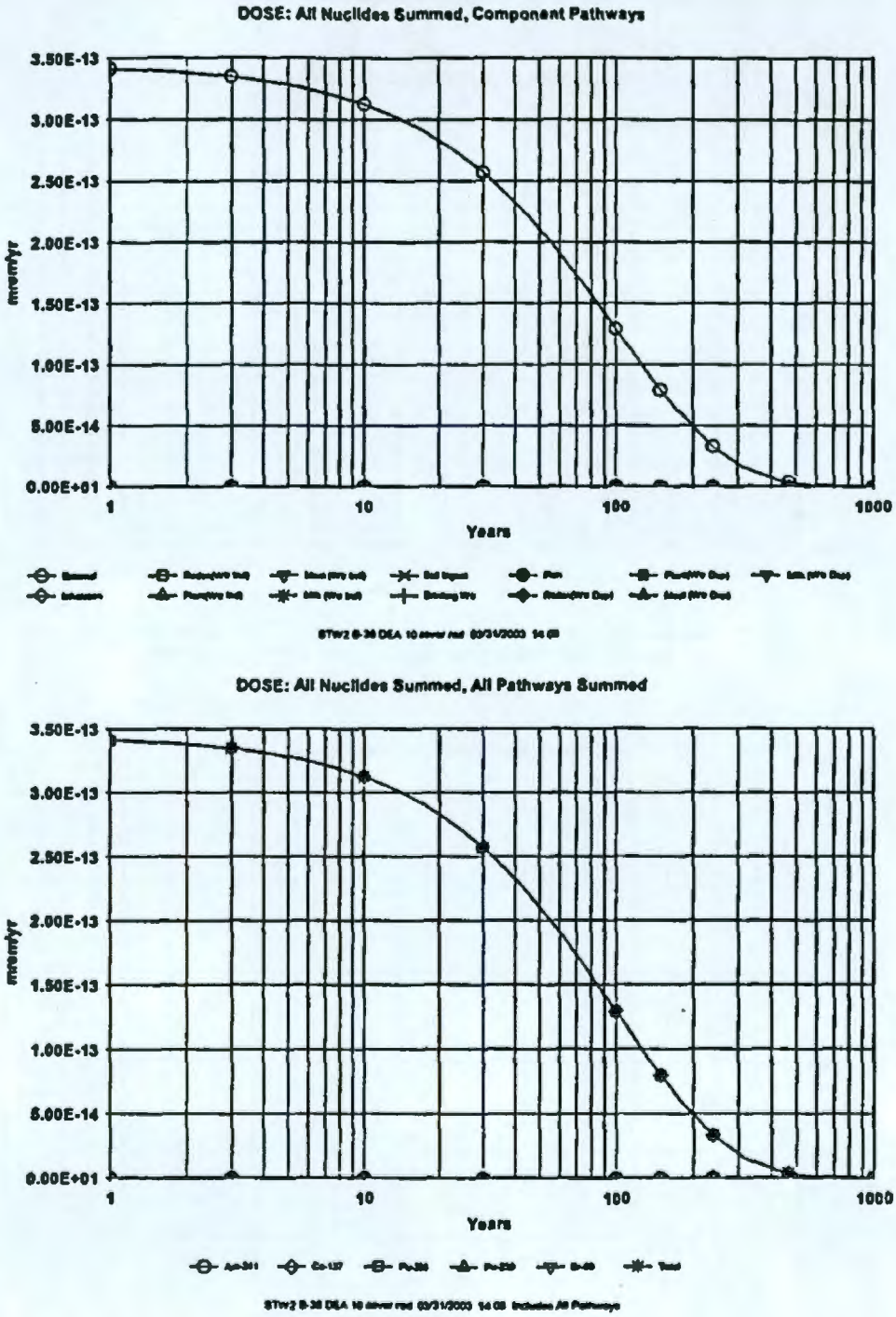
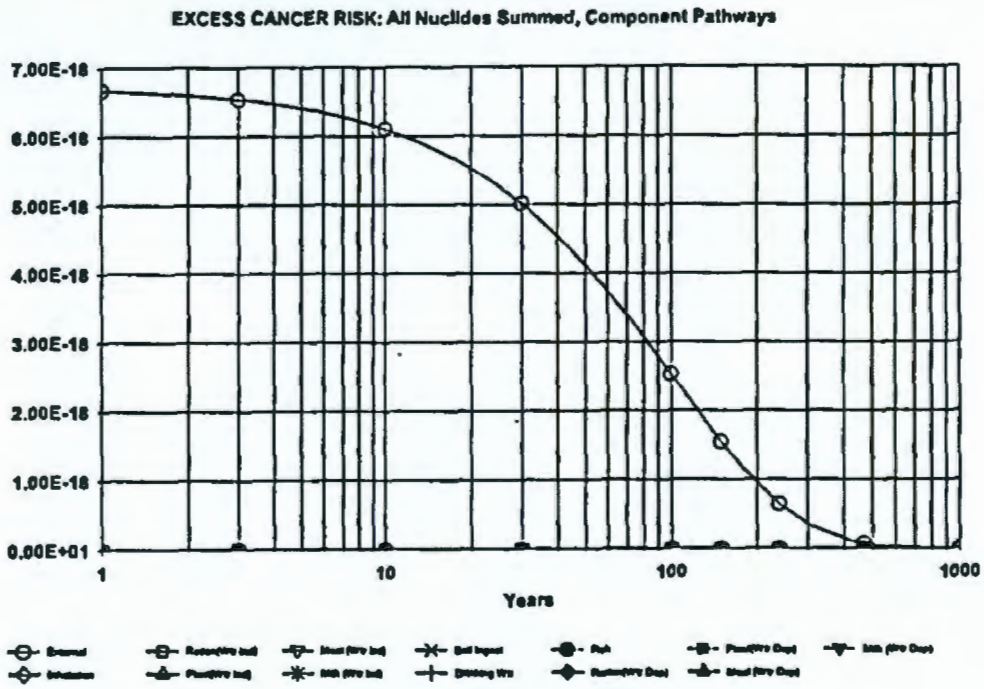


Figure 5-12. RESidual RADioactivity Analysis for the 200-TW-2 Operable Unit, 216-B-38 Trench – All Radionuclides, All Pathways Risk Estimate (10-ft Cover, Direct Contact Scenario).



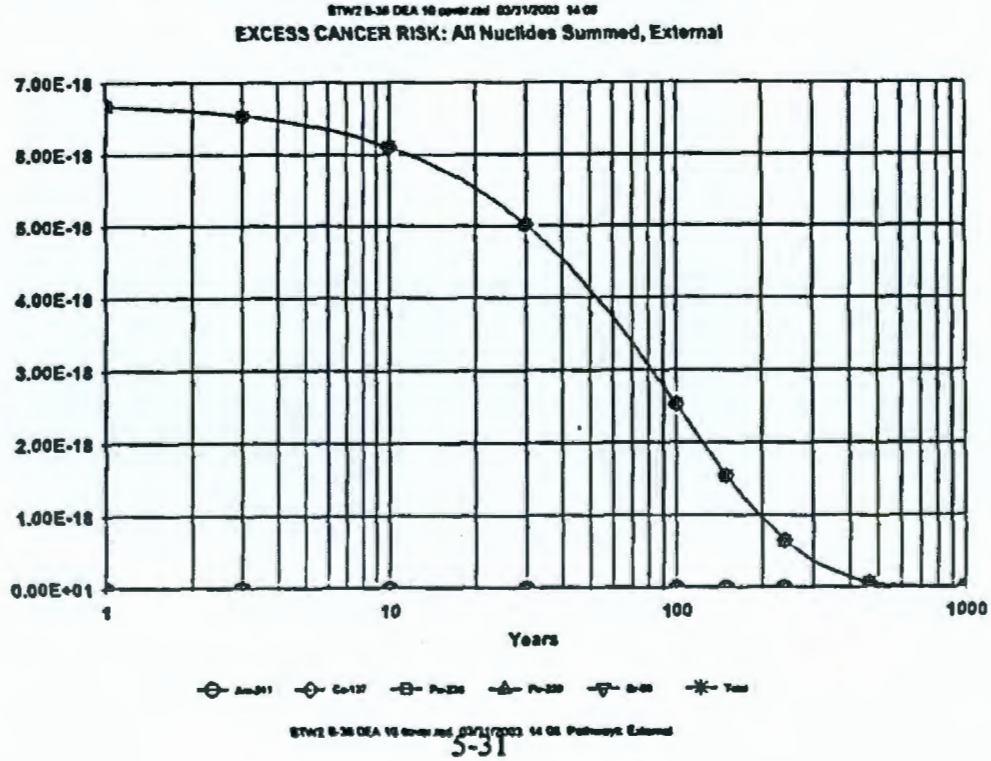
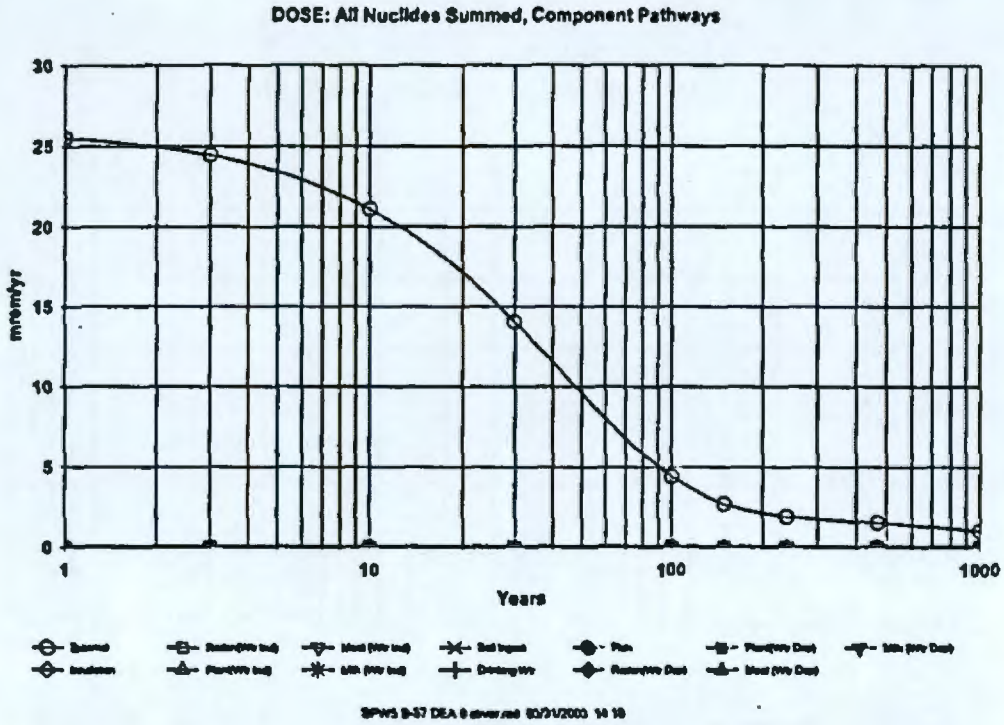


Figure 5-13. RESidual RADioactivity Analysis for the 200-PW-5 Operable Unit, 216-B-57 Crib – All Radionuclides, All Pathways Dose Estimate (No Cover, Direct Contact Scenario).



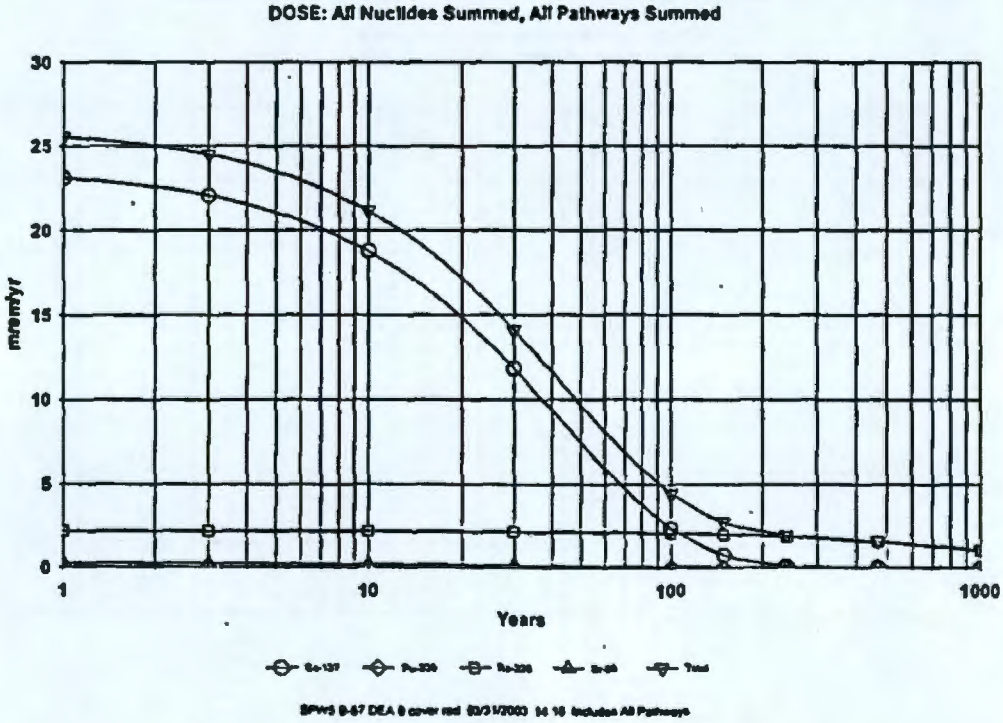
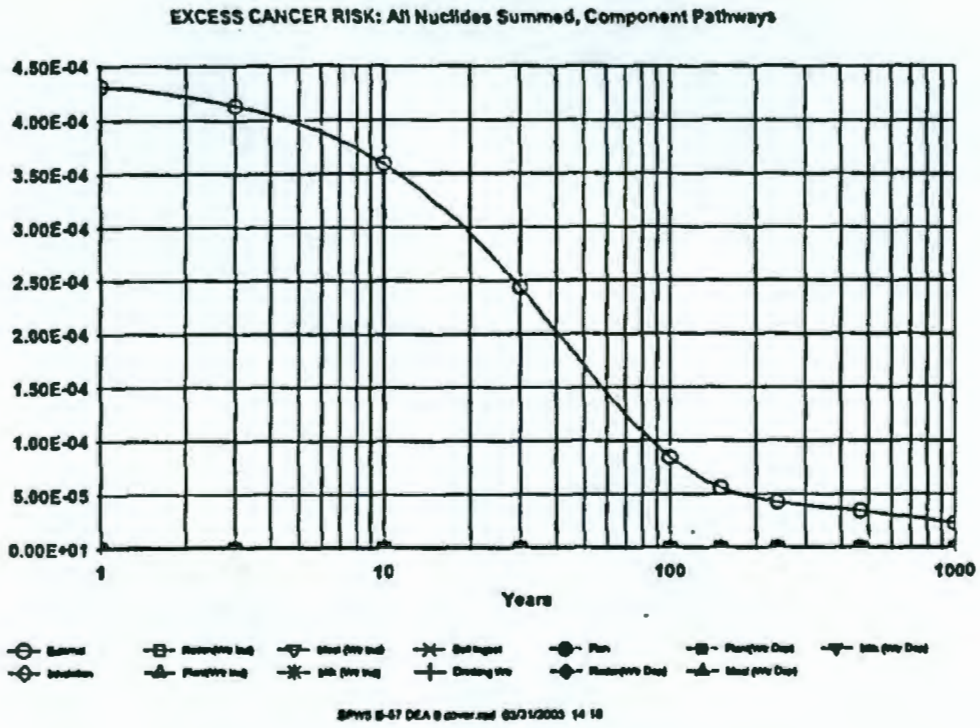


Figure 5-14. RESidual RADioactivity Analysis for the 200-PW-5 Operable Unit, 216-B-57 Crib – All Radionuclides, All Pathways Risk Estimate (No Cover, Direct Contact Scenario).



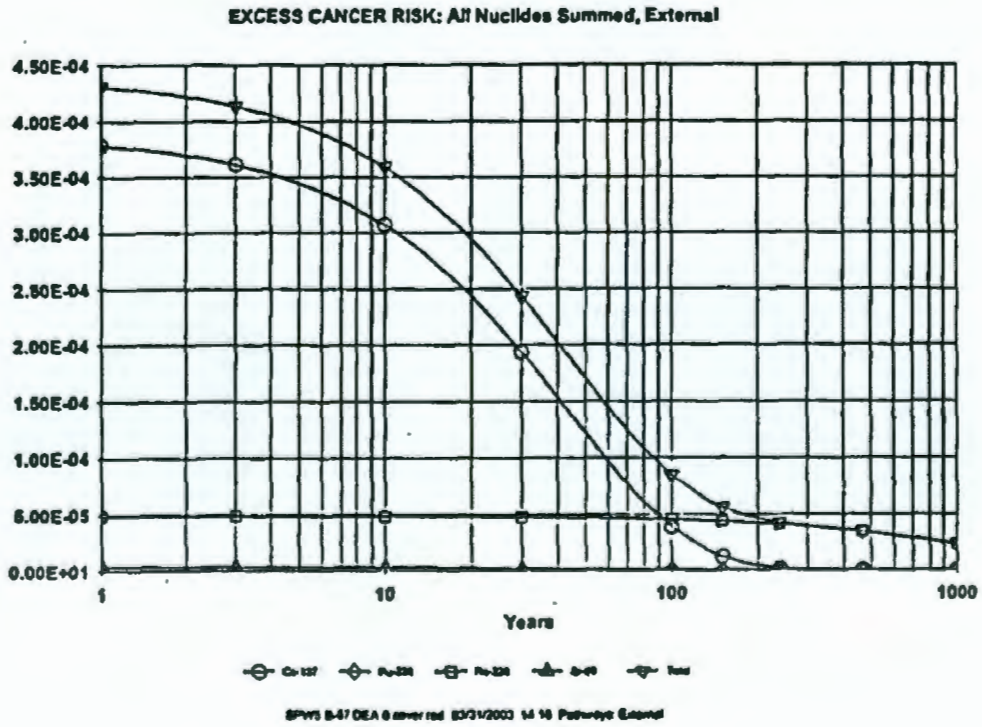


Table 5-1. Summary of the Shallow-Zone Soil Samples Used in the Risk Assessment for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units.

Sample Number	Sample Depth (ft)	Collection Date
200-TW-1 OU, 216-T-26 Crib		
B125Y3	10-12.5	June 25, 2001
B12682	0-6	June 19, 2001
200-TW-1 OU, 216-B-46 Crib		
B015P3	3-6	December 10, 1991
B015P7	8.5-11	December 11, 1991
B015N1	3-6	December 2, 1991
B015N5	8-10.5	December 2, 1991
B015N7	15-17.5	December 3, 1991
B015Q7	3.5-6	January 7, 1992
B015Q9	9-12	January 7, 1992
200-TW-2 OU, 216-B-38 Trench		
B12684	0-0.5	July 18, 2001
B12C63	14.5-15.5	August 2, 2001
B12C67	3.5-5	August 1, 2001
B12C68	9.5-12	August 2, 2001
200-TW-2 OU, 216-B-7A Crib		
B12683	0-0.5	June 19, 2001
B12MH4	12.5-15	August 23, 2001
B12MH5	2.5-5	August 22, 2001
B12MH6	5.5-8	August 22, 2001
B12MH7	10-12.5	August 22, 2001
200-PW-5 OU, 216-B-57 Crib		
B00X37	1.6-2.9	June 25, 1991
B00X57	7.5-9.5	June 27, 1991
B00X99	2-5	August 30, 1991
B00XB1	9-12	September 1, 1991
B00XC3	2-4.5	September 1, 1991
B00XC5	9-12	September 1, 1991
B00X61	15-17	July 1, 1991

Table 5-2. Summary Statistics for Shallow-Zone Soil Samples for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units. (5 pages)

Constituent Name	Constituent Class	Units	Number of Samples	Number of Detects	Frequency of Detect	Minimum Nondetect	Maximum Nondetect	Minimum Result	Maximum Result	Exposure Point Concentration
200-TW-1 OU, 216-B-46 Crib										
Chloride	GENCH	mg/kg	3	3	100%	--	--	2.4	79.2	79.2
Fluoride	GENCH	mg/kg	3	3	100%	--	--	1.6	1.7	1.7
Nitrate	GENCH	mg/kg	7	7	100%	--	--	39.5	135	135
Nitrate Nitrite	GENCH	mg/kg	7	7	100%	--	--	10.8	46.9	46.9
Phosphate	GENCH	mg/kg	7	5	71%	1.3	1.3	1.3	2.8	2.8
Sulfate	GENCH	mg/kg	7	7	100%	--	--	7.6	477	477
4,4'-DDT	HERB	mg/kg	7	1	14%	0.032	0.084	0.034	0.034	0.034
Aroclor-1254	HERB	mg/kg	7	1	14%	0.32	0.84	0.34	0.34	0.34
Gamma-BHC (Lindane)	HERB	mg/kg	7	1	14%	0.016	0.042	0.017	0.017	0.017
Heptachlor	HERB	mg/kg	7	2	29%	0.016	0.042	0.016	0.017	0.017
Aluminum	METAL	mg/kg	7	7	100%	--	--	3,220	4,720	4,720
Antimony	METAL	mg/kg	7	1	14%	3.95	8.9	5.7	5.7	5.7
Arsenic	METAL	mg/kg	7	7	100%	--	--	1.0	2.7	2.7
Barium	METAL	mg/kg	7	7	100%	--	--	44.1	70.7	70.7
Beryllium	METAL	mg/kg	7	7	100%	--	--	0.21	0.44	0.44
Cadmium	METAL	mg/kg	7	2	29%	0.59	1.3	1.1	1.5	1.5
Calcium	METAL	mg/kg	7	7	100%	--	--	5,070	7,750	7,750
Chromium	METAL	mg/kg	7	7	100%	--	--	4.0	8.5	8.5
Cobalt	METAL	mg/kg	7	5	71%	7.1	8.7	5.5	9.4	9.4
Copper	METAL	mg/kg	7	7	100%	--	--	7.0	17.8	17.8
Iron	METAL	mg/kg	7	7	100%	--	--	9,530	16,500	16,500
Lead	METAL	mg/kg	7	7	100%	--	--	2.5	5.7	5.7
Magnesium	METAL	mg/kg	7	7	100%	--	--	2,480	3,400	3,400
Manganese	METAL	mg/kg	7	7	100%	--	--	174	267	267
Mercury	METAL	mg/kg	7	1	14%	0.050	0.050	0.060	0.060	0.060

Table 5-2. Summary Statistics for Shallow-Zone Soil Samples for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units. (5 pages)

Constituent Name	Constituent Class	Units	Number of Samples	Number of Detects	Frequency of Detect	Minimum Nondetect	Maximum Nondetect	Minimum Result	Maximum Result	Exposure Point Concentration
Nickel	METAL	mg/kg	7	7	100%	--	--	4.5	10.8	10.8
Potassium	METAL	mg/kg	7	7	100%	--	--	720	1,250	1,250
Sodium	METAL	mg/kg	7	5	71%	132	132	186	450	450
Thallium	METAL	mg/kg	7	1	14%	0.38	0.42	0.60	0.60	0.60
Total uranium	METAL	mg/kg	6	2	33%	0.30	0.70	0.84	1.7	1.7
Vanadium	METAL	mg/kg	7	7	100%	--	--	18.7	30.3	30.3
Zinc	METAL	mg/kg	7	5	71%	20.1	21.9	21	39.1	39.1
4,6-Dinitro-2-methylphenol	SVOC	mg/kg	7	1	14%	1.6	1.8	1.7	1.7	1.7
Benzoic acid	SVOC	mg/kg	7	1	14%	1.6	1.8	0.041	0.041	0.041
Bis(2-ethylhexyl) phthalate	SVOC	mg/kg	7	5	71%	0.35	0.35	0.042	0.17	0.17
Di-n-butylphthalate	SVOC	mg/kg	7	4	57%	0.33	0.35	0.040	0.096	0.096
200-TW-1 OU, 216-T-26 Crib										
Chloride	GENCH	mg/kg	1	1	100%	--	--	3.23	3.23	3.23
Nitrate	GENCH	mg/kg	1	1	100%	--	--	10.2	10.2	10.2
Phosphate	GENCH	mg/kg	1	1	100%	--	--	2.9	2.9	2.9
Sulfate	GENCH	mg/kg	1	1	100%	--	--	7.5	7.5	7.5
Cadmium	METAL	mg/kg	1	1	100%	--	--	0.46	0.46	0.46
Chromium	METAL	mg/kg	1	1	100%	--	--	10.8	10.8	10.8
Copper	METAL	mg/kg	1	1	100%	--	--	14	14	14
Lead	METAL	mg/kg	1	1	100%	--	--	10.1	10.1	10.1
Nickel	METAL	mg/kg	1	1	100%	--	--	13	13	13
Total uranium	METAL	mg/kg	1	1	100%	--	--	1.8	1.8	1.8
Phenol	SVOC	mg/kg	1	1	100%	--	--	0.11	0.11	0.11

Table 5-2. Summary Statistics for Shallow-Zone Soil Samples for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units. (5 pages)

Constituent Name	Constituent Class	Units	Number of Samples	Number of Detects	Frequency of Detect	Minimum Nondetect	Maximum Nondetect	Minimum Result	Maximum Result	Exposure Point Concentration
200-TW-2 OU, 216-B-38 Crib										
Ammonia	GENCH	mg/kg	3	2	67%	0.53	0.53	2.4	3.2	3.2
Chloride	GENCH	mg/kg	3	2	67%	0.11	0.11	5.0	6.9	6.9
Fluoride	GENCH	mg/kg	3	1	33%	2.7	5.2	7.4	7.4	7.4
Nitrate	GENCH	mg/kg	3	3	100%	--	--	45.3	208	208
Nitrogen in Nitrite and Nitrate	GENCH	mg/kg	3	3	100%	--	--	23	59	59
pH	GENCH	mg/kg	3	3	100%	--	--	8.7	8.9	8.9
Phosphate	GENCH	mg/kg	3	2	67%	0.27	0.27	1.6	8.2	8.2
Sulfate	GENCH	mg/kg	3	3	100%	--	--	51	248	248
Total organic carbon	GENCH	mg/kg	3	3	100%	--	--	274	1,510	1,510
Aluminum	METAL	mg/kg	1	1	100%	--	--	7,600	7,600	7,600
Cadmium	METAL	mg/kg	3	2	67%	0.021	0.021	0.060	0.10	0.10
Calcium	METAL	mg/kg	1	1	100%	--	--	9,610	9,610	9,610
Chromium	METAL	mg/kg	3	3	100%	--	--	7.1	11.6	11.6
Copper	METAL	mg/kg	3	3	100%	--	--	12.2	15.1	15.1
Iron	METAL	mg/kg	1	1	100%	--	--	18,100	18,100	18,100
Lead	METAL	mg/kg	3	3	100%	--	--	4.5	8.0	8.0
Magnesium	METAL	mg/kg	1	1	100%	--	--	3,820	3,820	3,820
Manganese	METAL	mg/kg	1	1	100%	--	--	287	287	287
Mercury	METAL	mg/kg	3	1	33%	0.020	0.020	0.089	0.089	0.089
Nickel	METAL	mg/kg	3	3	100%	--	--	6.3	12.1	12.1
Potassium	METAL	mg/kg	1	1	100%	--	--	1,140	1,140	1,140
Sodium	METAL	mg/kg	1	1	100%	--	--	551	551	551
Total uranium	METAL	mg/kg	3	3	100%	--	--	1.6	11	11
Vanadium	METAL	mg/kg	1	1	100%	--	--	55.1	55.1	55.1
Zinc	METAL	mg/kg	1	1	100%	--	--	43.9	43.9	43.9

Table 5-2. Summary Statistics for Shallow-Zone Soil Samples for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units. (5 pages)

Constituent Name	Constituent Class	Units	Number of Samples	Number of Detects	Frequency of Detect	Minimum Nondetect	Maximum Nondetect	Minimum Result	Maximum Result	Exposure Point Concentration
200-TW-2 OU, 216-B-7A Crib										
Ammonia	GENCH	mg/kg	4	1	25%	2.4	2.5	21.3	21.3	21.3
Chloride	GENCH	mg/kg	4	4	100%	--	--	6.5	12.8	12.8
Nitrate	GENCH	mg/kg	4	4	100%	--	--	65.3	193	193
Nitrogen in Nitrite and Nitrate	GENCH	mg/kg	4	4	100%	--	--	15.6	46.2	46.2
pH	GENCH	mg/kg	4	4	100%	--	--	8.3	9.0	9.0
Phosphate	GENCH	mg/kg	4	4	100%	--	--	3.0	7.3	7.3
Sulfate	GENCH	mg/kg	4	4	100%	--	--	38.3	185	185
Total organic carbon	GENCH	mg/kg	4	4	100%	--	--	900	3,850	3,850
Cadmium	METAL	mg/kg	4	2	50%	0.030	0.030	0.060	0.070	0.070
Chromium	METAL	mg/kg	4	4	100%	--	--	12.4	13.5	13.5
Copper	METAL	mg/kg	4	4	100%	--	--	12.8	15	15
Lead	METAL	mg/kg	4	4	100%	--	--	5.9	23.3	23.3
Nickel	METAL	mg/kg	4	4	100%	--	--	10.1	13.7	13.7
Total uranium	METAL	mg/kg	4	4	100%	--	--	0.93	0.995	0.995
200-PW-5 OU, 216-B-57 Crib										
Aluminum	METAL	mg/kg	5	5	100%	--	--	2,590	3,410	3,410
Arsenic	METAL	mg/kg	7	7	100%	--	--	1.5	2.2	2.2
Barium	METAL	mg/kg	1	1	100%	--	--	40.6	40.6	40.6
Beryllium	METAL	mg/kg	7	7	100%	--	--	0.24	0.35	0.35
Cadmium	METAL	mg/kg	1	1	100%	--	--	0.72	0.72	0.72
Calcium	METAL	mg/kg	4	4	100%	--	--	5,090	6,984	6,984
Chromium	METAL	mg/kg	3	3	100%	--	--	1.2	8.0	8.0
Cobalt	METAL	mg/kg	7	7	100%	--	--	4.6	6.8	6.8
Copper	METAL	mg/kg	3	3	100%	--	--	9.1	11.2	11.2
Iron	METAL	mg/kg	2	2	100%	--	--	7,500	8,800	8,800

Table 5-2. Summary Statistics for Shallow-Zone Soil Samples for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units. (5 pages)

Constituent Name	Constituent Class	Units	Number of Samples	Number of Detects	Frequency of Detect	Minimum Nondetect	Maximum Nondetect	Minimum Result	Maximum Result	Exposure Point Concentration
Lead	METAL	mg/kg	5	5	100%	--	--	2.0	5.5	5.5
Magnesium	METAL	mg/kg	5	5	100%	--	--	2,000	2,400	2,400
Manganese	METAL	mg/kg	5	5	100%	--	--	162	188.5	188.5
Nickel	METAL	mg/kg	7	7	100%	--	--	2.5	8.3	8.3
Potassium	METAL	mg/kg	7	7	100%	--	--	593	932	932
Silver	METAL	mg/kg	1	1	100%	--	--	2.2	2.2	2.2
Sodium	METAL	mg/kg	5	5	100%	--	--	89.2	184	184
Uranium	METAL	mg/kg	2	2	100%	--	--	1.1	1.8	1.8
Vanadium	METAL	mg/kg	2	2	100%	--	--	14.4	15.8	15.8
Zinc	METAL	mg/kg	5	5	100%	--	--	17.2	24.7	24.7
Bis(2-ethylhexyl) phthalate	SVOC	mg/kg	2	2	100%	--	--	0.047	0.17	0.17
Chrysene	SVOC	mg/kg	1	1	100%	--	--	0.040	0.040	0.040
Di-n-butylphthalate	SVOC	mg/kg	1	1	100%	--	--	2.4	2.4	2.4
Pyrene	SVOC	mg/kg	1	1	100%	--	--	0.049	0.049	0.049
4-Methyl-2-Pentanone	VOC	mg/kg	1	1	100%	--	--	0.0050	0.0050	0.0050
Acetone	VOC	mg/kg	1	1	100%	--	--	0.022	0.022	0.022
Methylenechloride	VOC	mg/kg	1	1	100%	--	--	0.017	0.017	0.017
Toluene	VOC	mg/kg	3	3	100%	--	--	0.0010	0.0030	0.0030

-- = not applicable.
GENCH = general chemistry.
SVOC = semivolatile organic compound.
VOC = volatile organic compound.

Table 5-3. Comparison of Maximum Shallow-Zone Soil Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (3 pages)

Constituent Name	Constituent Class	Units	Maximum Result	90th Percentile Background Concentration	Does Maximum Concentration Exceed Background?	WAC 173-340-900 Table 749-3 Wildlife*	COEC?	Justification
200-TW-1 OU, 216-B-46 Crib								
Aluminum	METAL	mg/kg	4,720	11,800	No	--	No	Below Background
Antimony	METAL	mg/kg	5.7	NA	No	--	No	Not a 749-3 wildlife concern
Arsenic	METAL	mg/kg	2.7	6.5	No	7	No	Below Background
Barium	METAL	mg/kg	70.7	132	No	102	No	Below Background
Beryllium	METAL	mg/kg	0.44	1.5	No	--	No	Below Background
Cadmium	METAL	mg/kg	1.5	1.0	Yes	14	No	Below 749-3
Chromium	METAL	mg/kg	8.5	18.5	No	67	No	Below Background
Cobalt	METAL	mg/kg	9.4	15.7	No	--	No	Below Background
Copper	METAL	mg/kg	17.8	22.0	No	217	No	Below Background
Iron	METAL	mg/kg	16,500	32,600	No	--	No	Below Background
Lead	METAL	mg/kg	5.7	10.2	No	118	No	Below Background
Manganese	METAL	mg/kg	267	512	No	1500	No	Below Background
Mercury	METAL	mg/kg	0.06	0.33	No	5.5	No	Below Background
Nickel	METAL	mg/kg	10.8	19.1	No	980	No	Below Background
Thallium	METAL	mg/kg	0.6	0.3 to 0.6	No	--	No	Below Background
Total uranium	METAL	mg/kg	1.7	NA	No	--	No	Below Background
Vanadium	METAL	mg/kg	30.3	85.1	No	--	No	Below Background
Zinc	METAL	mg/kg	39.1	67.8	No	360	No	Below Background
200-TW-1 OU, 216-T-26 Crib								
Cadmium	METAL	mg/kg	0.46	1.0	No	14	No	Below Background
Chromium	METAL	mg/kg	10.8	18.5	No	67	No	Below Background

Table 5-3. Comparison of Maximum Shallow-Zone Soil Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (3 pages)

Constituent Name	Constituent Class	Units	Maximum Result	90th Percentile Background Concentration	Does Maximum Concentration Exceed Background?	WAC 173-340-900 Table 749-3 Wildlife*	COEC?	Justification
Copper	METAL	mg/kg	14	22	No	217	No	Below Background
Lead	METAL	mg/kg	10.1	10.2	No	118	No	Below Background
Nickel	METAL	mg/kg	13	19.1	No	980	No	Below Background
Total uranium	METAL	mg/kg	1.8	NA	No	--	No	Below Background
200-TW-2 OU, 216-B-38 Trench								
Aluminum	METAL	mg/kg	7,600	11,800	No	--	No	Below Background
Cadmium	METAL	mg/kg	0.10	1.0	No	14	No	Below Background
Chromium	METAL	mg/kg	11.6	18.5	No	67	No	Below Background
Copper	METAL	mg/kg	15.1	22	No	217	No	Below Background
Iron	METAL	mg/kg	18,100	32,600	No	--	No	Below Background
Lead	METAL	mg/kg	8.0	10.2	No	118	No	Below Background
Manganese	METAL	mg/kg	287	512	No	1500	No	Below Background
Mercury	METAL	mg/kg	0.089	0.33	No	5.5	No	Below Background
Nickel	METAL	mg/kg	12.1	19.1	No	980	No	Below Background
Total uranium	METAL	mg/kg	11.3	NA	No	--	No	Below Background
Vanadium	METAL	mg/kg	55.1	85.1	No	--	No	Below Background
Zinc	METAL	mg/kg	43.9	67.8	No	360	No	Below Background
200-TW-2 OU, 216-B-7A Crib								
Cadmium	METAL	mg/kg	0.070	1.0	No	14	No	Below Background
Chromium	METAL	mg/kg	14	18.5	No	67	No	Below Background
Copper	METAL	mg/kg	15	22	No	217	No	Below Background
Lead	METAL	mg/kg	23.3	10.2	Yes	118	No	Below 749-3
Nickel	METAL	mg/kg	13.7	19.1	No	980	No	Below Background
Uranium	METAL	mg/kg	0.995	NA	No	--	No	Below Background

Table 5-3. Comparison of Maximum Shallow-Zone Soil Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (3 pages)

Constituent Name	Constituent Class	Units	Maximum Result	90th Percentile Background Concentration	Does Maximum Concentration Exceed Background?	WAC 173-340-900 Table 749-3 Wildlife*	COEC?	Justification
200-PW-5 OU, 216-B-57 Crib								
Aluminum	METAL	mg/kg	3,410	11,800	No	--	No	Below Background
Arsenic	METAL	mg/kg	2.2	6.5	No	7	No	Below Background
Barium	METAL	mg/kg	40.6	132	No	102	No	Below Background
Beryllium	METAL	mg/kg	0.35	1.5	No	--	No	Below Background
Cadmium	METAL	mg/kg	0.72	1.0	No	14	No	Below Background
Chromium	METAL	mg/kg	8.0	18.5	No	67	No	Below Background
Cobalt	METAL	mg/kg	6.8	15.7	No	--	No	Below Background
Copper	METAL	mg/kg	11.2	22	No	217	No	Below Background
Iron	METAL	mg/kg	8,800	32,600	No	--	No	Below Background
Lead	METAL	mg/kg	5.5	10.2	No	118	No	Below Background
Manganese	METAL	mg/kg	188.5	512	No	1500	No	Below Background
Nickel	METAL	mg/kg	8.3	19.1	No	980	No	Below Background
Silver	METAL	mg/kg	2.2	0.73	Yes	--	No	Below Background
Uranium	METAL	mg/kg	1.8	NA	No	--	No	Below Background
Vanadium	METAL	mg/kg	15.8	85.1	No	--	No	Below Background
Zinc	METAL	mg/kg	24.7	67.8	No	360	No	Below Background

*WAC 173-340-900, "Tables," Table 749-3, "Ecological Indicator Soil Concentrations (mg/kg) for Protection of Terrestrial Plants and Animals," *Washington Administrative Code*, as amended.

-- = Means no screening concentration for wildlife receptors in WAC 173-340-900, "Tables," Table 749-3, "Ecological Indicator Soil Concentrations (mg/kg) for Protection of Terrestrial Plants and Animals," *Washington Administrative Code*, as amended.

COEC = contaminant of ecological concern.

Table 5-4. Comparison of Shallow-Zone Soil Exposure Point Concentrations to *Washington Administrative Code 173-340-745* Method C Soil Cleanup Levels.* (2 pages)

Constituent Name	Constituent Class	Units	Maximum Result	Method C Soil CUL	Is EPC > MTCA C Soil CUL?	MTCA Table 749-3 Wildlife	COEC?	Justification
200-TW-1 OU, 216-B-46 Crib								
4,4'-DDT	HERB/	mg/kg	0.034	386	No	0.75	No	Below 749-3
Aroclor-1254	HERB/	mg/kg	0.34	70	No	0.65	No	Below 749-3
Gamma-BHC (Lindane)	HERB/	mg/kg	0.017	101	No	6	No	Below 749-3
Heptachlor	HERB/	mg/kg	0.017	29	No	0.4	No	Below 749-3
Antimony	METAL	mg/kg	5.7	1,400	No	--	No	See Table 5-3
Cadmium	METAL	mg/kg	1.5	3,500	No	14	No	See Table 5-3
Thallium	METAL	mg/kg	0.6	280	No	--	No	See Table 5-3
4,6-Dinitro-2-methylphenol	SVOC	mg/kg	1.7	--	No	--	No	No Wildlife screening level; organics generally higher
Benzoic acid	SVOC	mg/kg	0.041	1.40E+07	No	--	No	No Wildlife screening level; organics generally higher
Bis(2-ethylhexyl) phthalate	SVOC	mg/kg	0.17	9,375	No	--	No	No Wildlife screening level; organics generally higher
Di-n-butylphthalate	SVOC	mg/kg	0.096	350,000	No	--	No	No Wildlife screening level; organics generally higher
200-TW-1 OU, 216-T-26 Crib								
Phenol	SVOC	mg/kg	0.11	2.10E+06	No	--	No	No Wildlife screening level; organics generally higher
200-TW-2 OU, 216-B-7A Crib								
Lead	METAL	mg/Kg	23.3	750	No	118	No	See Table 5-3
Uranium	METAL	mg/Kg	0.995	10,500	No	--	No	See Table 5-3

Table 5-4. Comparison of Shallow-Zone Soil Exposure Point Concentrations to *Washington Administrative Code 173-340-745* Method C Soil Cleanup Levels.* (2 pages)

Constituent Name	Constituent Class	Units	Maximum Result	Method C Soil CUL	Is EPC > MTCA C Soil CUL?	MTCA Table 749-3 Wildlife	COEC?	Justification
200-PW-5 OU, 216-B-57 Crib								
Bis(2-ethylhexyl) phthalate	SVOC	mg/kg	0.17	9,375	No	--	No	No Wildlife screening level; organics generally higher
Chrysene	SVOC	mg/kg	0.040	18	No	--	No	No Wildlife screening level; organics generally higher
Di-n-butylphthalate	SVOC	mg/kg	2.4	350,000	No	--	No	No Wildlife screening level; organics generally higher
Pyrene	SVOC	mg/kg	0.049	105,000	No	--	No	No Wildlife screening level; organics generally higher
4-Methyl-2-Pentanone	VOC	mg/kg	0.0050	280,000	No	--	No	No Wildlife screening level; organics generally higher
Acetone	VOC	mg/kg	0.022	350,000	No	--	No	No Wildlife screening level; organics generally higher
Methylene Chloride	VOC	mg/kg	0.017	17,500	No	--	No	No Wildlife screening level; organics generally higher
Toluene	VOC	mg/kg	0.0030	700,000	No	--	No	No Wildlife screening level; organics generally higher
Silver	METAL	mg/kg	2.2	17,500	No	--	No	See Table 5-3
Uranium	METAL	mg/kg	1.8	24,500	No	--	No	See Table 5-3

* WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties," *Washington Administrative Code*, as amended.

-- = Means no screening concentration for wildlife receptors in WAC 173-340-900, "Tables," Table 749-3, "Ecological Indicator Soil Concentrations (mg/kg) for Protection of Terrestrial Plants and Animals," *Washington Administrative Code*, as amended..

COEC = contaminant of ecological concern.
CUL = cleanup level.
EPC = exposure point concentration = maximum concentration.
SVOC = semi-volatile organic compound.
VOC = volatile organic compound.

Table 5-5. Summary Statistics for Shallow-Zone Soils for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units – Radionuclides. (3 pages)

Constituent Name	Constituent Class	Number of Samples	Number of Detects	Frequency of Detect	Units	Minimum Nondetect	Maximum Nondetect	Minimum Result	Maximum Result	Exposure Point Concentration
200-TW-1 OU, 216-B-46 Crib										
Cesium-137	RAD	7	5	67%	pCi/g	0.030	0.030	0.080	0.26	0.26
Plutonium-238	RAD	7	2	33%	pCi/g	0.020	0.030	0.040	0.070	0.070
Plutonium-239	RAD	7	2	33%	pCi/g	0.010	0.010	0.010	0.020	0.020
Potassium-40	RAD	7	7	100%	pCi/g	–	–	12	14	14
Radium-226	RAD	7	7	100%	pCi/g	–	–	0.68	0.95	0.95
Strontium-90	RAD	7	6	83%	pCi/g	0.040	0.040	0.080	2.90	2.90
Thorium-228	RAD	7	7	100%	pCi/g	–	–	0.48	0.79	0.79
Total uranium	RAD	6	2	40%	pCi/g	0.3	0.7	0.84	1.7	1.7
200-TW-1 OU, 216-T-26 Crib										
Potassium-40	RAD	1	1	100%	pCi/g	–	–	8.5	8.5	8.5
Radium-226	RAD	1	1	100%	pCi/g	–	–	0.37	0.37	0.37
Radium-228	RAD	1	1	100%	pCi/g	–	–	0.34	0.34	0.34
Thorium-228	RAD	1	1	100%	pCi/g	–	–	0.94	0.94	0.94
Thorium-230	RAD	1	1	100%	pCi/g	–	–	0.74	0.74	0.74
Thorium-232	RAD	1	1	100%	pCi/g	–	–	0.74	0.74	0.74
Uranium-233/234	RAD	1	1	100%	pCi/g	–	–	0.46	0.46	0.46
Uranium-238	RAD	1	1	100%	pCi/g	–	–	0.34	0.34	0.34
200-TW-2 OU, 216-B-38 Trench										
Americium-241	RAD	3	1	33%	pCi/g	0.022	0.035	43.9	43.9	43.9
Cesium-137	RAD	3	2	67%	pCi/g	0.036	0.036	1.82	226,000	226,000
Plutonium-238	RAD	1	1	100%	pCi/g	–	–	7.85	7.85	7.85
Plutonium-239/240	RAD	2	1	50%	pCi/g	0.029	0.029	106	106	106
Potassium-40	RAD	3	2	67%	pCi/g	87	87	14	14.5	14.5
Radium-226	RAD	3	1	33%	pCi/g	0.12	62	0.594	0.594	0.594

Table 5-5. Summary Statistics for Shallow-Zone Soils for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units – Radionuclides. (3 pages)

Constituent Name	Constituent Class	Number of Samples	Number of Detects	Frequency of Detect	Units	Minimum Nondetect	Maximum Nondetect	Minimum Result	Maximum Result	Exposure Point Concentration
Radium-228	RAD	3	2	67%	pCi/g	45	45	0.695	0.974	0.974
Thorium-228	RAD	3	2	67%	pCi/g	6.4	6.4	0.431	0.839	0.839
Thorium-230	RAD	2	2	100%	pCi/g	–	–	0.587	0.621	0.621
Thorium-232	RAD	3	2	67%	pCi/g	9.7	9.7	0.587	0.621	0.621
Total beta radiostrontium	RAD	2	1	50%	pCi/g	0.18	0.18	1390	1390	1390
Total uranium	RAD	3	3	100%	Mg/g			1.6	11.3	11.3
Uranium-233/234	RAD	3	2	67%	pCi/g	8.2	8.2	0.448	0.667	0.667
Uranium-238	RAD	3	2	67%	pCi/g	5.8	5.8	0.544	0.667	0.667
200-TW-2 OU, 216-B-7A Crib										
Carbon-14	RAD	4	1	25%	pCi/g	2.22	3.72	6.3	6.3	6.3
Cesium-137	RAD	4	4	100%	pCi/g	–	–	1.52	42.5	42.5
Potassium-40	RAD	4	4	100%	pCi/g	–	–	2.27	14.5	14.5
Radium-226	RAD	4	4	100%	pCi/g	–	–	0.094	0.584	0.584
Radium-228	RAD	4	4	100%	pCi/g	–	–	0.132	0.763	0.763
Thorium-228	RAD	4	3	75%	pCi/g	0.676	0.676	0.54	0.884	0.884
Thorium-230	RAD	4	3	75%	pCi/g	0.352	0.352	0.414	0.729	0.729
Thorium-232	RAD	4	3	75%	pCi/g	0.302	0.302	0.265	0.644	0.644
Total beta radiostrontium	RAD	4	4	100%	pCi/g	–	–	0.689	13.5	13.5
Total uranium	RAD	4	4	100%	Mg/g	–	–	0.93	0.995	0.995
Uranium-233/234	RAD	4	4	100%	pCi/g	–	–	0.463	0.474	0.474
Uranium-235	RAD	4	4	100%	pCi/g	–	–	0.016	0.029	0.029
Uranium-238	RAD	4	4	100%	pCi/g	–	–	0.458	0.465	0.465
200-PW-5 OU, 216-B-57 Crib										
Cesium-137	RAD	7	7	100%	pCi/g	–	–	0.15	50.5	50.5
Plutonium-238	RAD	1	1	100%	pCi/g	–	–	0.01	0.01	0.01
Potassium-40	RAD	7	7	100%	pCi/g	–	–	11.6	12.6	12.6

Table 5-5. Summary Statistics for Shallow-Zone Soils for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units – Radionuclides. (3 pages)

Constituent Name	Constituent Class	Number of Samples	Number of Detects	Frequency of Detect	Units	Minimum Nondetect	Maximum Nondetect	Minimum Result	Maximum Result	Exposure Point Concentration
Radium-226	RAD	5	5	100%	pCi/g	–	–	0.66	1.13	1.13
Strontium-90	RAD	5	5	100%	pCi/g	–	–	0.08	67	67
Thorium-228	RAD	7	7	100%	pCi/g	–	–	0.5	0.77	0.77

– = not applicable.

Table 5-6. RESidual RADioactivity Input Parameters. (5 pages)

Description	Parameter	Units	200-TW-1		200-TW-2		200-PW-5	Rationale and Citation
			216-B-46 Crib	216-T-26 Crib	216-B-7A Crib	216-B-38 Trench	216-B-57 Crib	
Exposure Pathways	--	--	External Gamma: Active Inhalation: Active Plant Ingestion: Suppressed Meat Ingestion: Suppressed Milk Ingestion: Suppressed Aquatic Foods: Suppressed Drinking Water: Suppressed Soil Ingestion: Active Radon: Suppressed					Based on 200-TW-1 and TW-2 work plan conceptual exposure models (DOE/RL-2000-38) and refinement of the model as part of this RI.
R011-CZ	Area of CZ	m^2	529	83	14	235	529	Site-specific areas from WIDS.
	Thickness of CZ (No Cover)	M	4.6	4.6	4.6	4.6	4.6	Assumes that site is contaminated at maximum concentration from surface to 4.6 m (15 ft) bgs.
	Thickness of CZ (Cover)	M	--	--	4.3	1.5	6.1	Represents actual thickness of contamination based on RI results.
	Length Parallel to Aquifer Flow	M	33	13	52	77	33	Site-specific.
	Radiation Dose Limit (Industrial Scenario)	mrem/yr	15	15	15	15	15	--
	Elapsed Time Since Waste Placement	yr	0	0	0	0	0	Environmental samples were collected in 1999 and 2000.
Exposure Point Concentrations	EPCs	pCi/g	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	See Table 5-16.
R013-Cover and CZ Hydrological Data	Cover depth (No Cover)	M	0	0	0	0	0	Assumes that site is contaminated at maximum concentration from surface to 4.6 m (15 ft) bgs.

Table 5-6. RESidual RADioactivity Input Parameters. (5 pages)

Description	Parameter	Units	200-TW-1		200-TW-2		200-PW-5	Rationale and Citation
			216-B-46 Crib	216-T-26 Crib	216-B-7A Crib	216-B-38 Trench	216-B-57 Crib	
	Cover depth (cover)	M	--	--	0.3	3	--	Represents actual conditions of cover based on RI results.
	Cover material density	g/cm^3	1.81	1.5	2.01	1.4	1.5	Site-specific.
	Cover erosion rate	M/yr	0.001	0.001	0.001	0.001	0.001	RESRAD Default.
	Density of CZ	g/cm^3	1.5	2.16	1.95	1.98	1.5	Site-specific values based on RI results.
	CZ erosion rate	M/yr	0.001	0.001	0.001	0.001	0.001	RESRAD Default.
	CZ Total Porosity	unitless	0.43	0.183	0.25	0.25	0.43	Site-specific values based on physical property samples from RI and WHC-EP-0883.
	CZ Field Capacity	unitless	1.0E-34	1.0E-34	1.0E-34	1.0E-34	1.0E-34	Site-specific values based on physical property samples from RI and WHC-EP-0883.
	CZ Hydraulic conductivity	M/yr	6570	21900	21900	21900	6570	WHC-SD-EN-SE-004.
	CZ b parameter	unitless	4.05	4.05	4.05	4.05	4.05	RESRAD Table E:2; Environmental Restoration Contractor (ERC) (CCN070578).
	Humidity in air	g/cm^3	8	8	8	8	8	RESRAD Default.
	Evapotranspiration coefficient	Unitless	0.91	0.91	0.91	0.91	0.91	WDOH/320-015.
	Precipitation	M/yr	0.16	0.16	0.16	0.16	0.16	Based on 16 cm (6.3 in.) average annual rainfall (DOE/RL-92-19).
	Runoff coefficient	unitless	0.2	0.2	0.2	0.2	0.2	RESRAD Default.
	Watershed area for nearby stream or pond	M^2	1.00E+06	1.00E+06	1.00E+06	1.00E+06	--	RESRAD Default.
	Accuracy for water/soil computations	unitless	0.001	0.001	0.001	0.001	--	RESRAD Default.

Table 5-6. RESidual RADioactivity Input Parameters. (5 pages)

Description	Parameter	Units	200-TW-1		200-TW-2		200-PW-5	Rationale and Citation
			216-B-46 Crib	216-T-26 Crib	216-B-7A Crib	216-B-38 Trench	216-B-57 Crib	
R014 – Saturated Zone (SZ) Hydrologic Data	Density of SZ	g/cm3	1.9	1.9	1.9	1.9	–	Site-specific values based on RI
	SZ total porosity	unitless	0.27	0.27	0.27	0.27	–	Site-specific values based on physical property samples from RI and WHC-EP-0883.
	SZ effective porosity	unitless	0.23	0.23	0.23	0.23	–	Site-specific values based on physical property samples from RI and WHC-EP-0883.
	SZ field capacity	unitless	1.0E-34	1.0E-34	1.0E-34	1.0E-34	–	Site-specific values based on physical property samples from RI and WHC-EP-0883.
	SZ hydraulic conductivity	m/yr	2207500	5520	2207500	2207500	–	WHC-SD-EN-SE-004.
	SZ b parameter	unitless	4.05	4.05	4.05	4.05	–	RESRAD Table E:2; CCN070578.
	Water table drop rate	m/yr	0.001	0.001	0.001	0.001	–	RESRAD default.
	Well pump intake depth below water table	m	4.6	4.6	4.6	4.6	–	Typical RCRA well screen length.
	Nondispersion (ND) or mass-balance	–	ND	ND	ND	ND	–	RESRAD default.
	Well pumping rate	M^3/yr	250	250	250	250	–	RESRAD default.
	Number of unsaturated strata	–	1	1	1	1	–	Site-specific.
	Thickness of unsaturated strata	M	54.3	50.6	60	62	–	Site-specific.
R015 – Uncontaminated and Unsaturated Strata Hydrologic Data	Soil Density	g/cm3	1.61	1.45	1.61	1.69	–	Site-specific values based on RI.
	Total porosity	unitless	0.39	0.39	0.39	0.36	–	Site-specific values based on physical property samples from RI and WHC-EP-0883.
	Effective porosity	unitless	0.39	0.39	0.39	0.36	–	Site-specific values based on physical property samples from RI and WHC-EP-0883.

Table 5-6. RESidual RADioactivity Input Parameters. (5 pages)

Description	Parameter	Units	200-TW-1		200-TW-2		200-PW-5	Rationale and Citation
			216-B-46 Crib	216-T-26 Crib	216-B-7A Crib	216-B-38 Trench	216-B-57 Crib	
	Field capacity	unitless	1.0E-34	1.0E-34	1.0E-34	1.0E-34	--	Site-specific values based on physical property samples from RI and WHC-EP-0883.
	Soil-specific b parameter	unitless	4.05	4.05	4.05	4.05	--	RESRAD Table E:2; CCN070578.
	Hydraulic conductivity	m/yr	2207500	5520	2207500	2207500	--	WHC-SD-EN-SE-004.
R016 – Distribution Coefficients for Individual Radionuclides	Distribution coefficients (Kd) for CZ and SZ	ml/g	Am-241: 3 C-14: 0 Co-60: 0 Cs-137: 10 Eu-152/154/155: 3 Tritium (H-3): 0 Ni-63: 5 Np-237: 5 Pu-238/239/240: 3 Ra-226/228: 5 Sr-90: 5 Tc-99: 0 Th-232: 3 U-233/234/235/238: 0.4		Am-241: 300 C-14: 0 Co-60: 50 Cs-137: 500 Eu-152/154/155: 350 Tritium (H-3): 0 Ni-63: 50 Np-237: 0.8 Pu-238/239/240: 20 Ra-226/228: 5 Sr-90: 0.5 Tc-99: 0 Th-232: 50 U-233/234/235/238: 0.3		--	PNNL-11800.
R017 – Inhalation and External Gamma	Inhalation rate	M^3/yr	7300	7300	7300	7300	7300	WDOH/320-015.
	Mass loading for inhalation	g/m^3	0.0001	0.0001	0.0001	0.0001	0.0001	WDOH/320-015.
	Dilution length for airborne dust	M	3	3	3	3	3	RESRAD Default.
	Exposure duration	yr	30	30	30	30	30	WAC 173-340.
	Inhalation shielding factor	Unitless	0.4	0.4	0.4	0.4	0.4	RESRAD Default.
	External gamma shielding factor	Unitless	0.8	0.8	0.8	0.8	0.8	WDOH/320-015.

Table 5-6. RESidual RADioactivity Input Parameters. (5 pages)

Description	Parameter	Units	200-TW-1		200-TW-2		200-PW-5	Rationale and Citation
			216-B-46 Crib	216-T-26 Crib	216-B-7A Crib	216-B-38 Trench	216-B-57 Crib	
	Indoor time fraction (Industrial Scenario)	Unitless	0.137	0.137	0.137	0.137	0.137	200 Area Industrial scenario; on-site 2,000 h/yr (indoors 60%).
	Outdoor time fraction (Industrial Scenario)	Unitless	0.091	0.091	0.091	0.091	0.091	200 Area Industrial scenario; on-site 2000 h/yr (outdoors 40%).
	Shape factor	Unitless	1	1	1	1	1	RESRAD Default.

ANL/EAD-4, *User's Manual for RESRAD, Version 6.*
CCN070578, "Estimation of the Soil-Specific Exponential Parameter(s)."
DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan.*
DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report.*
PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site.*
Resource Conservation and Recovery Act of 1976.
WAC 173-340, "Model Toxics Control Act – Cleanup."
Waste Information Data System Report, Hanford Site database.
WDOH/320-015, *Hanford Guidance for Radiological Cleanup.*
WHC-EP-0883, *Variability and Scaling of Hydraulic Properties for 200 Area Soils.*
WHC-SD-EN-SE-004, *Site Characterization Report Results Of Detailed Evaluation of Suitability of Site Proposed For Disposal of 200 Area Treated Effluent.*

– = not applicable.
CZ = contaminated zone.
RCRA = *Resource Conservation and Recovery Act of 1976*
RESRAD = RESidual RADioactivity.
RI = remedial investigation.
WIDS = *Waste Information Data System.*

Table 5-7. Comparison of Maximum Shallow-Zone Soil Concentrations to Background and to Ecological Screening Values for Radionuclides. (3 pages)

Constituent Name	Number of Samples	Number of Detects	Frequency of Detection	Maximum Result	90th Percentile Background Concentration	Exceeds Background ?	Biota Concentration Guide	COEC?	Justification
200-TW-1 OU, 216-B-46 Crib									
Cesium-137	6	4	67%	0.26	1.1	No	20	No	Below background
Plutonium-238	6	2	33%	0.07	0.0038	Yes	5400	No	Below BCG
Plutonium-239	6	2	33%	0.02	0.025	No	6,000	No	Below background
Potassium-40	6	6	100%	14	17	No	NA	No	Below background
Radium-226	6	6	100%	0.95	0.815	Yes	3.0	No	Below BCG
Strontium-90	6	5	83%	2.9	0.18	Yes	20.0	No	Below BCG
Thorium-228	6	6	100%	0.79	1.3	No	2200	No	Below background
Total Uranium	6	2	40%	1.7	3.21	No	NA	No	Below background
200-TW-1 OU, 216-T-26 Crib									
Potassium-40	1	1	100%	8.5	17	No	NA	No	Below background
Radium-226	1	1	100%	0.37	0.815	No	3.0	No	Below background
Radium-228	1	1	100%	0.34	1.3	No	2.0	No	Below background
Thorium-228	1	1	100%	0.94	1.3	No	2200	No	Below background
Thorium-230	1	1	100%	0.74	1.1	No	2700	No	Below background
Thorium-232	1	1	100%	0.74	1.3	No	2000	No	Below background
Uranium-233/234	1	1	100%	0.46	1.1	No	5000	No	Below background
Uranium-238	1	1	100%	0.34	1.1	No	2000	No	Below background
200-TW-2 OU, 216-B-38 Trench									
Americium-241	3	1	33%	43.9	NA	No	4,000	No	Below BCG
Cesium-137	3	2	67%	226,000	1.1	Yes	20	Yes	--
Plutonium-238	1	1	100%	7.85	0.0038	Yes	5400	No	Below BCG
Plutonium-239/240	2	1	50%	106	0.025	Yes	6,000	No	Below BCG
Potassium-40	3	2	67%	14.5	17	No	NA	No	Below background
Radium-226	3	1	33%	0.594	0.815	No	3.0	No	Below background

Table 5-7. Comparison of Maximum Shallow-Zone Soil Concentrations to Background and to Ecological Screening Values for Radionuclides. (3 pages)

Constituent Name	Number of Samples	Number of Detects	Frequency of Detection	Maximum Result	90th Percentile Background Concentration	Exceeds Background ?	Biota Concentration Guide	COEC?	Justification
Radium-228	3	2	67%	0.974	1.3	No	2.0	No	Below background
Thorium-228	3	2	67%	0.839	1.3	No	2200	No	Below background
Thorium-230	2	2	100%	0.621	1.1	No	2700	No	Below background
Thorium-232	3	2	67%	0.621	1.3	No	2000	No	Below background
Total beta radiostrontium	2	1	50%	1,390	0.18	Yes	20	Yes	–
Total uranium (µg/g)	3	3	100%	11.3	3.21	Yes	NA	No	Isotopic below background
Uranium-233/234	3	2	67%	0.667	1.1	No	5000	No	Below background
Uranium-238	3	2	67%	0.667	1.1	No	2000	No	Below background
200-TW-2 OU, 216-B-7A Crib									
Carbon-14	4	1	25%	6.3	NA	No	19000000	No	Below BCG
Cesium-137	4	4	100%	42.5	1.1	Yes	20	Yes	–
Potassium-40	4	4	100%	14.5	17	No	NA	No	Below background
Radium-226	4	4	100%	0.584	0.815	No	3.0	No	Below background
Radium-228	4	4	100%	0.763	1.3	No	2.0	No	Below background
Thorium-228	4	3	75%	0.884	1.3	No	2200	No	Below background
Thorium-230	4	3	75%	0.729	1.1	No	2700	No	Below background
Thorium-232	4	3	75%	0.644	1.3	No	2000	No	Below background
Total beta radiostrontium	4	4	100%	13.5	0.18	Yes	20	No	Below BCG
Total uranium (µg/g)	4	4	100%	0.995	3.21	No	NA	No	Below background
Uranium-233/234	4	4	100%	0.474	1.1	No	5000	No	Below background
Uranium-235	4	4	100%	0.029	0.11	No	3000	No	Below background
Uranium-238	4	4	100%	0.465	1.1	No	2000	No	Below background

Table 5-7. Comparison of Maximum Shallow-Zone Soil Concentrations to Background and to Ecological Screening Values for Radionuclides. (3 pages)

Constituent Name	Number of Samples	Number of Detects	Frequency of Detection	Maximum Result	90th Percentile Background Concentration	Exceeds Background ?	Biota Concentration Guide	COEC?	Justification
200-PW-5 OU, 216-B-57 Crib									
Cesium-137	6	6	100%	50.5	1.1	Yes	20	Yes	--
Plutonium-238	1	1	100%	0.01	0.0038	Yes	5400	No	Below BCG
Potassium-40	6	6	100%	12.6	17	No	NA	No	Below background
Radium-226	5	5	100%	1.13	0.815	Yes	3.0	No	Below BCG
Strontium-90	4	4	100%	67	0.18	Yes	20	Yes	--
Thorium-228	6	6	100%	0.77	1.3	No	2200	No	Below background

-- = Not applicable.
BCG = biota concentration guides.
COEC = contaminant of ecological concern.

Table 5-8. Summary of RESidual RADioactivity Modeling for Radionuclide Total Dose Rates for the 216-B-46 Crib.

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
216-B-46					
No Cover, Direct Contact	1.9	0	Radium-226	99.3%	Ground
	1.9	1	Radium-226	99.4%	Ground
	1.9	3	Radium-226	99.4%	Ground
	1.9	10	Radium-226	99.5%	Ground
	1.9	30	Radium-226	99.7%	Ground
	1.8	100	Radium-226	99.9%	Ground
	1.7	150	Radium-226	100%	Ground
	1.6	239	Radium-226	100%	Ground
	1.3	467	Radium-226	100%	Ground
	0.9	1,000	Radium-226	100%	Ground

Table 5-9. Summary of RESidual RADioactivity Modeling for Radionuclide Risk for the 216-B-46 Crib.

Scenario	Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Risk	Primary Pathway
216-B-46					
No Cover, Direct Contact	4.28E-05	0	Radium-226	99.2%	Ground
	4.27E-05	1	Radium-226	99.2%	Ground
	4.27E-05	3	Radium-226	99.2%	Ground
	4.24E-05	10	Radium-226	99.2%	Ground
	4.18E-05	30	Radium-226	99.1%	Ground
	3.97E-05	100	Radium-226	99.1%	Ground
	3.82E-05	150	Radium-226	99.1%	Ground
	3.57E-05	239	Radium-226	99.2%	Ground
	3.00E-05	467	Radium-226	99.2%	Ground
	2.0E-06	1,000	Radium-226	99.2%	Ground

Table 5-10. Summary of RESidual RADioactivity Modeling for Radionuclide Total Dose Rates for the 216-B-7A Crib.

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
216-B-7A					
No Cover, Direct Contact	15.1	0	Cesium-137	99.8%	Ground
	14.8	1	Cesium-137	99.8%	Ground
	14.1	3	Cesium-137	99.8%	Ground
	12.0	10	Cesium-137	99.8%	Ground
	7.6	30	Cesium-137	99.8%	Ground
	1.5	100	Cesium-137	99.8%	Ground
	0.47	150	Cesium-137	99.9%	Ground
	0.06	239	Cesium-137	99.9%	Ground
	0.00	467	Cesium-137	99.9%	Ground
	0.00	1,000	Cesium-137	100%	Ground
1-ft Cover, Direct Contact	0.08	0	Cesium-137	100%	Ground
	0.08	1	Cesium-137	100%	Ground
	0.08	3	Cesium-137	100%	Ground
	0.07	10	Cesium-137	100%	Ground
	0.07	30	Cesium-137	100%	Ground
	0.05	100	Cesium-137	99.9%	Ground
	0.04	150	Cesium-137	99.9%	Ground
	0.02	239	Cesium-137	99.9%	Ground
	0.00	467	Cesium-137	100%	Ground
	0.00	1,000	Cesium-137	100%	Ground

Table 5-11. Summary of RESidual RADioactivity Modeling for Radionuclide Risk for the 216-B-7A Crib.

Scenario	Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Risk	Primary Pathway
216-B-7A					
No Cover, Direct Contact	2.48E-04	0	Cesium-137	99.8%	Ground
	2.42E-04	1	Cesium-137	99.8%	Ground
	2.31E-04	3	Cesium-137	99.8%	Ground
	1.97E-04	10	Cesium-137	99.8%	Ground
	1.24E-04	30	Cesium-137	99.8%	Ground
	2.46E-05	100	Cesium-137	99.8%	Ground
	7.73E-06	150	Cesium-137	99.9%	Ground
	9.89E-07	239	Cesium-137	99.9%	Ground
	5.09E-09	467	Cesium-137	99.9%	Ground
	2.28E-14	1,000	Cesium-137	100%	Ground
1-ft Cover, Direct Contact	1.61E-06	0	Cesium-137	100%	Ground
	1.60E-06	1	Cesium-137	100%	Ground
	1.59E-06	3	Cesium-137	100%	Ground
	1.54E-06	10	Cesium-137	100%	Ground
	1.42E-06	30	Cesium-137	99.9%	Ground
	1.05E-06	100	Cesium-137	99.9%	Ground
	8.30E-07	150	Cesium-137	99.9%	Ground
	4.97E-07	239	Cesium-137	99.9%	Ground
	5.09E-09	467	Cesium-137	100%	Ground
	2.28E-14	1,000	Cesium-137	100%	Ground

Table 5-12. Summary of RESidual RADioactivity Modeling for Radionuclide Total Dose Rates for the 216-B-38 Trench.

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
216-B-38					
No Cover, Direct Contact	128,300	0	Cesium-137	100%	Ground
	125,300	1	Cesium-137	100%	Ground
	119,700	3	Cesium-137	100%	Ground
	101,800	10	Cesium-137	100%	Ground
	64,140	30	Cesium-137	100%	Ground
	12,720	100	Cesium-137	99.9%	Ground
	4,009	150	Cesium-137	99.9%	Ground
	514	239	Cesium-137	99.7%	Ground
	4.1	467	Cesium-137	63.9%	Ground
	1.22	1,000	Cesium-137	86.2%	Ground
10-ft Cover, Direct Contact	3.45E-13	0	Cesium-137	100%	Ground
	3.41E-13	1	Cesium-137	100%	Ground
	3.35E-13	3	Cesium-137	100%	Ground
	3.13E-13	10	Cesium-137	100%	Ground
	2.57E-13	30	Cesium-137	100%	Ground
	1.29E-13	100	Cesium-137	100%	Ground
	7.91E-14	150	Cesium-137	100%	Ground
	3.30E-14	239	Cesium-137	100%	Ground
	3.53E-15	467	Cesium-137	100%	Ground
	6.27E-17	1,000	Plutonium-238	69.1%	Ground

Table 5-13. Summary of RESidual RADioactivity Modeling for Radionuclide Risk for the 216-B-38 Trench.

Scenario	Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Risk	Primary Pathway
216-B-38					
No Cover, Direct Contact	>1E-02	0	Cesium-137	100%	Ground
	>1E-02	1	Cesium-137	100%	Ground
	>1E-02	3	Cesium-137	100%	Ground
	>1E-02	10	Cesium-137	100%	Ground
	>1E-02	30	Cesium-137	100%	Ground
	>1E-02	100	Cesium-137	100%	Ground
	>1E-02	150	Cesium-137	100%	Ground
	8.40E-03	239	Cesium-137	99.9%	Ground
	4.93E-05	467	Cesium-137	87.7%	Ground
	3.99E-06	1,000	Plutonium-239	63.5%	Ground
10-ft Cover, Direct Contact	6.73E-18	0	Cesium-137	100%	Ground
	6.67E-18	1	Cesium-137	100%	Ground
	6.54E-18	3	Cesium-137	100%	Ground
	6.10E-18	10	Cesium-137	100%	Ground
	5.02E-18	30	Cesium-137	100%	Ground
	2.52E-18	100	Cesium-137	100%	Ground
	1.55E-18	150	Cesium-137	100%	Ground
	6.45E-19	239	Cesium-137	100%	Ground
	6.89E-20	467	Cesium-137	100%	Ground
	1.57E-21	1,000	Plutonium-238	75.6%	Ground

Table 5-14. Summary of RESidual RADioactivity Modeling for Radionuclide Total Dose Rates for the 216-B-57 Crib.

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
216-B-57					
No Cover, Direct Contact	26.1	0	Cesium-137	90.6%	Ground
	25.6	1	Cesium-137	90.4%	Ground
	24.5	3	Cesium-137	90.1%	Ground
	21.2	10	Cesium-137	88.7%	Ground
	14.1	30	Cesium-137	83.8%	Ground
	4.43	100	Cesium-137	53.0%	Ground
	2.73	150	Radium-226	72.7%	Ground
	1.95	239	Radium-226	95.1%	Ground
	1.56	467	Radium-226	100%	Ground
	1.04	1,000	Radium-226	100%	Ground

Table 5-15. Summary of RESidual RADioactivity Modeling for Radionuclide Risk for the 216-B-57 Crib.

Scenario	Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Risk	Primary Pathway
216-B-57					
No Cover, Direct Contact	4.41E-04	0	Cesium-137	87.8%	Ground
	4.32E-04	1	Cesium-137	87.6%	Ground
	4.15E-04	3	Cesium-137	87.1%	Ground
	3.60E-04	10	Cesium-137	85.4%	Ground
	2.44E-04	30	Cesium-137	79.3%	Ground
	8.47E-05	100	Radium-226	53.7%	Ground
	5.64E-05	150	Radium-226	77.7%	Ground
	4.29E-05	239	Radium-226	95.5%	Ground
	3.47E-05	467	Radium-226	99.1%	Ground
	2.31E-05	1,000	Radium-226	99.2%	Ground

Table 5-16. Radionuclide Concentrations Used in RESRAD Modeling to Evaluate Protection of Groundwater.

Radionuclide	216-B-46	216-T-26	216-B-7A	216-B-38
Amercium-241		5.50E+01	1.40E+03	1.40E+01
Cesium-137		2.20E+04	5.20E+04	3.80E+04
Europium-154		1.75E+01	3.30E+01	
Europium-155		2.00E+01		
Hydrogen-3				8.60E+00
Plutonium-238	1.60E+00	9.00E+00	2.20E+01	2.30E+00
Plutonium-239/240		2.00E+03	4.20E+04	
Radium-226	1.20E+00			
Strontium-90	8.00E+04	5.00E+03	2.00E+06	6.00E+02
Technetium-99			6.00E+00	4.00E-01
Uranium-233		6.00E+00	2.00E+01	3.80E+00
Uranium-235			1.00E-01	
Uranium-238		8.00E+00	1.85E+01	1.80E+00

Table 5-17. Summary of RESidual RADioactivity Modeling Doses for Protection of Groundwater at the 200-TW-1 Operable Unit.

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose
216-B-46 Crib				
Groundwater Protection	0	0	N/A	N/A
	0	1	N/A	N/A
	0	3	N/A	N/A
	0	10	N/A	N/A
	0	30	N/A	N/A
	0	100	N/A	N/A
	0	150	N/A	N/A
	0	239	N/A	N/A
	0	467	N/A	N/A
	0	1000	N/A	N/A
216-T-26 Crib				
Groundwater Protection	0	0	N/A	N/A
	0	1	N/A	N/A
	0	3	N/A	N/A
	0	10	N/A	N/A
	0	30	N/A	N/A
	0	100	N/A	N/A
	0	150	N/A	N/A
	0	239	N/A	N/A
	0	467	N/A	N/A
	0	1000	N/A	N/A

N/A = not applicable

Table 5-18. Summary of RESidual RADioactivity Modeling Risks for Protection of Groundwater at the 200-TW-1 Operable Unit.

Scenario	Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Risk
216-B-46 Crib				
Groundwater Protection	0	0	N/A	N/A
	0	1	N/A	N/A
	0	3	N/A	N/A
	0	10	N/A	N/A
	0	30	N/A	N/A
	0	100	N/A	N/A
	0	150	N/A	N/A
	0	239	N/A	N/A
	0	467	N/A	N/A
	0	1000	N/A	N/A
216-T-26 Crib				
Groundwater Protection	0	0	N/A	N/A
	0	1	N/A	N/A
	0	3	N/A	N/A
	0	10	N/A	N/A
	0	30	N/A	N/A
	0	100	N/A	N/A
	0	150	N/A	N/A
	0	239	N/A	N/A
	0	467	N/A	N/A
	0	1000	N/A	N/A

N/A = not applicable

Table 5-19. Summary of RESidual RADioactivity Modeling Doses for Protection of Groundwater at the 200-TW-2 Operable Unit.

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose
216-B-7A Crib				
Groundwater Protection	0	0	N/A	N/A
	0	1	N/A	N/A
	0	3	N/A	N/A
	0	10	N/A	N/A
	0	30	N/A	N/A
	0	100	N/A	N/A
	0	150	N/A	N/A
	0	239	N/A	N/A
	2.64E-2	467	Technetium-99	100%
	1.65E-5	1000	Technetium-99	100%
216-B-38 Trench				
Groundwater Protection	0	0	N/A	N/A
	0	1	N/A	N/A
	0	3	N/A	N/A
	0	10	N/A	N/A
	0	30	N/A	N/A
	0	100	N/A	N/A
	0	150	N/A	N/A
	0	239	N/A	N/A
	2.75E-3	467	Technetium-99	100%
	5.76E-6	1000	Technetium-99	100%

N/A = not applicable

Table 5-20. Summary of RESidual RADioactivity Modeling Risks for Protection of Groundwater at the 200-TW-2 Operable Unit.

Scenario	Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Risk
216-B-7A				
Groundwater Protection	0	0	N/A	N/A
	0	1	N/A	N/A
	0	3	N/A	N/A
	0	10	N/A	N/A
	0	30	N/A	N/A
	0	100	N/A	N/A
	0	150	N/A	N/A
	0	239	N/A	N/A
	1.23E-6	467	Technetium-99	100%
	7.67E-10	1000	Technetium-99	100%
216-B-38				
Groundwater Protection	0	0	N/A	N/A
	0	1	N/A	N/A
	0	3	N/A	N/A
	0	10	N/A	N/A
	0	30	N/A	N/A
	0	100	N/A	N/A
	0	150	N/A	N/A
	0	239	N/A	N/A
	1.32E-7	467	Technetium-99	100%
	2.76E-10	1000	Technetium-99	100%

N/A = not applicable

Table 5-21. Uncertainties Associated with Human Health Risk Estimations. (2 Pages)

Uncertainty Factor (UF)	Effects of Uncertainty	Comment
I. Uncertainty in Environmental Sampling and Analysis		
Estimates of chemical concentrations	May underestimate or overestimate risk	Sampling errors, sample representativeness, and variability in chemical analyses will affect chemical concentrations. Available analytical data may not accurately reflect site conditions. Chemical concentrations may change as a result of migration or degradation.
II. Uncertainty in Fate and Transport		
Source concentrations assumed constant over time	May underestimate or overestimate risk	Did not account for environmental fate, transport, or transfer, which may alter contaminant concentrations.
III. Exposure Assessment		
Exposure assumptions	May under- or overestimate risk	Assumptions regarding media intake, population characteristics, and exposure patterns may not characterize exposures.
Use of applied dose to estimate risks	May over- or underestimate risks	Assumes that the absorption of the chemical is the same as it was in the study that derived the toxicity value. Assumes that absorption is equivalent across species (animal to humans). Absorption may vary with age and species.
Population characteristics	May over- or underestimate risks	Assumes weight, lifespan, and ingestion rate, are potentially representative for a potentially exposed population.
Intake	May underestimate risks	Assumes all intake of COPCs is from the exposure medium being evaluated (no relative source contribution).
IV. Toxicity Assessment		
Slope Factor	May overestimate risks	Slope factors are upperbound UCLs derived from a linearized model. Considered unlikely to underestimate risk.
Toxicity values derived from animal studies	May over- or underestimate risks	Extrapolation from animal to humans may induce error because of differences in pharmacokinetics, target organs, and population variability.
Toxicity values derived primarily from high doses (most exposures are at low doses)	May over- or underestimate risks	Assumes linearity at low doses. Tends to have conservative exposure assumptions.
Toxicity values	May over- or underestimate risks	Not all values represent the same degree of certainty. All are subject to change, as new evidence becomes available.
Toxicity data not available for all constituents	Risks could not be estimated	Potential negative effects of exposure to these constituents are not quantifiable.
Surrogate toxicity values	May over- or underestimate risks	Assumes toxicity of structurally similar compound is equivalent.
Toxicity values derived from short-term tests to predict chronic exposures	May over- or underestimate risks	Assumes that the dose-response observed from short-term exposure to high concentrations is similar to exposure to low concentration environmental exposures.
Toxicity values derived from homogeneous animal populations	May over- or underestimate risks	Human populations may have a wide range of sensitivities to a chemical.

Table 5-21. Uncertainties Associated with Human Health Risk Estimations. (2 Pages)

Uncertainty Factor (UF)	Effects of Uncertainty	Comment
V. Risk Estimation		
Estimation of risks across exposure routes	May under- or overestimate risk	Some exposure routes have greater uncertainty associated with their risk estimates than others.
Cumulative risk estimates	May under- or overestimate risk	Assumes additivity of risks from multiple chemicals; may have synergistic or antagonistic effects.
Cancer risk estimates (no threshold assumed)	May overestimate risks	Possibility that some thresholds do exist.
Cancer risk estimate (low dose) linearity	May overestimate risks	Response at low doses is not known.

6.0 CONCLUSIONS, SUMMARY, AND PATH FORWARD

The 200-TW-1 and 200-PW-5 OUs consist of CERCLA past-practice waste sites and will be remediated under the CERCLA process. The 200-TW-2 OU consists of RCRA past-practice waste sites; therefore, while the CERCLA process will be used to fulfill the RCRA corrective action requirements, additional documentation to support the RCRA permit will be required. Tasks to be completed following the RI include preparing an FS, a proposed plan and proposed permit modification, and an ROD and permit modification as described in the Implementation Plan (DOE/RL-98-28).

6.1 GENERAL CONCLUSIONS

The purpose of this RI report was to determine if sufficient data have been collected to support risk assessment and remedial decision making, to estimate risks at the representative sites based on the data collected during the RI and other existing data, to determine the need to proceed with an FS, and to determine those constituents and site-specific considerations that need to be addressed in the FS. The first purpose was met; the data collected are considered to be of sufficient quantity and quality to support the risk assessment activities and to proceed to the FS to support evaluation of remedial alternatives and identify preferred remedial actions. The second purpose was achieved by the estimation of risk for human health in Chapter 5.0.
A screening of potential ecological risk was included in Chapter 5.0. An evaluation of protection of groundwater indicated that contaminants currently in the vadose zone likely will impact groundwater in the future; however, the contaminants are not expected to increase groundwater concentrations above current levels. These risk evaluations indicate the need for an FS to evaluate remedial alternatives. Those constituents and site-specific considerations that the FS needs to address are presented in Table 6-1. Further ecological risk evaluation will be needed in the FS for the radiological constituents; nonradiological constituents were not detected above levels of concern for wildlife in the 0 to 4.6 m (0 to 15 ft) zone. These waste sites are highly disturbed and many were constructed deeply; therefore, the availability of habitat on these sites is very low and is of very poor quality.

6.2 SUMMARY

One representative site, the 216-T-26 Crib, was evaluated for the 200-TW-1 OU during the recent RI activities. A second 200-TW-1 OU representative site, the 216-B-46 Crib, was evaluated as part of the 200-BP-1 OU RI. Both sites are evaluated in this report. Two representative sites, the 216-B-7A Crib and the 216-B-38 Trench, were evaluated for the 200-TW-2 OU during the recent RI activities. A third 200-TW-2 OU representative site, the 216-B-5 Reverse Well, was evaluated previously (RHO-ST-37). A representative site for the 200-PW-5 OU (the 216-B-57 Crib) was evaluated as part of the 200-BP-1 OU RI. This site was selected for implementation of a treatability test of the Hanford barrier. The barrier was constructed over the 216-B-57 Crib in 1997 and continues to be monitored and evaluated annually.

The evaluation of the representative sites involved site characterization, a baseline human health risk evaluation, an ecological screening of site-specific contaminants that augments the Central Plateau screening-level ecological risk assessment in DOE/RL-2001-54, fate and transport modeling, and a refinement of the contaminant distribution models. COCs were identified for

each of the sites following a data evaluation process that is based on HSRAM (DOE/RL-91-45), regulatory guidance, and professional judgment. Contaminants that were identified as COCs for the waste sites will be carried forward into the FS for evaluation of remedial alternatives as identified in Table 6-1. The COCs and the contaminant distribution and exposure models are summarized in Sections 6.1.1 and 6.1.2.

6.2.1 Contaminants of Concern and Site Risks

Nonradioactive constituents analyzed in the RI were screened based on detection (constituents with no detections were eliminated), comparison to background, and comparison to regulatory requirements. Radiological constituents were screened based on detection and background. Radiological dose and cancer risk to receptors were evaluated using RESRAD (ANL/EAD-4). Contaminants with the potential to impact groundwater were evaluated using the STOMP code (PNNL-12034). The COCs, relative risks, and radiological dose rates for each waste site are summarized in Table 6-1. Based on the results of the data evaluation, Table 6-1 identifies those COCs that must be considered for remedial action in the FS. Table 6-2 identifies those COCs that were consistently identified in the 200-TW-1, 200-TW-2, and 200-PW-5 OUs and that are the most likely contaminants for future sampling efforts (i.e., confirmatory sampling, design sampling, verification sampling).

Numerous Sitewide activities are aimed at monitoring environmental impacts. A qualitative discussion of ecological impacts, including summaries of Sitewide activities, was included in this document.

6.2.2 Contaminant Distribution Models and Exposure Models

The conceptual contaminant distribution models and the conceptual exposure model developed for the 200-TW-1 and 200-TW-2 OUs in the Work Plan (DOE/RL-2000-38) were refined based on the data obtained during the RI and other data collection activities. The contaminant distribution models are presented in Section 3.2, but generally can be described as follows.

- Contamination associated with less mobile COCs (mainly cesium-137) is confined near the waste site bottom.
- Contamination associated with moderately mobile COCs (such as strontium-90) is found deeper in the vadose zone and, depending on the thickness of that zone, may be found throughout the vadose zone.
- Highly mobile COCs (such as nitrate, tritium, or technetium) have passed through the vadose zone and are not present or are present only at low concentrations.

The exposure pathway model for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs is presented in Section 1.4.2, and is generally summarized as follows.

- Potentially contaminated media include sediments, shallow-zone soils, deep zone soils, biota, and groundwater.
- Potential receptors are mainly current and future workers, based on the current land-use assumptions, and terrestrial biota.

- Exposure pathways include ingestion, dermal contact, inhalation, and exposure to external radiation.

6.3 PATH FORWARD

6.3.1 Feasibility Study

The FS will follow CERCLA guidance and the strategy in the Implementation Plan (DOE/RL-98-28). Although some refinement is expected during the FS, Appendix D of DOE/RL-98-28 satisfies the requirements for the screening phase (steps 1 through 6) of the FS process. The preliminary RAOs, preliminary remediation goals, general response actions, and the screening-level analysis of alternatives are incorporated by reference into the RI/FS documents. As a result of the work completed in the Implementation Plan, the FS report will focus on the final phase of the FS, which consists of refining and analyzing in detail a limited number of alternatives identified in the screening phase. Remedial action alternatives considered applicable in the Implementation Plan to the 200-TW-1, 200-TW-2, and 200-PW-5 OUs include the following:

- No action
- Institutional controls/monitored natural attenuation
- Engineered surface barriers
- Excavation and disposal with or without ex situ treatment
- In situ grouting or stabilization
- In situ vitrification.

For the 200-TW-2 OU, one additional alternative (excavation, ex situ treatment, and geologic disposal of TRU waste) was identified in the Implementation Plan because of the potential for this OU to contain TRU waste. During the RI, plutonium-239/240 was found at the base of the 216-B-7A Crib at a concentration of 153,000 pCi/g, which exceeds the definition for TRU waste (see Section 3.2.2.6).

An initial activity of the FS will be the detailed evaluation of available information for the remaining analogous waste sites in the OU. Data will be compiled to evaluate the applicability to the analogous sites of the contaminant distribution models and relative risks developed in the RI report for the representative sites. Sites that are determined not to be analogous to the representative sites will be evaluated against representative sites from other OUs; they also may be reassigned to a more appropriate OU. The sites that are determined to be analogous to one or more of the representative sites will be evaluated for appropriate remedial measures through the FS process. Additional data needs may be identified during the FS process and during the DQO process to support the confirmatory sampling for these analogous sites.

6.3.2 Proposed Plan and Proposed RCRA Permit Modification

The decision-making process for the waste sites within the 200-TW-1, 200-TW-2, and 200-PW-5 OUs will be based on the use of a proposed plan and an ROD. During the RI/FS process, a number of options for development of proposed plans and RODs will be evaluated. Remedial decisions may proceed on an OU-by-OU basis, but alternative site groupings may be

considered for waste sites in the Central Plateau. Several alternatives are under consideration, some of which may be used for the waste sites addressed in this RI report.

Three alternatives to the OU-by-OU remediation approach have been identified to provide flexibility in the decision-making process, facilitate early action, and remediate and close specific areas or zones. Examples of these alternatives are presented below.

High-Risk Waste Sites Identified for Early Action

This alternative accelerates the start of remedial actions and closure of waste sites that present an ongoing or expected future threat to groundwater. Some high-risk sites already have been identified for early actions within the B/C Cribs and Trenches Area and near U Plant, the Plutonium-Uranium Extraction (PUREX) Plant, and the Plutonium Finishing Plant. Many of the B/C Cribs and Trenches are in the 200-TW-1 OU.

Regional Site Closure

Waste site remedial decision-making may be realigned under a regional closure strategy that aligns wastes sites into groups defined by geographical zones. For example, the 200-TW-1 OU waste sites in the B/C Cribs and Trenches Area may be considered for an accelerated closure with sites from the 200-LW-1 and 200-UR-1 OUs located in that area via proposed plans and RODs.

Waste Site Grouping by Characteristics or Hazards

A third example of remedial decision-making strategies would be based on a specific characteristic or hazard that mandates additional requirements such as supplemental potential ARARs or more robust remedial alternatives. At least one waste site in the 200-TW-2 OU (the 216-B-7A and 216-B-7B Cribs) contains concentrations of transuranic radionuclides in excess of the 100 nCi/g concentration limit for designation as TRU waste. Waste sites containing concentrations of TRU radionuclides above 100 nCi/g may require selective removal actions or more protective barrier designs to prevent intrusion based on this particular hazard. Such alternatives may not be required for other waste sites within the 200-TW-1, 200-TW-2, and 200-PW-5 OUs where only low levels of these radionuclides are present. Grouping 200-TW-2 OU waste sites with other suspect TRU-contaminated soil sites (and possibly burial grounds) could streamline the decision-making process and tailor the requirements and alternatives to these specific hazards.

Following the completion of the FS, a proposed plan will be prepared that identifies a preferred remedial alternative for each of the waste sites. In addition to identifying preferred alternatives, the proposed plan will perform the following:

- Provide a summary of the completed RI/FS
- Provide criteria by which analogous waste sites within the OUs will be evaluated after the ROD to confirm that the contaminant distribution model for the site is consistent with the preferred alternative
- Identify performance standards and potential ARARs for the OUs or other site groupings.

After the public review process is complete, the lead regulatory agency for these OUs will decide on the remedial actions to be taken and will document those decisions in an ROD. If alternative decision-making strategies are employed, lead agency realignments may be considered in consultations between the EPA and Ecology.

6.4 POST-RECORD-OF-DECISION ACTIVITIES AND ANALOGOUS SITE APPROACH

The ROD for these OUs will cover all the sites in the OUs, not just the representative sites characterized under the RI. This analogous site approach is described in more detail in the Implementation Plan (DOE/RL-98-28) and in Section 1.3. The basic approach is that the representative sites contain types, concentrations, and distributions of contaminants similar to those at the other sites in the OU, because the sites are grouped on the basis of similar site histories and processes. The sites, therefore, share similar risks and a similar need for remedial action. The data collected for the representative sites will be considered to be analogous to the remaining sites (Section 1.3).

After the ROD has been issued, a remedial design report and remedial action work plan will be prepared to detail the scope of the remedial action. As part of this activity, DQOs will be established, and sampling and analysis plans will be prepared to direct confirmatory/remedial design and verification sampling and analysis efforts. A preliminary list of contaminants for the confirmatory sampling is identified in Table 6-2, based on the results of the RI. The actual confirmatory sampling design will be developed through the DQO process. Before the start of remediation, confirmation/remedial design sampling will be performed to ensure that sufficient characterization data are available to confirm that the selected remedy is appropriate for the waste sites within the ROD, to collect data necessary for the remedial design, and to support final cumulative risk assessment for the entire 200 Areas National Priority List site (40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priority List"). Verification sampling will be performed after the remedial action is complete to determine if ROD requirements have been met and if the remedy was protective of human health and the environment. Additional guidance for confirmatory and verification sampling is provided in Section 6.2 of DOE/RL-98-28.

The remedial design report/remedial action work plan will include an integrated schedule of remediation activities for waste sites and releases covered by the ROD or RODs. The available options for remedy implementation throughout the 200 Areas will be explored during the course of the RI/FS process and may be reflected in the remedial action work plan. Following the completion of the remediation effort, closeout activities will be performed as discussed in Section 2.4 of DOE/RL-98-28.

Table 6-1. Contaminants of Concern, Risk, and Dose Summary. (2 pages)

Site	Nonradiological			Radiological			
	COCs that Exceeded WAC 173-340-745 Soil Cleanup Standards for Industrial Properties	COCs That Exceeded Groundwater Protection Standards under WAC 173-340-747[a]	COCs That Exceeded WAC 173-340-900, Table 749-3 Concentrations[b]	Total Maximum Excess Lifetime Cancer Risk from Radiological COCs[c]	Total Maximum Dose Rate/Time[c]	Primary Risk Contributor	COCs that May Impact Groundwater Above WAC 173-340-720 Standards
216-B-46 Crib	No contaminants exceeded WAC 173-340-745 Method B soil cleanup standards	Antimony, Cadmium, Cyanide, Nitrate, Total Uranium	No contaminants exceeded the Table 749-3 wildlife standards	4.3×10^{-5} for no cover.	1.9 mrem/yr @ 0 yr for no cover scenario.	Radium-226	Cobalt-60, Technetium-99, Radium-226, Uranium-238
216-T-26 Crib	No contaminants exceeded WAC 173-340-745 Method B soil cleanup standards	Chromium (III), Cyanide, Fluoride, Nitrate, Nitrite, Total Uranium	No contaminants exceeded the Table 749-3 wildlife standards	Not applicable; no contamination from 0 to 4.6 m (0 to 15 ft)	Not applicable; no contamination from 0 to 4.6 m (0 to 15 ft)	Not applicable; no contamination from 0 to 4.6 m (0 to 15 ft)	Technetium-99, Uranium-233/234/238
216-B-7A Crib	No contaminants exceeded WAC 173-340-745 Method B soil cleanup standards	Iron, Manganese, Fluoride, Nitrate, Total Uranium	No contaminants exceeded the Table 749-3 wildlife standards	2.5×10^{-4} at 0 yr for no cover scenario; 1.6×10^{-6} at 0 yr for 1 ft cover scenario.	15 mrem/yr @ 0 yr for no cover scenario 1; 0.1 mrem/yr @ 0 yr for 1 ft cover scenario.	Cesium-137	Uranium-233/234/238
216-B-38 Trench	No contaminants exceeded WAC 173-340-745 Method B soil cleanup standards	Fluoride, Nitrate, Nitrite, Total Uranium	No contaminants exceeded the Table 749-3 wildlife standards	$> 1 \times 10^{-2}$ at 0 yr for no cover scenario; 6.7×10^{-18} at 0 yr for 10 ft cover scenario.	128,300 mrem/yr @ 0 yr for no cover scenario; 3.5×10^{-13} mrem/yr @ 0 yr for 10 ft cover scenario.	Cesium-137	Uranium-233/234/238
216-B-5 Reverse Well	See results for 216-B-7A Crib	See results for 216-B-7A Crib	Not applicable; no contamination from 0 to 4.6 m (0 to 15 ft)	Not applicable; no contamination from 0 to 4.6 m (0 to 15 ft)	Not applicable; no contamination from 0 to 4.6 m (0 to 15 ft)	Not applicable; no contamination from 0 to 4.6 m (0 to 15 ft)	Contaminants injected at or near water table

Table 6-1. Contaminants of Concern, Risk, and Dose Summary. (2 pages)

Site	Nonradiological			Radiological			
	COCs that Exceeded WAC 173-340-745 Soil Cleanup Standards for Industrial Properties	COCs That Exceeded Groundwater Protection Standards under WAC 173-340-747[a]	COCs That Exceeded WAC 173-340-900, Table 749-3 Concentrations[b]	Total Maximum Excess Lifetime Cancer Risk from Radiological COCs[c]	Total Maximum Dose Rate/Time[c]	Primary Risk Contributor	COCs that May Impact Groundwater Above WAC 173-340-720 Standards
216-B-57 Crib	No contaminants exceeded WAC 173-340-745 Method B soil cleanup standards	Modeling not conducted; site is bounded by other representative sites	No contaminants exceeded the Table 749-3 wildlife standards	4.4×10^{-4} for no cover scenario.	26.1 mrem/yr @ 0 years for no cover scenario.	Cesium-137 until 100 yr, radium-226 after that for no cover scenario.	Hanford Barrier currently exists over waste site; without barrier, similar contaminants to other representative sites could be expected to impact groundwater

[a] WAC 173-340-747, "Deriving Soil Concentrations for Ground Water Protection," *Washington Administrative Code*, as amended.

[b] WAC 173-340-900, "Tables," Table 749-3, "Ecological Indicator Soil Concentrations (mg/kg) for Protection of Terrestrial Plants and Animals," *Washington Administrative Code*, as amended.

[c] No cover – contaminated zone from 0 to 15 ft bgs with no cover; clean cover above contaminated zone, contaminated zone from bottom of the cover to 15 ft

bgs = below ground surface.
COC = contaminant of concern.

Table 6-2. Preliminary List of Contaminants for Confirmatory Sampling Phase at the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units.

Radioactive Constituents	
Americium-241	Technetium-99
Cesium-137	Tritium
Plutonium-238[a]	Uranium-233/234
Plutonium-239/240[a]	Uranium-235/236
Strontium-90	Uranium-238
Chemical Constituents – Metals	
Bismuth	Total uranium
Sodium	
Chemical Constituents – General Chemistry Anions	
Ammonia	Nitrite
Cyanide[b]	Phosphate
Fluoride	Sulfate
Nitrate	

[a]Analyzed only when americium-241 is detected.
[b]200-TW-1 Operable Unit waste sites only.

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APPENDIX A

200-TW-1, 200-TW-2, AND 200-PW-5 OPERABLE UNIT CONSOLIDATION

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APPENDIX A

200-TW-1, 200-TW-2, AND 200-PW-5 OPERABLE UNIT CONSOLIDATION

Table A-1. 200-TW-1/200-TW-2/200-PW-5 Operable Unit Consolidation Logic Waste Site Summary. (7 pages)

Site Code	Site Names	Site Type	Site Status	Classification Status	Reclassification Status	Table Assignment*
200-TW-1 Operable Unit Waste Sites**						
200-E-14	200-E-14, 216-BC-201 Siphon Tank, 216-B-201, Inactive Miscellaneous Underground Storage Tank (IMUST)	Storage Tank	Inactive	Accepted		No
200-E-49	200-E-49, Borrow Pit North of BC Cribs and Trenches	Depression/ Pit (non-specific)	Inactive	Rejected		Table A-2
200-E-114	200-E-114, Pipeline From 241-BY Tank Farm to 241-C Tank Farm and BC Cribs Trenches	Tank Farm Process Piping	Inactive	Accepted		No
216-B-14	216-B-14, 216-BC-1 Crib	Crib	Inactive	Accepted		No
216-B-15	216-B-15, 216-BC-2 Crib	Crib	Inactive	Accepted		No
216-B-16	216-B-16, 216-BC-3 Crib	Crib	Inactive	Accepted		No
216-B-17	216-B-17, 216-BC-4 Crib	Crib	Inactive	Accepted		No
216-B-18	216-B-18, 216-BC-5 Crib	Crib	Inactive	Accepted		No
216-B-19	216-B-19, 216-BC-6 Crib	Crib	Inactive	Accepted		No
216-B-20	216-B-20, 216-BC-7 Trench, 216-B-20 Trench	Trench	Inactive	Accepted		No
216-B-21	216-B-21, 216-BC-8 Trench, 216-B-21 Trench	Trench	Inactive	Accepted		No
216-B-22	216-B-22, 216-BC-9 Trench, 216-B-22 Trench	Trench	Inactive	Accepted		No
216-B-23	216-B-23, 216-BC-10 Trench, 216-B-23 Trench	Trench	Inactive	Accepted		No

Table A-1. 200-TW-1/200-TW-2/200-PW-5 Operable Unit Consolidation Logic Waste Site Summary. (7 pages)

Site Code	Site Names	Site Type	Site Status	Classification Status	Reclassification Status	Table Assignment*
216-B-24	216-B-24, 216-BC-11 Trench, 216-B-24 Trench	Trench	Inactive	Accepted		No
216-B-25	216-B-25, 216-BC-12 Trench, 216-B-25 Trench	Trench	Inactive	Accepted		No
216-B-26	216-B-26, 216-BC-13 Trench, 216-B-26 Trench	Trench	Inactive	Accepted		No
216-B-27	216-B-27, 216-BC-14 Trench, 216-B-27 Trench	Trench	Inactive	Accepted		No
216-B-28	216-B-28, 216-BC-15 Trench, 216-B-28 Trench	Trench	Inactive	Accepted		No
216-B-29	216-B-29, 216-BC-16 Trench	Trench	Inactive	Accepted		No
216-B-30	216-B-30, 216-BC-17 Trench, 216-B-30 Trench	Trench	Inactive	Accepted		No
216-B-31	216-B-31, 216-BC-18 Trench, 216-B-31 Trench	Trench	Inactive	Accepted		No
216-B-32	216-B-32, 216-BC-19 Trench, 216-B-32 Trench	Trench	Inactive	Accepted		No
216-B-33	216-B-33, 216-BC-20 Trench, 216-B-33 Trench	Trench	Inactive	Accepted		No
216-B-34	216-B-34, 216-BC-21 Trench	Trench	Inactive	Accepted		No
216-B-42	216-B-42, 241-BX-8 Grave, 216-BX-8 Trench, 216-B-42 Trench	Trench	Inactive	Accepted		No
216-B-43	216-B-43, 216-BY-1 Crib, 216-BY-1 Cavern	Crib	Inactive	Accepted		No
216-B-44	216-B-44, 216-BY-2 Crib, 216-BY-2 Cavern	Crib	Inactive	Accepted		No
216-B-45	216-B-45, 216-BY-3 Crib, 216-BY-3 Cavern	Crib	Inactive	Accepted		No

Table A-1. 200-TW-1/200-TW-2/200-PW-5 Operable Unit Consolidation Logic Waste Site Summary. (7 pages)

Site Code	Site Names	Site Type	Site Status	Classification Status	Reclassification Status	Table Assignment*
216-B-46	216-B-46, 216-BY-4 Crib, 216-BY-4 Cavern	Crib	Inactive	Accepted		Table A-3
216-B-47	216-B-47, 216-BY-5 Crib, 216-BY-5 Cavern	Crib	Inactive	Accepted		No
216-B-48	216-B-48, 216-BY-6 Crib, 216-BY-6 Cavern	Crib	Inactive	Accepted		No
216-B-49	216-B-49, 216-BY-7 Crib, 216-BY-7 Cavern	Crib	Inactive	Accepted		No
216-B-51	216-B-51, 216-BY-9 Crib	French Drain	Inactive	Accepted		No
216-B-52	216-B-52, 216-B-52 Trench, 216-BC-22	Trench	Inactive	Accepted		No
216-BY-201	216-BY-201, 241-BY Flush Tank, 216-BY-47, Supernatant Disposal Flush Tank, IMUST,	Settling Tank	Inactive	Accepted		No
216-T-18	216-T-18, Test Crib for 221-U Building, Scavenged TBP Waste, 216-T-17, 241-T-17 Crib	Crib	Inactive	Accepted		No
216-T-26	216-T-26, 216-TY-1 Cavern, 216-TY-1 Crib, 241-TX-1 Cavern, 216-TX-1 Crib	Crib	Inactive	Accepted		Table A-3
UPR-200-E-9	UPR-200-E-9, Liquid Overflow at 216-BY-201, UN-200-E-9	Unplanned Release	Inactive	Accepted		No
200-TW-2 OU Waste Sites**						
200-E-45	200-E-45, HI Shaft, Health Instrument Shaft, Contaminated Pump Run-in Caisson	Depression/ Pit (non-specific)	Inactive	Accepted		No
200-W-48	200-W-48, 241-TX 90-Day Waste Accumulation Area	Storage Pad (<90 day)	Inactive	Accepted	Rejected	Table A-2
200-W-52	200-W-52, 216-T-7 Crib, 241-T-3 Crib	Crib	Inactive	Accepted		No

Table A-1. 200-TW-1/200-TW-2/200-PW-5 Operable Unit Consolidation Logic Waste Site Summary. (7 pages)

Site Code	Site Names	Site Type	Site Status	Classification Status	Reclassification Status	Table Assignment*
216-B-5	216-B-5, 241-B-361 Reverse Well, 241-B-361 Dry Well, 241-B-5 Dry Well, 299-E28-29	Injection/ Reverse Well	Inactive	Accepted		Table A-3
216-B-7A&B	216-B-7A&B, 241-B-201 Crib, 216-B-7 Crib, 216-B-7A Sump, 216-B-7B Sump, 241-B-1 and 2 Cribs, 216-B-7A & B	Crib	Inactive	Accepted		Table A-3
216-B-8	216-B-8, 241-B-3 Crib, 216-B-8, 216-B-8TF	Crib	Inactive	Accepted		No
216-B-9	216-B-9, 241-B-361 Crib, 5-6 Crib and Tile Field, 216-B-361 Crib, 216-B-9TF	Crib	Inactive	Accepted		No
216-B-35	216-B-35, 241-BX-1 Grave, 216-BX-1 Trench, 216-B-35 Trench	Trench	Inactive	Accepted		No
216-B-36	216-B-36, 241-BX-2 Grave, 216-BX-2 Trench, 216-B-36 Trench	Trench	Inactive	Accepted		No
216-B-37	216-B-37, 241-BX-3 Grave, 216-BX-3 Trench, 216-B-37 Trench	Trench	Inactive	Accepted		No
216-B-38	216-B-38, 241-BX-4 Grave, 216-BX-4 Trench, 216-B-38 Trench	Trench	Inactive	Accepted		Table A-3
216-B-39	216-B-39, 241-BX-5 Grave, 216-BX-5 Trench, 216-B-39 Trench	Trench	Inactive	Accepted		No
216-B-40	216-B-40, 241-BX-6 Grave, 241-BX-6 Trench, 216-B-40 Trench, 216-BX-6 Trench	Trench	Inactive	Accepted		No

Table A-1. 200-TW-1/200-TW-2/200-PW-5 Operable Unit Consolidation Logic Waste Site Summary. (7 pages)

Site Code	Site Names	Site Type	Site Status	Classification Status	Reclassification Status	Table Assignment*
216-B-41	216-B-41, 241-BX-7 Grave, 216-BX-7 Trench, 216-B-41 Trench	Trench	Inactive	Accepted		No
216-T-3	216-T-3, 241-T-361-A Reverse Well, 361-T Reverse Well	Injection/ Reverse Well	Inactive	Accepted		No
216-T-5	216-T-5, 216-T-5 Grave, 216-T-12, 216-T-5 Trench, 241-T-5 Trench	Trench	Inactive	Accepted		No
216-T-6	216-T-6, 241-T-361 (1&2 Cribs), 216-T-5, 361-T-1&2 Cribs	Crib	Inactive	Accepted		No
216-T-7	216-T-7, 216-T-7TF, 216-T-7 Tile Field, 241-T-3 Tile Field	Drain/Tile Field	Inactive	Accepted		No
216-T-14	216-T-14, 241-T-1 Trench, 216-T-1 Grave, 216-T-13	Trench	Inactive	Accepted		No
216-T-15	216-T-15, 241-T-2 Trench, 241-T-2 Grave, 216-T-14, 216-T-15 Crib	Trench	Inactive	Accepted		No
216-T-16	216-T-16, 241-T-3 Trench, 241-T-3 Grave, 216-T-15, 216-T-16 Crib	Trench	Inactive	Accepted		No
216-T-17	216-T-17, 241-T-4 Trench, 216-T-4 Grave, 216-T-16	Trench	Inactive	Accepted		No
216-T-21	216-T-21, 241-TX-1 Trench, 216-TX-1 Grave, 216-TX-3	Trench	Inactive	Accepted		No
216-T-22	216-T-22, 241-TX-2 Trench, 216-TX-2 Grave, 216-TX-4	Trench	Inactive	Accepted		No
216-T-23	216-T-23, 241-TX-3 Trench, 216-TX-3 Grave, 216-TX-5, 241-TX-3 Grave	Trench	Inactive	Accepted		No

Table A-1. 200-TW-1/200-TW-2/200-PW-5 Operable Unit Consolidation Logic Waste Site Summary. (7 pages)

Site Code	Site Names	Site Type	Site Status	Classification Status	Reclassification Status	Table Assignment*
216-T-24	216-T-24, 241-TX-4 Trench, 216-TX-4 Grave, 216-TX-6	Trench	Inactive	Accepted		No
216-T-25	216-T-25, 241-TX-5 Trench, 216-TX-5 Grave, 216-TX-7	Trench	Inactive	Accepted		No
216-T-32	216-T-32, 241-T #1 & 2 Cribs, 216-T-6	Crib	Inactive	Accepted		No
241-B-361	241-B-361, 241-B-361 Settling Tank, IMUST, Inactive Miscellaneous Underground Storage Tank	Settling Tank	Inactive	Accepted		No
241-T-361	241-T-361, 241-T-361 Settling Tank, 361-T-Tank, IMUST	Settling Tank	Inactive	Accepted		No
UPR-200-E-7	UPR-200-E-7, UN-200-E-7, Cave-In Near 219-B-9 (241-B-361 Crib)	Unplanned Release	Inactive	Accepted		No
200-PW-5 OU Waste Sites						
216-B-11A&B	216-B-11A&B, 216-B-11 Crib, 242-B-1 Crib, 216-B-11A & B, 216-B-11B	French Drain	Inactive	Accepted		Table A-3
216-B-50	216-B-50, 216-BY-8 Crib, 216-BY-8 Cavern	Crib	Inactive	Accepted		Table A-3
216-B-57	216-B-57, 216-B-57 Enclosed Trench, Hanford Prototype Barrier	Crib	Inactive	Accepted		Table A-3
216-B-62	216-B-62, 216-B-62 Enclosed Trench, 216-B-62 Crib	Crib	Inactive	Accepted		Table A-3
216-C-6	216-C-6, 241-CX Crib	Crib	Inactive	Accepted		Table A-3
216-S-9	216-S-9	Crib	Inactive	Accepted		Table A-3
216-S-21	216-S-21, 216-SX-1, 216-SX-1 Cavern or Crib	Crib	Inactive	Accepted		Table A-3

Table A-1. 200-TW-1/200-TW-2/200-PW-5 Operable Unit Consolidation Logic Waste Site Summary. (7 pages)

Site Code	Site Names	Site Type	Site Status	Classification Status	Reclassification Status	Table Assignment*
UPR-200-W-108	UPR-200-W-108, Line leak at 216-S-9 Crib, UN-216-W-18, UN-200-W-108	Unplanned Release	Inactive	Accepted		Table A-4
UPR-200-W-109	UPR-200-W-109, Waste Line Leak near 218-W-9, UN-216-W-19, UN-200-W-109	Unplanned Release	Inactive	Accepted		Table A-4

Notes:

* Specific table assignments for each waste site are based on the most applicable contaminant distribution model.

** 200-TW-1 and 200-TW-2 accepted waste sites have no table listing because they were approved in the TW1/TW2 Work Plan (DOE/RL-2000-38).

DOE/RL-2000-38, 2001, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

IMUST = Inactive Miscellaneous Underground Storage Tank.

UPR = unplanned release.

UN = unplanned release.

TBP = tributyl phosphate.

Table A-2. 200-TW-1/1/PW-5 Operable Unit Consolidation Logic Rejected Waste Sites.

Operable Unit	Site Code	Site Names	Site Type	Site Status	Classification Status	Reclassification Status
200-TW-1	200-E-49	200-E-49, Borrow Pit North of BC Cribs and Trenches	Depression/Pit (nonspecific)	Inactive	Rejected	
200-TW-2	200-W-48	200-W-48, 241-TX 90-Day Waste Accumulation Area	Storage Pad (<90 day)	Inactive	Accepted	Rejected

Notes:

200-E-49 is a borrow pit where no waste was disposed.

200-W-48 is a 90-day storage pad not addressed by RL-TPA-90-0001, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS).

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Table A-3. 200 TW-1/2/PW-5 Operable Unit Consolidation Logic Waste Sites Conforming to the Work Plan Contaminant Distribution Models. (2 pages)

											Contaminant Inventory											
Representative Site or TSD	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized and Data Evaluated	Case (Inventory)	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferrocyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
216-B-7A&B		Crib	Characterization is described in this RI Report for this representative site. Most of the contamination is in a 20-ft zone near the bottom of the crib.	4m x 4m x 1.2m (12ft x 12ft x 4ft)	200 East	Tank Farm/B Plant (Bismuth phosphate/lanthanum fluoride): 1946-1967 The site received liquid waste including 2nd cycle and cell 5/6 drainage and process wastes from 221-B and 224-B Buildings via overflow of 241-B-201, 202, 203, and 204 Tank Farm Settling Tanks. The waste was a combination of effluents originating from the 221-B and 224-B Buildings.	Worst Case	Yes/78	Yes	Typical	1.80E+02	4.30+03	—	4.32E+01	2.20E+03	—	—	—	2E+06	—	—	—
200-PW-5 OU Analogous Waste Sites																						
	216-B-11A&B	French Drain	Inventory and release mechanisms are similar to the 216-B-7A&B Crib. Contamination is expected to extend deeper into the vadose zone. The French drains are vertical cylinders whose tops are buried 10 ft below ground surface (bgs).	2.4m in diameter x 9m long (8ft x 30ft)	200 East	Tank Farm/B Plant (Bismuth phosphate/lanthanum fluoride): 1951-1954. The site received process condensate from the 242-B Evaporator. The process evaporated cladding and first cycle waste in the 241-B Tank Farm to reduce the volume of waste in the tanks.	Typical	Yes/175	No	Typical	1.40E+01	4.00E+00	—	2.13E+01	2.01E+00	—	—	—	—	—	—	—
216-B-38		Trench	Characterization is described in this RI Report for this representative site. Most of the contamination is in a 25-ft zone below the bottom of the crib.	77m x 3m x 3m (250ft x 10ft x 10ft)	200 East	Tank Farm/B Plant (Bismuth phosphate/lanthanum fluoride): 1954. This trench actively received 241-BX/BY tank waste (first cycle supernate from 221-B) stored in the single-shell tanks.	Typical	No	Yes	Typical	4.20E+01	1.20E+00	—	2.21E+02	9.27E+00	—	—	—	120000	—	—	—
200-PW-5 OU Analogous Waste Sites																						
	216-S-9	Crib	The contaminant distribution of this site should be similar to 216-B-38 Trench as most of the contamination is expected to be 20 ft +- 10 ft beneath the bottom of the crib, high above the water table in the vadose zone. The inventory is slightly higher and a greater amount of effluent was processed through the crib, so the impact to groundwater is greater than the 216-B-38 Trench. Construction of this crib is similar to 216-B-38 Trench. The geology at the 216-S-9 Crib is different than the geology of the 216-B-38 Crib in the 200 East Area. From a contaminant inventory standpoint, this site would be bounded by the 216-A-7A&B Crib.	91m x 9.1m x 4.5m (300ft x 30ft x 15ft)	200 West	REDOX: 1965-1969. The site received REDOX process condensate from the D-2 Receiver Tank. After the site was closed the waste was rerouted to the 216-S-23 Crib.	Typical	Yes/3	No	Worst Case	3.27E+01	6.50E+01	—	2.90E+02	9.63E+E01	—	—	—	—	—	—	—
216-B-57		Crib	Characterization is described in this RI Report for this representative site. Most of the contamination is in an 18-ft zone below the bottom of the crib. This site was also characterized in the 200-BP-1 RI Report (DOE/RL-92-70).	61m x 4.5m and 3m deep (200ft x 15ft x 10ft)	200 East	Tank Farm/B Plant (Bismuth phosphate/lanthanum fluoride and Sr-90 and Cs-137 Waste Fractionalization): 1968-1973. The site received condensate from the "In Tank Solidification (ITS) #2" Unit in 241-BY Tank Farm. ITS tank farm operations treated wastes from B Plant that included stored Bismuth phosphate/lanthanum fluoride and Sr-90 and Cs-137 processing and waste fractionalization operations.	Typical	Yes/14	Yes	Typical	8.90E-01	1.87E-01	—	2.26E+02	1.81E+E00	—	—	—	—	—	—	—
200-PW-5 OU Analogous Waste Sites																						
	216-B-50	Crib	Inventory and effluent volume are similar to 216-B-57 Crib.	22.8m x 22.8m x 4.2m (75ft x 75ft x 14ft)	200 East	Tank Farm/B Plant (Bismuth phosphate/lanthanum fluoride and Sr-90 and Cs-137 Waste Fractionalization): 1965-1974 The site received intermediate level process condensate from the ITS #1" unit in the 241-BY Tank Farm. ITS tank farm operations treated wastes from B Plant that included stored bismuth phosphate/lanthanum fluoride and Sr-90 and Cs-137 processing and waste fractionalization operations.	Typical	Yes/6	No	Typical	2.90E-01	2.39E-01	—	5.12E+01	3.39E+E00	—	—	—	1500	—	—	—
216-T-26		Crib	Characterization is described in the 200-TW-1 and 2 RI Report (DOE/RL-2002-42) for this representative site. Most of the contamination is in a 16.5-ft zone below the bottom of the crib. RLS data indicate that contamination adjacent to the crib may extend to a depth of about 90 ft.	9m x 9m x 4 6m(30ft x 30ft x 15ft)	200 West	Tank Farm/T-Plant (Bismuth phosphate/lanthanum fluoride): 1953-1956 The crib received first-cycle scavenged supernatant waste from 221-T via an underground pipeline and the 216-TY-201 Flush Tank after cascading through the 241-TY-101, 241-TY-103, and 241-TY-104 tanks. It also received scavenged $BiPO_4$ solvent extraction waste from "In Plant" and "In Tank Farm" scavenging operations.	Worst Case	Yes/18	Yes	Typical	1.50E+02	5.90E+01	—	7.56E+01	2.82E+02	—	6000	—	1E+06	—	—	—

Table A-3. 200 TW-1/2/PW-5 OU Consolidation Logic Waste Sites Conforming to the Work Plan Contaminant Distribution Models. (2 pages)

											Contaminant Inventory											
Representative Site or TSD	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized and Data Evaluated	Case (Inventory)	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferrocyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
200-PW-5 OU Analogous Waste Sites																						
	216-S-21	Crib	Inventory and volume are similar to 216-T-26 Crib. The contaminant distribution should be similar as most of the contamination should be high above the water table in the vadose zone.	15.2m x 15.2m x 6.75m (50ft x 50ft x 22ft)	200 West	Tank Farm/REDOX: 1954-1970 The crib received condensate from the 241-SX-401 Condenser Facility, located inside the 241-SX Tank Farm. This building processed condensation from the 241-SX Tank Farm off gases. The SX tanks primarily received waste from REDOX operations.	Typical	Yes/25	No	Typical	4.16E+00	—	—	8.80E+01	—	—	—	—	—	—	—	—
Other 200-TW-1 and 200-TW-2 OU Representative Sites																						
216-B-5		Reverse Well	Characterization is described in RHO-ST-37. Effluent was injected directly into the aquifer.	20cm x 92m (8-in x 302ft)	200 East	B Plant (Bismuth phosphate/Lanthanum fluoride): 1945-1947. The reverse well received approximately 30,600,000 liters (808,000 gallons) of B Plant and 224-B waste solutions. The waste overflowed into the reverse well from the 241-B-361 settling tank, which removed the particulates.	—	Yes	Yes	Worst Case	—	4.27E+03	—	2.92E+01	2.55E+01	—	—	—	400000	—	—	—
216-B-46		Crib	Characterization is described in this RI Report (DOE/RL-2002-42) for this representative site. Most of the contamination is in a 30-ft zone below the bottom of the crib.	9m x 9m x 4.6m (30ft x 30ft x 15ft)	200 East	Tank Farm/U-Plant: 1955. The site received scavenged Uranium Recovery Processed (URP) supernatant waste from 221-U Building. The waste cascaded through the 241-BY Tank Farm tanks before being discharged to the crib. The waste was originally bismuth phosphate/Lanthanum fluoride metal wastes from 221-B.	Typical	No	Yes	Typical	1.90E+02	2.00E+01	—	8.89E+01	6.31E+02	—	4000	—	1E+06	—	—	—

DOE/RL-92-70, 1993, *Phase I Remedial Investigation Report for 200-BP-1 Operable Unit*, Vols. 1 and 2, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
RHO-ST-37, 1980, 216-B-5 Reverse Well Characterization Study, Rockwell Hanford Operations, Richland, Washington.
bgs = below ground surface
ITS = in-tank solidification
REDOX = Reduction oxidation (S Plant)
RLS = Radiologic logging system
URP = uranium recovery process

Table A-4. 200 TW-1/2/PW-5 Consolidation Logic Waste Sites Aligned with Other OU Contaminant Distribution Models.

											Contaminant of Concern											
Representative Site or TSD/OU	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized or Data Evaluated	Case (Inventory)	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferro-cyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
216-B-12/ 200-PW-2		Crib	The contaminant distribution model for this representative site is developed in the 200-PW-2/-4 RI/FS Work Plan (DOE/RL-2002-60). The site is a crib where groundwater was impacted.	48.8 m x 15.2 m (160 ft x 50 ft)	200 East	Uranium Recovery and B Plant processes: 1952-1973. The site is a cascading wood box design that received process condensate from 221-U, 224-U, and 221-B Tanks. The waste was low salt, neutral to basic containing ammonium nitrate, uranium (from the uranium recovery process [URP] condensate), and other radionuclides.	Typical	Yes/28	No	Worst Case	2.10E+04	3.74E+02	—	7.16E+02	7.93E+01	—	—	—	—	—	—	—
200-PW-5 OU Consolidated Analogous Waste Sites																						
	216-B-62	Crib	The 216-B-12 Crib is a bounding condition for this waste site. The inventory and effluent volumes are similar because of comparable waste stream chemistry based on process knowledge. However less uranium and plutonium were discharged, and groundwater would not be as severely impacted as it is at the 216-B-12 Crib.	152 m x 3 m (500 ft x 10 ft)	200 East	B Plant (Sr-90 and Cs-137 Waste Fractionalization Operations/WESF): 1973-1991 The crib received B Plant process condensate. It replaced the 216-B-12 Crib.	Worst Case	Yes/24	No	Typical	2.75E+00	7.75E-01	1.03E-02	1.35E+02	7.46+E01	—	—	—	—	—	—	—
	216-C-6	Crib	The 216-B-12 Crib is a bounding condition for this waste site. The inventory and effluent volumes are similar because of comparable waste stream chemistry based on process knowledge. However less effluent was discharged, and ground water would not be impacted as it is at the 216-B-12 Crib.	6.1m x 3m x 4.8m (20 ft x 10 ft x 16ft)	200 East	Semi-Works (REDOX and PUREX experimental runs): 1955-1964 The crib received radioactive REDOX and PUREX type process condensate from 201-C (Semiworks) and 241-CX vault floor drainage.	Typical	Yes/1	No	Typical	5.00E-02	1.00E-01	—	4.65E-02	2.88E+E01	—	—	—	—	—	—	—
200-E-111/ 200-IS-1		Process Piping	The 200-E-111 Conceptual Contaminant Distribution Model was developed in the 200-IS-1 DQO (CP-13196) and RI/FS Work Plan (DOE/RL-2002-14). The conceptual model illustrates a shallow vertical extent of contaminants that potentially occurred during process operations. Leaks are the primary source of potential contamination.	3 m long (9 ft long)	200 East	Tank Farm: The underground, encased pipeline was used to transfer waste from 241-ER-151 to the 241-C Tank Farm and the 244-AR Vault. The pipeline transported liquid effluent from the 241-ER-151 Diversion Box to the tank farms. Some adjacent soil has been contaminated from pipeline leaks.	Typical	UNKN	No	UNKN	—	—	—	—	—	—	—	—	—	—	—	—
200-PW-5 OU Consolidated Analogous Waste Sites																						
	UPR-200-W-108	Unplanned Release	This unplanned release site is associated with a pipeline that transported effluent to the 216-S-9 Crib. Because this site is a pipeline, it is assigned to the pipeline contaminant distribution model. Contamination is expected to be near the point of release.	UNKN	200 West	REDOX: 1969. During the tie-in of the 216-S-9 Crib waste line to the new 216-S-23 Crib, contaminated water was encountered coming from a break at the junction of the two crib lines. There is no way of determining how long the line had been leaking or how much waste was discharged to the ground. The site was contaminated with process condensate from the D-2 Receiver Tank in the 202-S Building.	UNKN	—	No	UNKN	—	—	—	—	—	—	—	—	—	—	—	—
	UPR-200-W-109	Unplanned Release	This unplanned release site is associated with a pipeline that transported effluent to the 216-S-9 Crib. Because this site is a pipeline, it is assigned to the pipeline contaminant distribution model. Contamination is expected to be near the point of release.	UNKN	200 West	REDOX: 1969. After repairing the initial buckled portions of the 216-S-23 Crib line (also known as UPR-200-W-108), a pressure test indicated another leak in the line at some point upstream toward the 202-S Building. The site was contaminated with process condensate from the D-2 Receiver Tank in the 202-S Building.	UNKN	—	No	UNKN	—	—	—	—	—	—	—	—	—	—	—	—

CP-13196, 2002, *Remedial Investigation Data Quality Objectives Summary Report – 200-IS-1 and 200-ST-1 Operable Units*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
DOE/RL-2002-60, 2003, *Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan*; Includes: 200-PW-2 and 200-PW-4 Operable Units, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
DOE/RL-2002-14, 2002, Tanks/Lines/Pits/Boxes/Septic Tanks and Drain Field Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan, Includes: 200-IS-1 and 200-ST-1 Operable Units, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
REDOX = Reduction oxidation (S Plant).
UNKN = unknown.
URP = uranium recovery process.
WESF = Waste Encapsulation and Storage Facility.

Table A-5. 200-TW-1/200-TW-2/200-PW-5 Operable Unit Consolidation Logic: Waste Sites Not Aligned with the 200-TW-1/200-TW-2/200-PW-5 Operable Unit or Other Operable Unit Containment Distribution Models.

Note: No waste sites were identified that fell into this category. No new contaminant distribution models were required for these operable units.

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APPENDIX B

PHYSICAL PROPERTY AND QUALITY ASSURANCE DATA

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Maxim Technologies, Inc.
Data Summary
PHYS SDG H1420

Sample	Moisture Content (%)	% Gravel	% Sand	% Silt and Clay	
B12BR4	15.1	0.2	16.0	83.8	(1412)
B12BR5	2.7	12.8	39.0	48.2	(1422)
B12674	2.6	NR	NR	NR	(1406)
B12676	4.0	64.5	32.5	3.0	(1426)
B12677	3.3	0.0	93.3	6.7	(1421)
B12678	18.5	0.0	3.4	96.6	(1491)

Gravel > 4.75 mm
4.75 mm > Sand > 0.075 mm
Silt and Clay < 0.075 mm

Moisture Content, ASTM D2216

MAXIM Technolgies, Inc.
1908 Innerbelt Business Center Drive
St. Louis, MO 63114-5700
314-426-0880

Client: Thermo Nutech

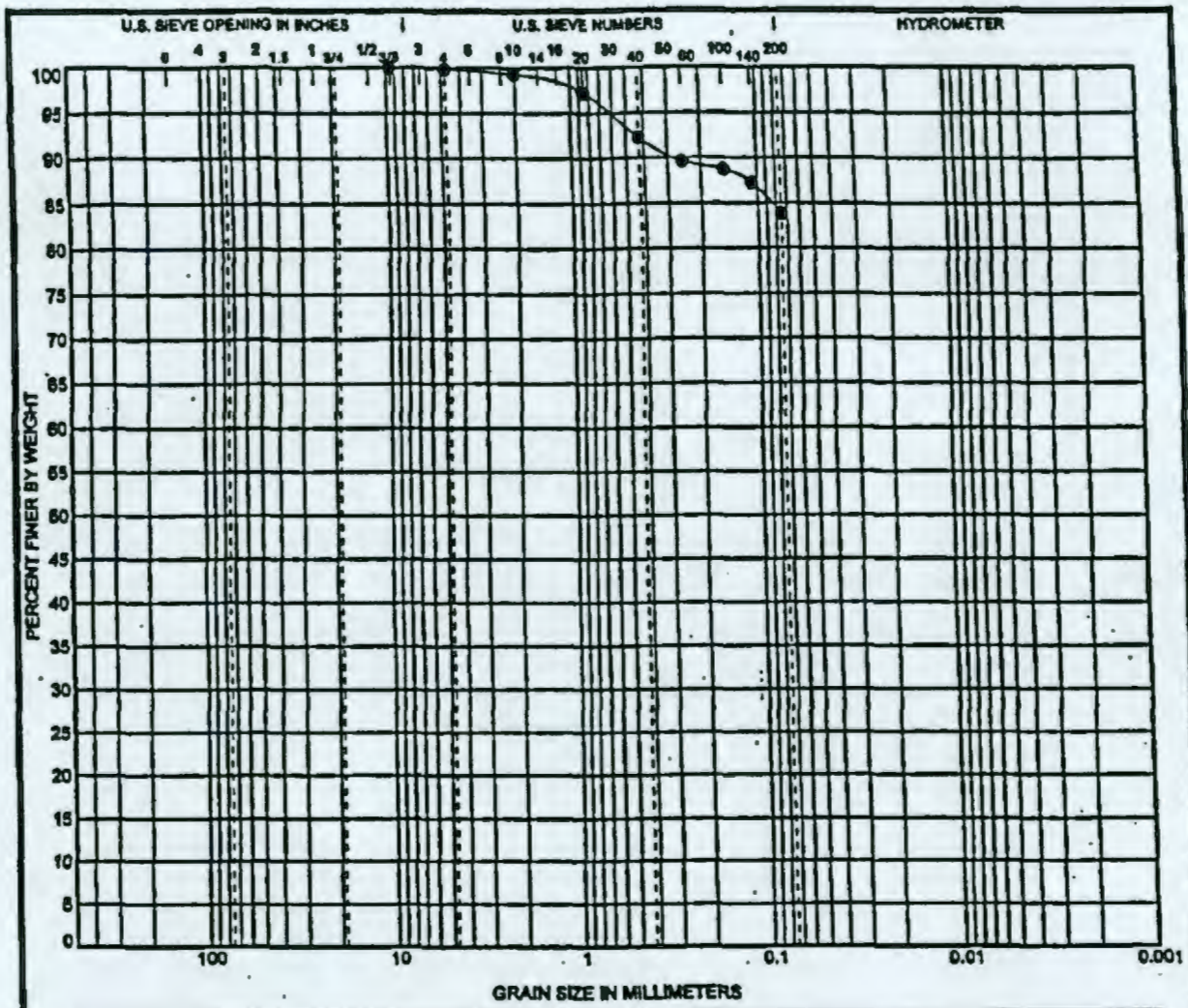
Date: 7/20/01

Project Number: 9905093

File: mc7-20

Performed By: B. Lindenbusch

Maxim Sample Number	Client Sample Name	Container Number	Container Weight	Wet Sample + Container	Dry Sample + Container	Moisture Content (%)
	B12BR5	1	11.66	45.74	44.85	2.7
	B12BR5 DUP	2	12.06	49.55	48.60	2.6
	B12BR4	3	12.08	52.52	47.21	15.1
	B12678	4	11.69	52.23	45.89	18.5
	B12677	5	11.86	49.20	47.99	3.3
	B12676	6	11.84	76.01	73.55	4.0
	B12674	7	11.98	75.59	73.99	2.6



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	0108001-001	0.0	Soil					
	B12BR4							

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	0108001-001	0.0	9.52				0.2	16.0	83.8	

US GRAIN SIZE EBERLINE GPJ US LAB.GDT 9/2/01

Logo

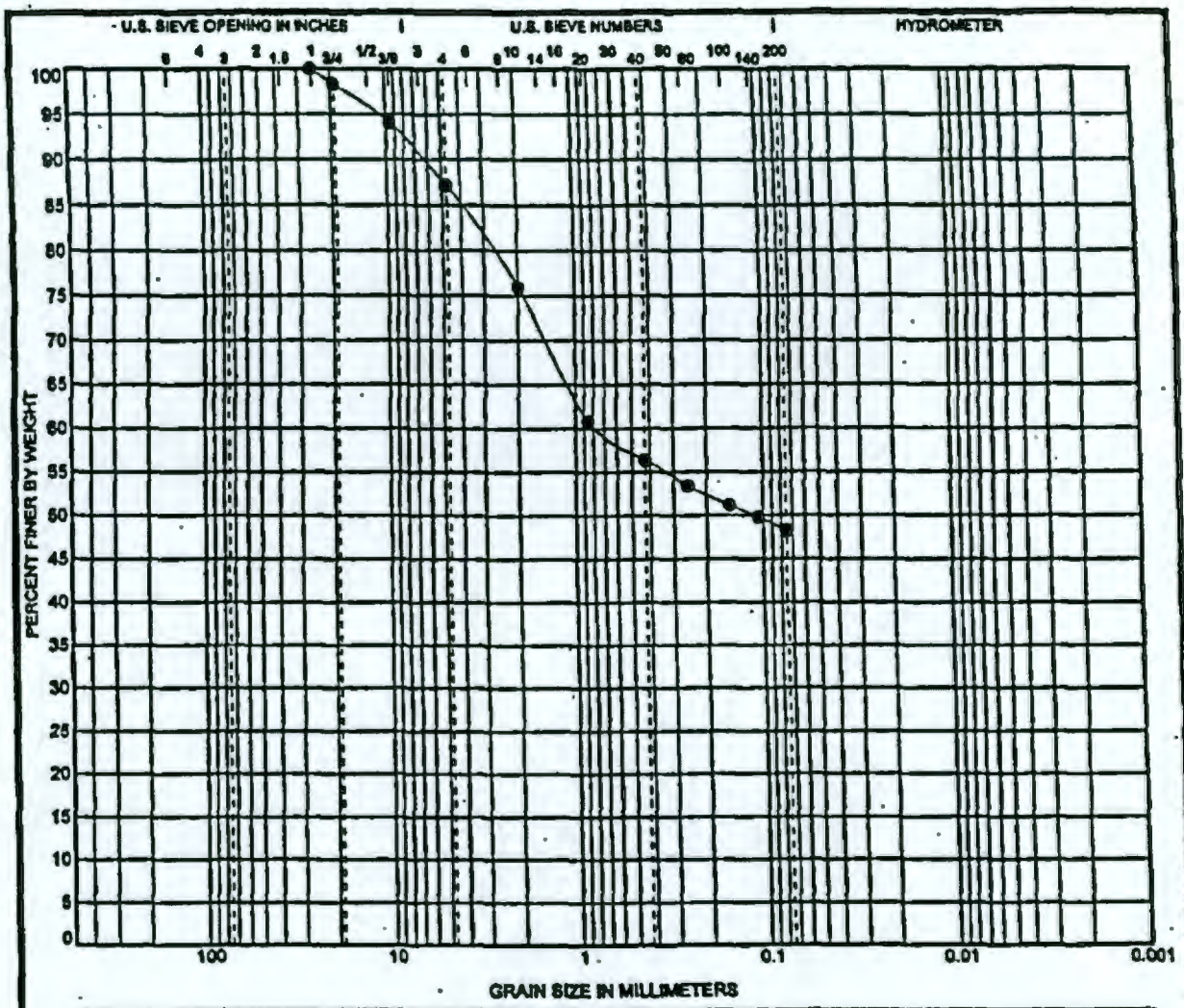
Maxim Technologies, Inc.
1908 Innerbelt Business Center Drive
St. Louis, Missouri 63114
Telephone: 314-426-0880
Fax: 314-426-4212

GRAIN SIZE DISTRIBUTION

Project: Eberline

Location:

Number: 9905093



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 0108001-002	0.0	Soil					
B12BR5							

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 0108001-002	0.0	26.4	0.747			12.8	39.0	48.2	

Logo

Maxim Technologies, Inc.
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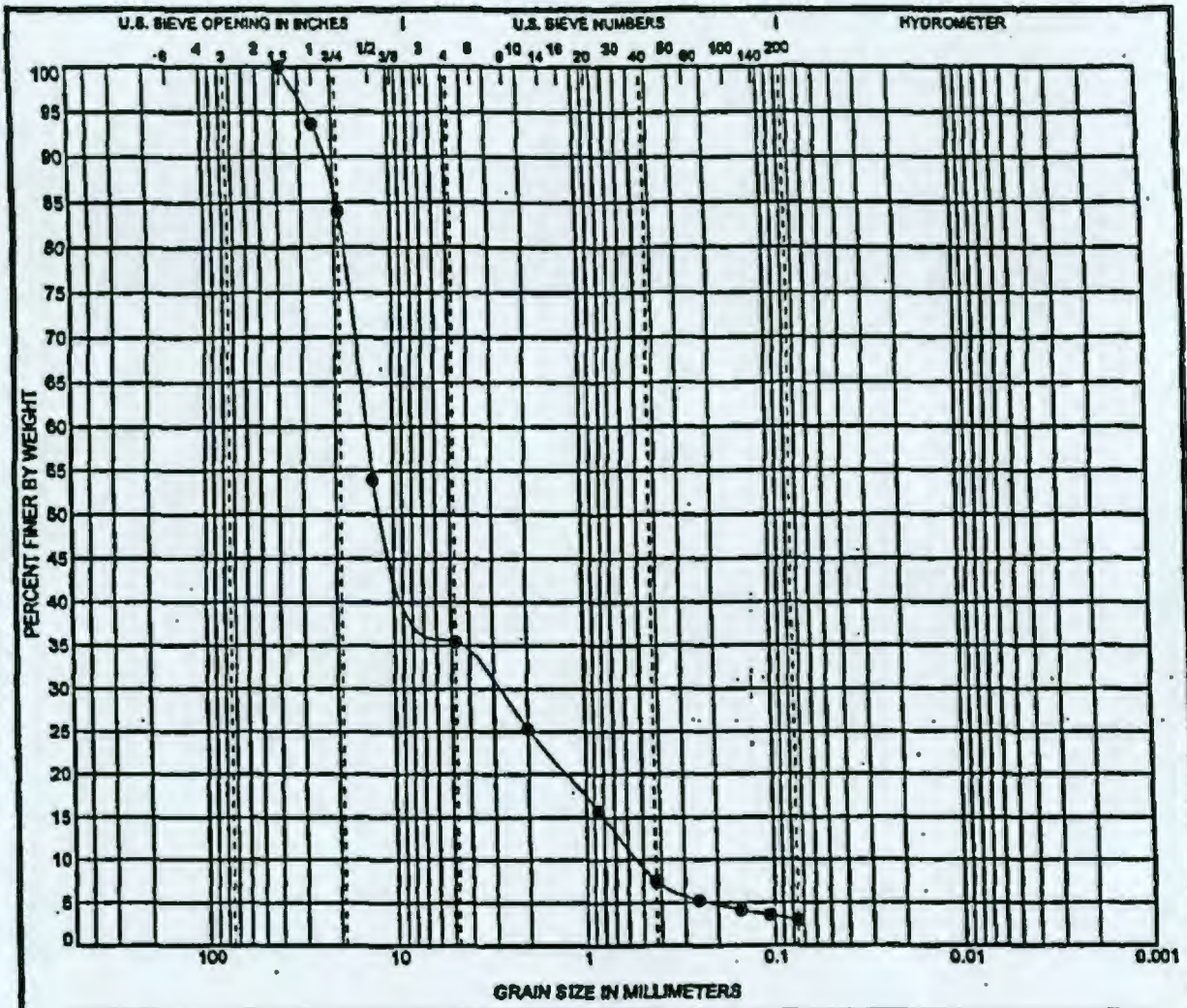
Fax: 314-426-4212

GRAIN SIZE DISTRIBUTION

Project: Eberline
Location:
Number: 9905093



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	0108001-003	0.0	Soil				1.23	26.27
	B12676							

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	0108001-003	0.0	37.5	13.773	2.983	0.524	64.5	32.5	3.0	

Logo

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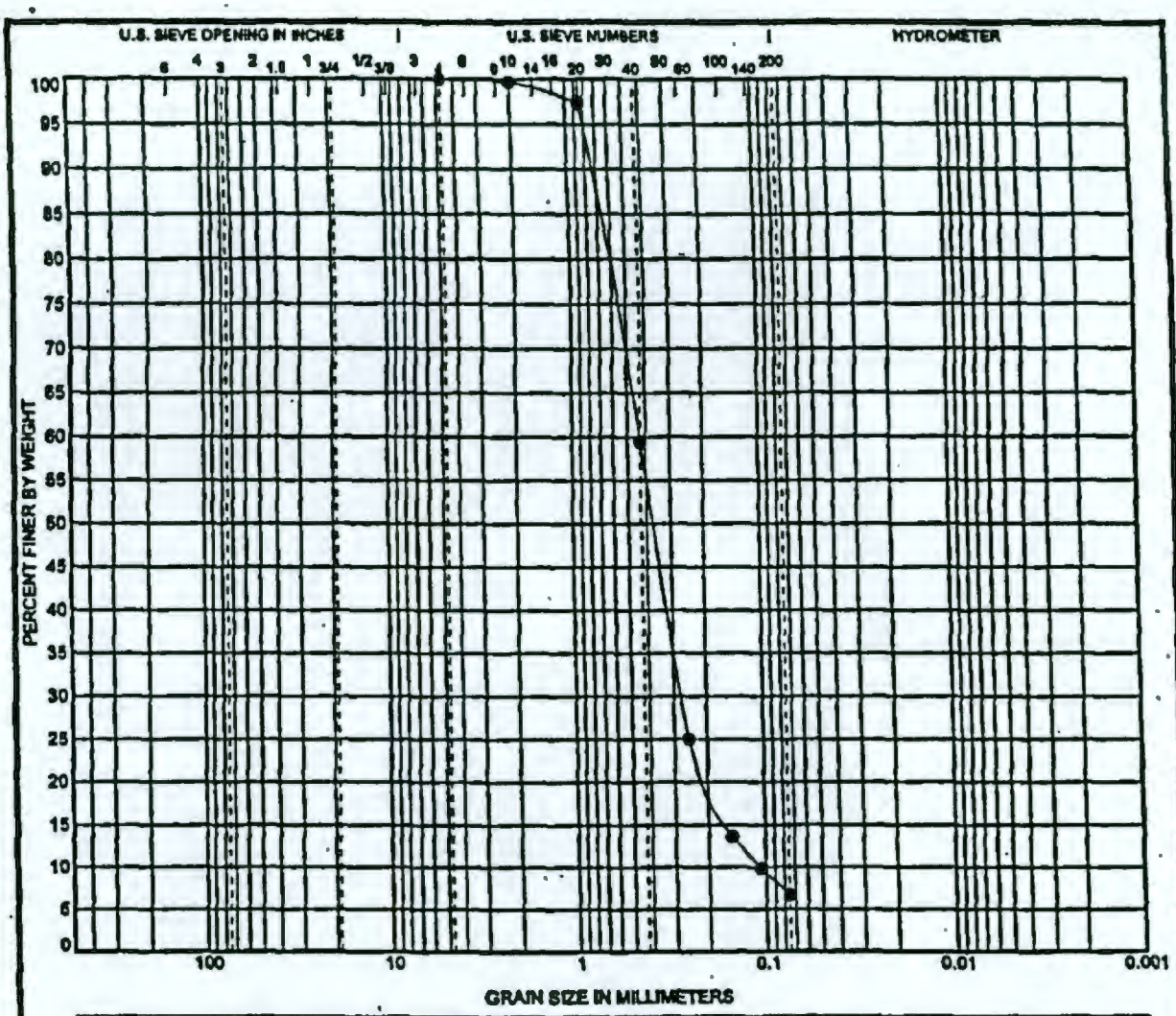
GRAIN SIZE DISTRIBUTION

Project: Eberline

Location:

Number: 9905093



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	0108001-004	0.0	Soil				1.58	4.01
	B12677							

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	0108001-004	0.0	4.75	0.43	0.27	0.107	0.0	93.3	6.7	

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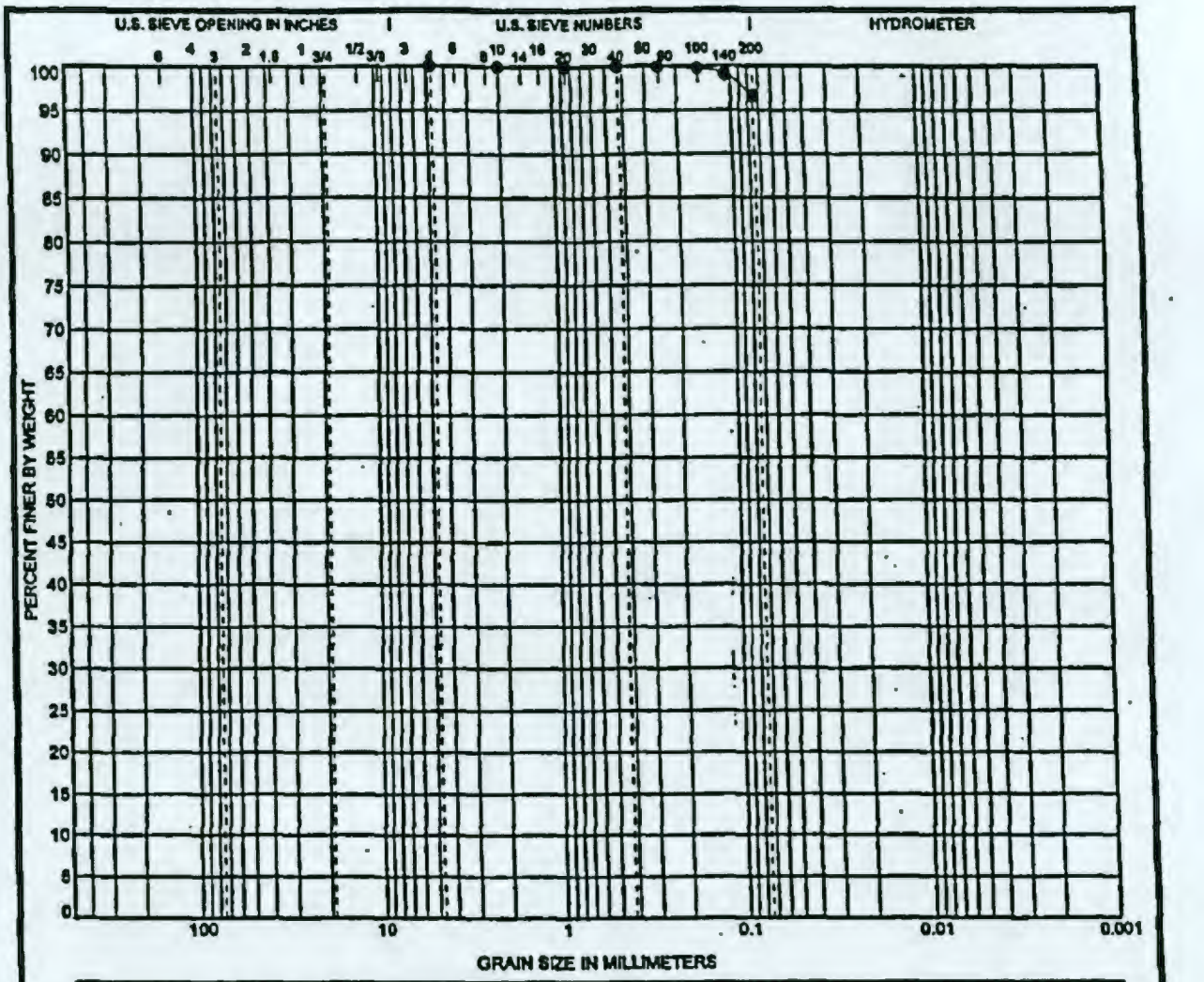
Fax: 314-426-4212

GRAIN SIZE DISTRIBUTION

Project: Eberline

Location:

Number: 9905093



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 0108001-005	0.0	Soil					
B12678							

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 0108001-005	0.0	4.75				0.0	3.4	96.6	

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GRAIN SIZE DISTRIBUTION

Project: Eberline
Location:
Number: 9905093

Maxim Technologies, Inc. St.-Louis, Missouri

Client Name: Eberline

Maxim Project Number: 0006083

	Sample Identification				ASTM D422, Particle Size Distribution				ASTM 2216	ASTM 2937			ASTM 2434		
	Maxim Sample Number	Client Sample Number	Sample Delivery Group	Sample Description	D_{100} (mm)	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	Moisture Content (%)	Dry Density (PCF)	Length of Sample, (inches)	Diameter of Sample, (inches)	Percent Oversized Material	Void Ratio (%)	k (coefficient of permeability, cm/s)
HP150	0109001-001	812C87	SDG3	Sandy Gravel	37.5	6	0.53	–	3.4	nr	nr	nr	nr	nr	nr
HP159	0109001-002	812C88	SDG3	Sandy Gravel	9.52	0.6	0.43	0.1	1.4	nr	nr	nr	nr	nr	nr
HP175	0109001-003	812SR7	SDG3	Silty Sand	19	0.135	0.078	–	4.9	nr	nr	nr	nr	nr	nr

nr: not requested

Moisture Content, ASTM D2216

MAXIM Technolgies, Inc.
1908 Innerbelt Business Center Drive
St. Louis, MO 63114-5700
314-426-0880

Client: Thermo Nutech

Date: 8/30/01

Project Number: 9905093

File: mc8-30

Performed By: B. Lindenbusch

Maxim Sample Number	Client Sample Name	Container Number	Container Weight	Wet Sample + Container	Dry Sample + Container	Moisture Content (%)
	B12BR7	1	12.04	68.27	55.00	4.9

Moisture Content, ASTM D2216

MAXIM Technolgies, Inc.
1908 Innerbelt Business Center Drive
St. Louis, MO 63114-5700
314-426-0880

Client: Thermo Nutech

Date: 8/16/01

Project Number: 9905093

File: mc8-16

Performed By: B. Lindenbusch

Maxim Sample Number	Client Sample Name	Container Number	Container Weight	Wet Sample + Container	Dry Sample + Container	Moisture Content (%)
	B12CB8	1	12.04	51.10	50.24	1.4

Moisture Content, ASTM D2216

MAXIM Technolgies, Inc.
1908 Innerbelt Business Center Drive
St. Louis, MO 63114-5700
314-426-0880

Client: Thermo Nutech

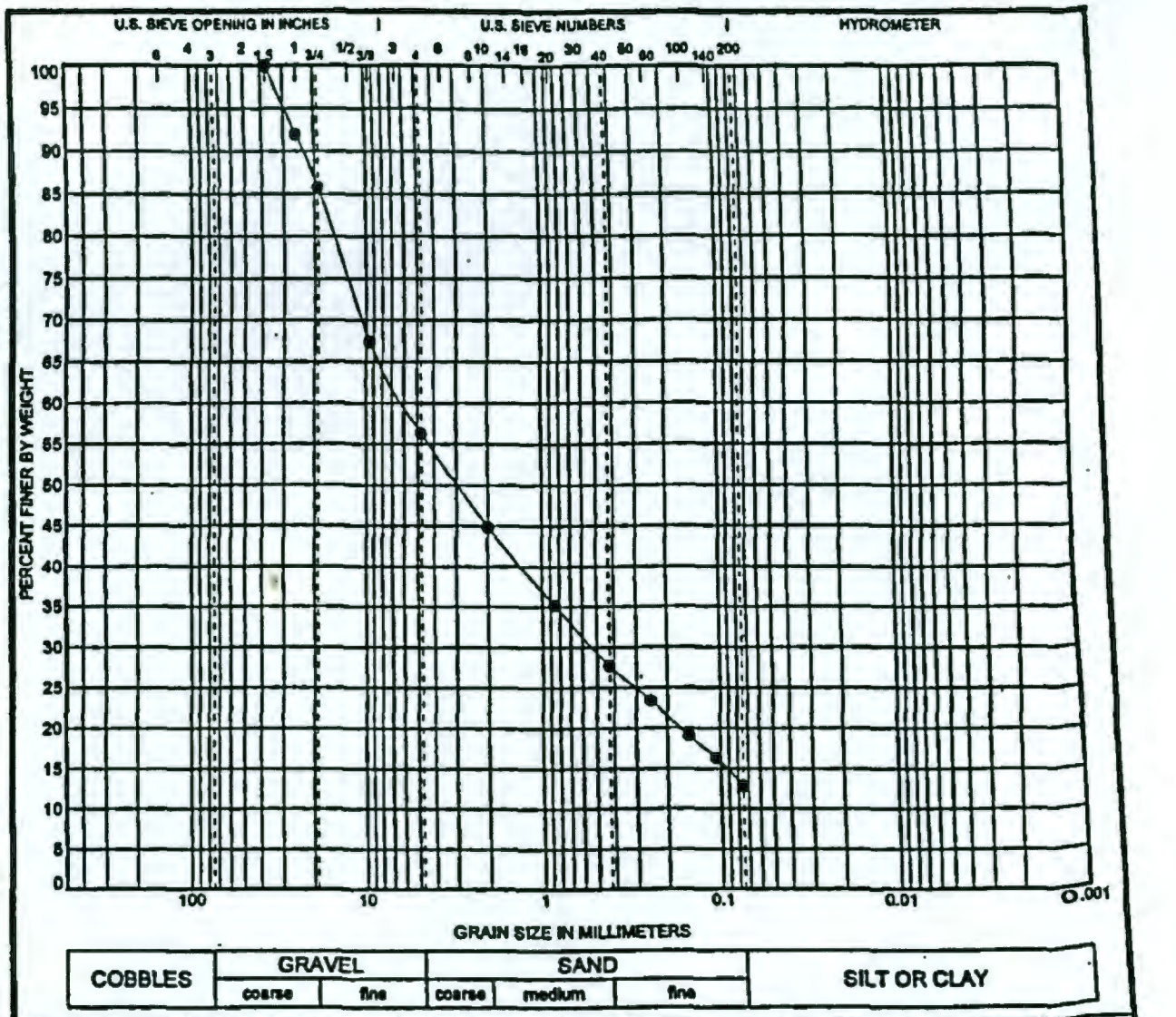
Date: 8/10/01

Project Number: 9905093

File: mc8-10

Performed By: B. Lindenbusch

Maxim Sample Number	Client Sample Name	Container Number	Container Weight	Wet Sample + Container	Dry Sample + Container	Moisture Content (%)
	B12CB7	1	11.54	48.85	46.87	3.4



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 0108001-001	0.0	Soil					
B12CB7							

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 0108001-001	0.0	37.5	5.987	0.527		43.7	43.5	12.9	

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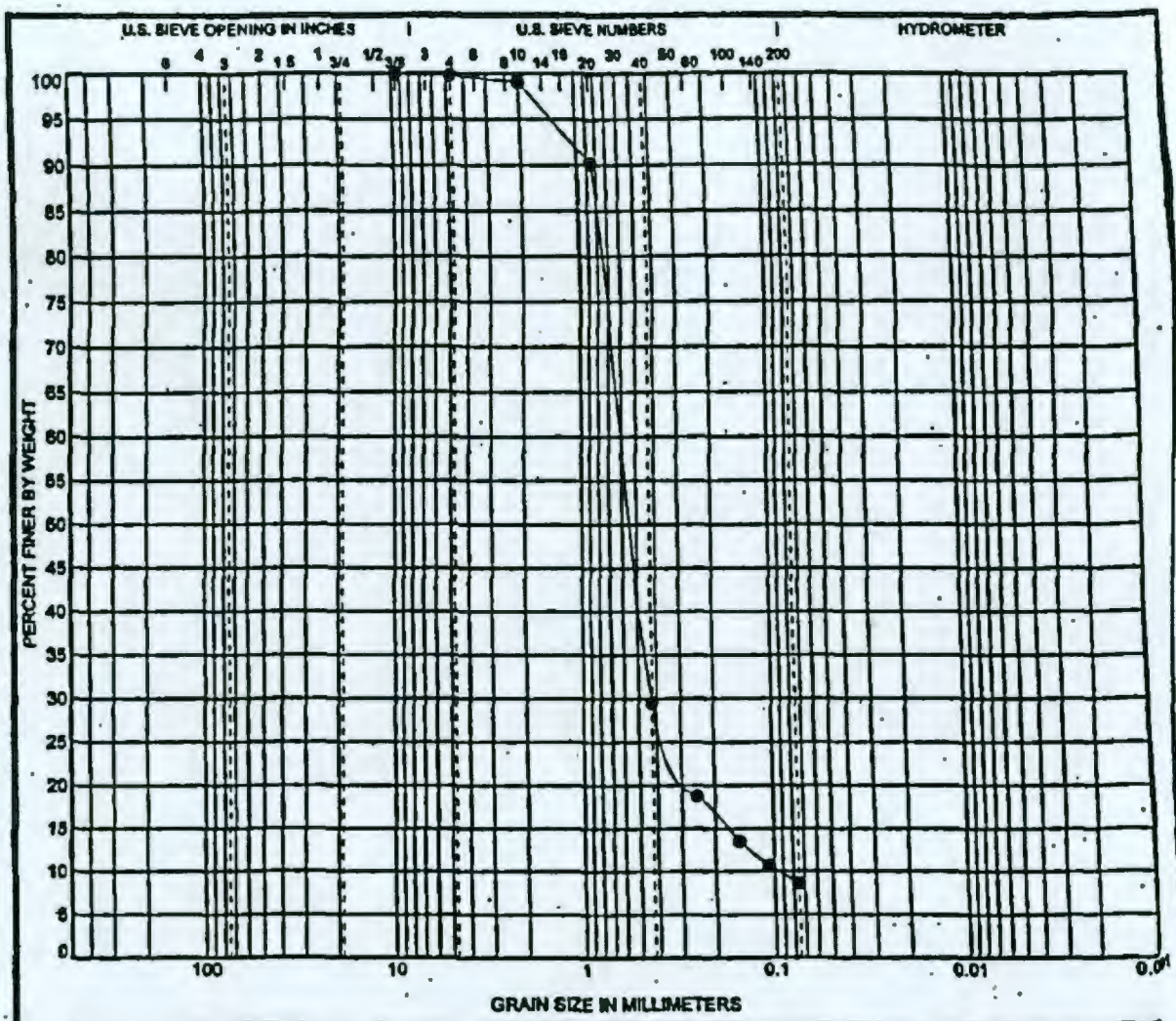
Project: Eberline Services

Location:

Number: 9905093



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 0108001-002	0.0	Soil				3.21	6.37
B12CB8							

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 0108001-002	0.0	9.52	0.602	0.428	0.095	0.2	91.2	8.6	

US GRAIN SIZE BSCHTL.GPJ US LAB.GDT 10/19/01

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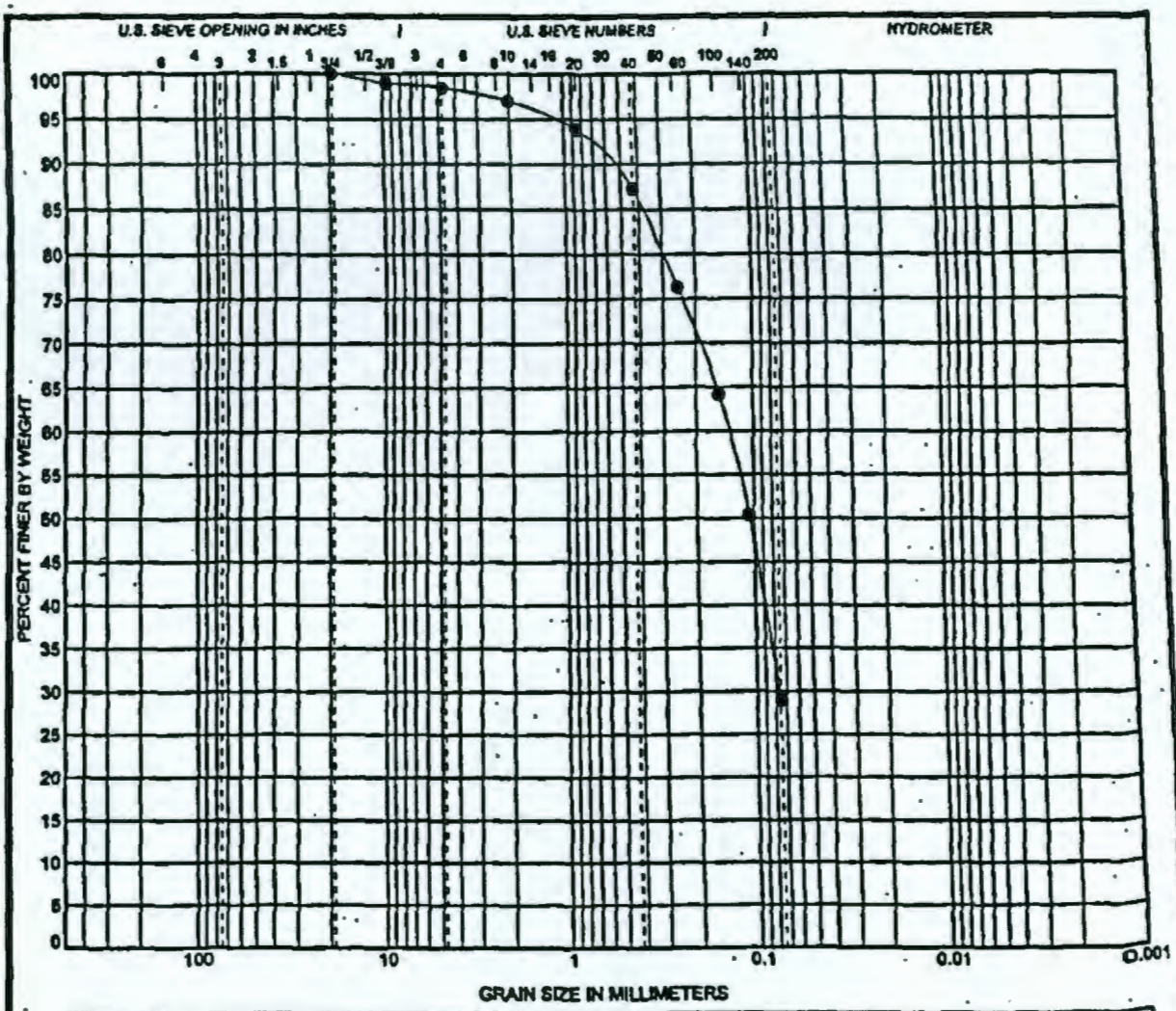
GRAIN SIZE DISTRIBUTION

Project: Eberline Services

Location:

Number: 9905093



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	0108002-001	0.0	Soil					
	B12BR7							

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	0108002-001	0.0	19	0.135	0.076		1.6	69.5	29.0	

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Project: Eberline Services

Location:

Number: 9905093

US GRAIN SIZE REPORTS CP LIB LAB.GDT 10/13/01

Maxim Technologies, Inc. St-Louis, Missouri

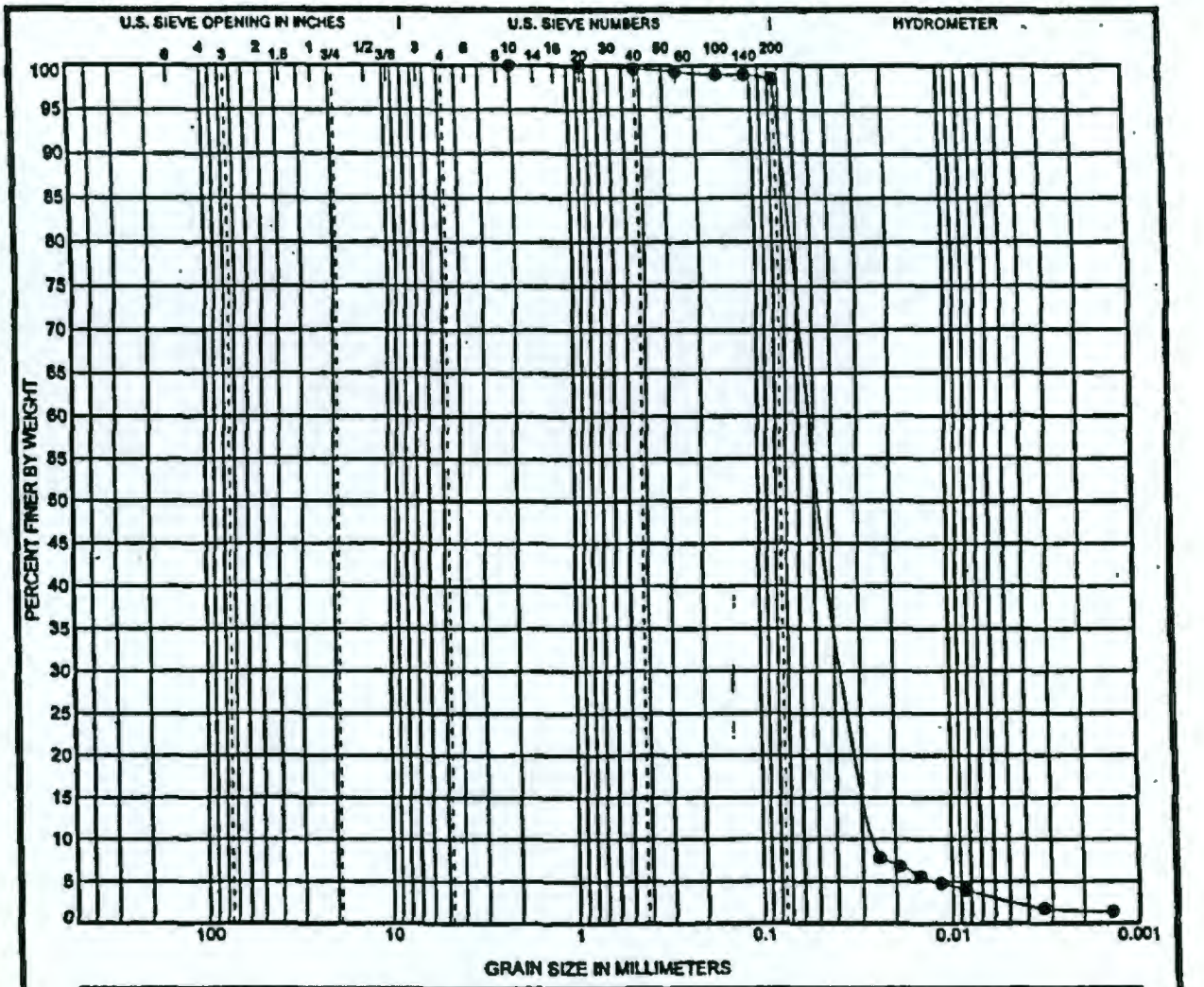
Client Name: Ebasco

Maxim Project Number: 9905083

Sample Identification				ASTM D422, Particle Size Distribution				ASTM 1557		ASTM 2216	ASTM 2937			ASTM 2434		
Maxim Sample Number	Client Sample Number	Sample Delivery Group	Sample Description	D_{100} (mm)	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	Maximum Dry Density (PCF)	Optimum Moisture Content (%)	Moisture Content (%)	Dry Density (PCF)	Length of Sample, (inches)	Diameter of Sample, (inches)	Percent Oversized Material	Void Ratio (%)	k (coefficient of permeability, cm/s)
0110003-001	8128Ra	SDG5	Sand with Organic Matter	4.75	0.829	0.408	0.183	nr	nr	2.7	nr	nr	nr	nr	nr	nr
0110003-002	8128Rb	SDG5	Sand with Silt	2.00	0.048	0.032	0.025	nr	nr	22.5	nr	nr	nr	nr	nr	nr

H1152A H1159

nr: not requested



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	0110003-002	0.0	Soil				0.88	1.87
	B12BR9							

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	0110003-002	0.0	2	0.046	0.032	0.025	0.0	1.6	95.8	2.8

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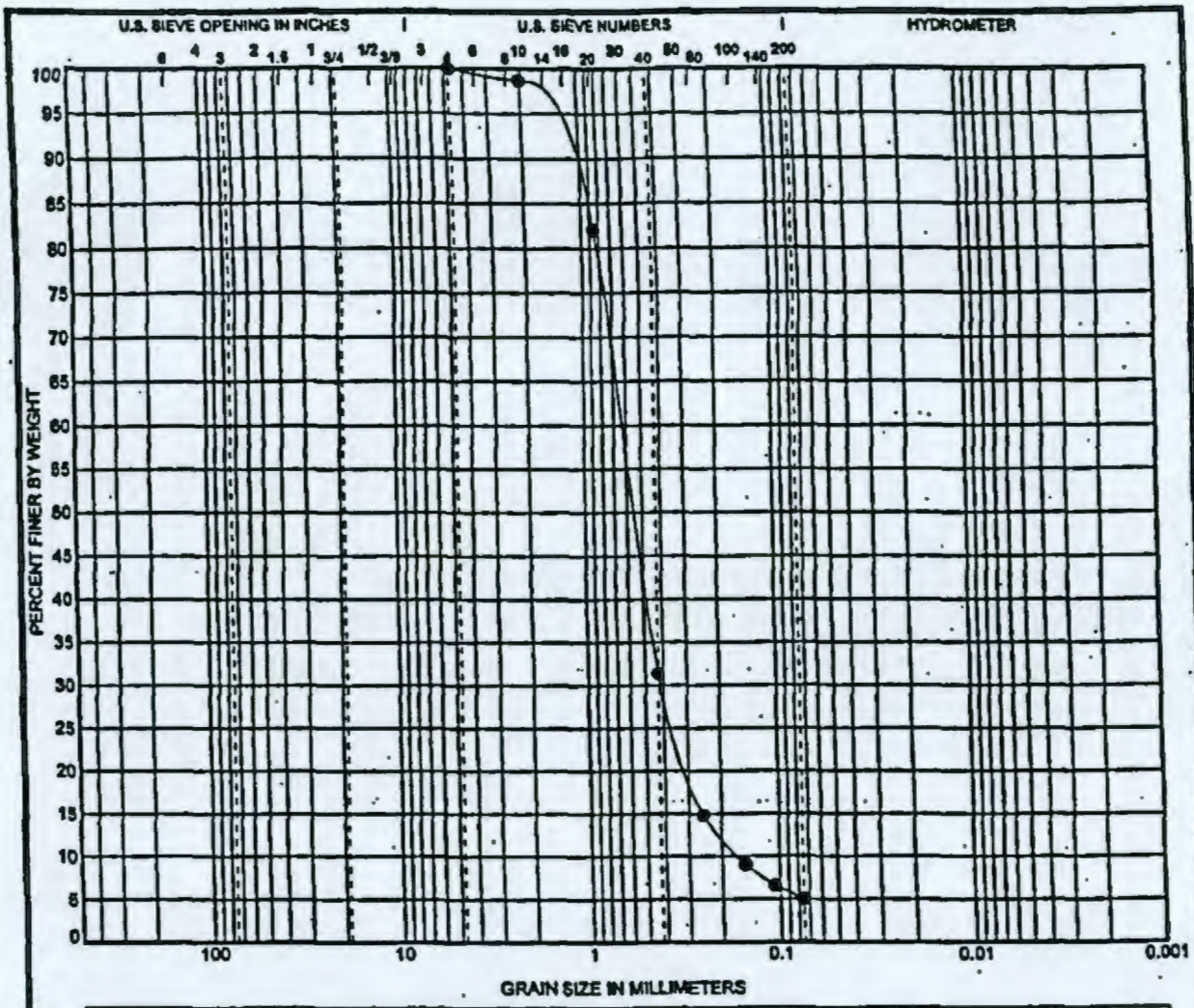
Project: Eberline Services

Location:

Number: 9905093



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	0110003-001	0.0	Soil				1.62	3.85
	B12BR8							

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	0110003-001	0.0	4.75	0.629	0.408	0.163	0.0	94.9	5.0	

US GRAIN SIZE REPORTS OPJ US LAB OCT 11/1/00

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GRAIN SIZE DISTRIBUTION

Project: Eberline Services

Location:

Number: 9905093

APPENDIX C

DATA EVALUATION AND DATA SUMMARY TABLES

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APPENDIX C

DATA EVALUATION AND DATA SUMMARY TABLES

C1.0 DATA VALIDATION AND QUALITY CONTROL

Data validation was performed and field quality control samples were collected in accordance with DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan,* Appendix A, "Quality Assurance Project Plan," Section A.2.

C1.1 DATA VALIDATION

Two sample delivery groups, consisting of eight samples, were validated by an independent contractor. The selected sample delivery groups, H1409 and W03587, contained two samples from the 216-T-26 Crib and six samples from the 216-B-7A Crib, respectively. These two sample sets represent the samples collected from the locations at and directly below the original crib bottoms, which contained the highest contamination for each of the two respective waste sites. The chemical and radiological analytical data packages were validated according to BHI-01435, *Data Validation Procedure for Chemical Analysis,* and BHI-01433, *Data Validation Procedure for Radiochemical Analysis,* Level C methods.

Several minor deficiencies were found as a result of the data validation that resulted in samples being flagged with a J (estimate) qualifier. Data qualifiers were added primarily on the basis of exceeding holding times, sample preservation (i.e., cooler temperature greater than 4°C upon receipt at laboratory), laboratory blank contamination problems, laboratory matrix spike and surrogate recovery problems, or because matrix spike analyses were not performed. All of the qualifiers added as a result of the validation process are reflected in the Tables C-1 through C-19 and will be entered into the Hanford Environmental Information System database.

C1.2 QUALITY CONTROL

Quality control samples were collected to evaluate the potential of cross-contamination and laboratory performance in accordance with DOE/RL-2000-38, Appendix A. Five trip blanks and one equipment rinsate blank were collected for the 200-TW-1 Operable Unit (OU) field activities. Two equipment rinsate blanks were collected for the 200-TW-2 OU field activities.

The trip blanks were analyzed only for volatile organic compounds (VOC). Methylene chloride and acetone were the only compounds detected in the trip blank submitted for analysis. However, these compounds also were detected in laboratory blanks and are likely the result of laboratory cross-contamination.

The equipment blank for the 200-TW-1 OU was analyzed for volatile organics, tributyl phosphate, anions (except cyanide), metals (excluding hexavalent chromium and mercury), and

gross alpha and gross beta. Methylene chloride was the only VOC detected in the equipment blank submitted for analysis. Methylene chloride was also detected in the laboratory blank and is likely the result of laboratory cross-contamination.

Two metal constituents and six anions were detected in the equipment blanks. Chromium and copper were the only metals detected at concentrations of 3.9 and 4.7 µg/L, respectively. Ammonia, chloride, nitrate, sulfate, nitrate/nitrite as nitrogen, and total organic carbon were detected in the equipment blank. Concentrations ranged from 0.035 mg/L for nitrate/nitrite as nitrogen to 1.1 mg/L for total organic compound (TOC). Gross beta also was detected at a concentration of 3.58 pCi/L.

Two equipment blanks for the 200-TW-2 OU were analyzed for VOCs and semivolatile organic compounds (SVOCs), anions (except cyanide), metals (excluding hexavalent chromium and mercury), and gross alpha and gross beta. Methylene chloride was the only VOC detected in the equipment blanks submitted for analysis. Methylene chloride was also detected in the laboratory blank and is likely the result of laboratory cross-contamination. Two SVOCs were detected in the equipment blanks. Bis(2-ethylhexyl)phthalate and tributyl phosphate were detected in one of the two equipment rinsate blanks at concentrations of 4 µg/L. The detection is the result of laboratory cross-contamination associated with low-level contamination from the matrix spike compounds. Tributyl phosphate also was detected in one equipment blank at a concentration of 0.6 µg/L.

Five metal constituents and four anions were detected in the equipment blanks. Cadmium, chromium, copper, nickel and silver were detected in one equipment blank at concentrations from 0.45 to 4.0 µg/L. Chloride, nitrate, sulfate, and nitrate/nitrite were detected in the equipment blanks. Concentrations ranged from 0.1 to 0.4 mg/L. No radiological contamination was detected.

C2.0 REFERENCES

BHI-01435, *Data Validation Procedure for Chemical Analysis*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI-01433, *Data Validation Procedure for Radiochemical Analysis*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Table C-1. 216-T-26 Borehole – Radionuclide Analytical Data. (3 sheets)

Intervals (ft)	HEIS Number	Date	Americium-241 (pCi/g)	Carbon-14 (pCi/g)	Cesium-137 (pCi/g)	Cobalt-60 (pCi/g)	Europium-152 (pCi/g)	Europium-154 (pCi/g)	Europium-155 (pCi/g)	Neptunium-237 (pCi/g)
			CAS Number							
			14596-10-2	14762-75-5	10045-97-3	10198-40-0	14683-23-9	15585-10-1	14391-16-3	13994-20-2
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	-0.03 U	-1.02 U	0.088 U	0.048 U	0.11 U	0.14 U	0.11 U	0.00 U
18-20.50	B125Y2	6/26/2001	2.04	-1.79 U	47,900	0.22 U	17 U	1.8 U	7.2 U	0.00 U
22-24.50	B125X3	6/26/2001	0.07 U	-1.64 U	318	0.062 U	0.99 U	0.18 U	0.6 U	0.00 U
27.50-30	B125Y4	6/27/2001	-0.01 U	1.23 UJ	0.54	0.041 U	0.097 U	0.12 U	0.075 U	0.03 U
34-36.50	B125X2	6/27/2001	227	-0.96 UJ	21,200	0.85 U	20 U	61.9	85.1	2.17 U
67.30-69.80	B125X5	7/2/2001	0.00 U	-0.36 U	0.061 U	0.068 U	0.12 U	0.22 U	0.095 U	0.04 U
67.30-69.80 Duplicate	B125X6	7/2/2001	0.03 U	-1.97 U	0.049 U	0.054 U	0.12 U	0.17 U	0.11 U	0.00 U
92-94.50	B125Y9	7/2/2001	0.10 U	2.86 U	0.035 U	0.074	0.079 U	0.12 U	0.11 U	0.00 U
147.50-148.50	B125X7	7/9/2001	0.00 U	-0.30 U	0.035 U	0.037 U	0.084 U	0.11 U	0.082 U	0.01 U
197.50-198.80 Split	B12BW3	7/13/2001	-0.00 U	0.05 U	0.01 U	0.01 U	-0.03 U	-0.08 U	-0.02 U	0.01 U
197.50-198.80	B12CR8	7/13/2001	0.00 U	1.15 U	0.031 U	0.041 U	0.073 U	0.14 U	0.073 U	0.06 U
226-227	B12C15	7/18/2001	0.03 U	-0.81 U	0.064 U	0.084 U	0.097 U	0.25 U	0.097 U	0.02 U

Table C-1. 216-T-26 Borehole – Radionuclide Analytical Data. (3 sheets)

Intervals (ft)	HEIS Number	Date	Nickel-63 (pCi/g)	Plutonium-238 (pCi/g)	Plutonium-239/240 (pCi/g)	Potassium-40 (pCi/g)	Radium-226 (pCi/g)	Radium-228 (pCi/g)	Technetium-99 (pCi/g)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)
			CAS Number								
			13981-37-8	13981-16-3	PU-239/240	13966-00-2	13982-63-3	15262-20-1	14133-76-7	14274-82-9	14269-63-7
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	0.22 U	0.03 U	-0.03 U	8.5	0.37	0.34	0.12 U	0.94	0.74 J
18-20.50	B125Y2	6/26/2001	-4.79 U	0.23 U	44.5	10.4	0.00 U	0.00 U	0.80 U	2.18 U	0.73 U
22-24.50	B125X3	6/26/2001	-0.76 U	-0.03 U	0.49 J	8.93	0.00 U	0.57	0.16 U	0.56	0.14 U
27.50-30	B125Y4	6/27/2001	0.49 U	0.00 UJ	0.09 U	4.98	0.2	0.25	-0.01 U	0.45 U	0.28 U
34-36.50	B125X2	6/27/2001	-1.80 U	35.2 J	6,320	17	9.1 U	11 U	0.91 U	4.09 U	0.58 U
67.30-69.80	B125X5	7/2/2001	1.06 U	-0.03 U	-0.03 U	12.6	0.42	0.66	1.68 J	0.75	0.50 J
67.30-69.80 Duplicate	B125X6	7/2/2001	0.30 U	-0.03 U	0.03 U	9.65	0.44	0.57	1.61 J	1.05	0.74 J
92-94.50	B125Y9	7/2/2001	0.15 U	-0.06 U	0.03 U	18.2	0.89	1.48	4.87 J	1.07	0.59 J
147.50-148.50	B125X7	7/9/2001	0.15 U	0.03 U	0.06 U	8.08	0.35	0.41	2.36 J	0.94	0.03 U
197.50-198.80 Split	B12BW3	7/13/2001	2.85 U	0.00 U	0.00 U	--	0.40 U	0.81	0.27 U	0.59	0.3
197.50-198.80	B12CR8	7/13/2001	1.02 U	0.08 U	0.00 U	12.6	0.3	0.46	0.78 U	0.58	0.67 J
226-227	B12C15	7/18/2001	0.28 U	0.00 U	0.00 U	11	0.28	0.54	-0.09 U	0.78	0.00 U

Table C-1. 216-T-26 Borehole – Radionuclide Analytical Data. (3 sheets)

Intervals (ft)	HEIS Number	Date	Thorium-232 (pCi/g)	Total beta radiostrontium (pCi/g)	Tritium (pCi/g)	Uranium (µg/kg)	Uranium-233/234 (pCi/g)	Uranium-235 (pCi/g)	Uranium-238 (pCi/g)
			CAS Number						
			TH-232	SR-RAD	10028-17-8	7440-61-1	U-233/234	15117-96-1	U-238
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--
10.0-12.50	B125Y3	6/25/2001	0.74 J	0.00 U	-0.16 U	1,760	0.46 J	0.09 U	0.34 J
18-20.50	B125Y2	6/26/2001	0.97 U	1,500	-2.41 U	8,780	2.54	0.00 U	4.58
22-24.50	B125X3	6/26/2001	0.63 J	43.2	-0.11 U	10,500	3.11	0.26 J	3.16
27.50-30	B125Y4	6/27/2001	0.37 J	0.03 U	0.03 U	1,720 J	0.36 J	0.06 U	0.66 J
34-36.50	B125X2	6/27/2001	1.74 U	49,100	0.47 U	61,100 J	18.1	1.22 U	21.1
67.30-69.80	B125X5	7/2/2001	0.71 J	-0.04 U	352 J	3,410	1.09	0.06 U	1.43
67.30-69.80 Duplicate	B125X6	7/2/2001	1.26	-0.02 U	260 J	3,730	1	0.18 U	0.82 J
92-94.50	B125Y9	7/2/2001	0.87 J	-0.03 U	2,650	9,470	3.27	0.16 U	2.65
147.50-148.50	B125X7	7/9/2001	0.43 J	0.09 U	-0.03 U	1,830	0.30 J	0.00 U	0.37 J
197.50-198.80 Split	B12BW3	7/13/2001	0.52	0.04 U	0.61 U	1,150	0.38	0.00 U	0.36
197.50-198.80	B12CR8	7/13/2001	0.51 J	0.02 U	-0.01 U	710	0.37 J	0.00 U	0.26 J
226-227	B12C15	7/18/2001	0.26 U	0.03 U	3.84 J	1,160	0.16 U	0.00 U	0.18 U

-- = Not analyzed.
B = The associated QC sample blank has a result greater than two times the minimum detectable activity (MDA).
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
J = concentration is estimated.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.
UJ = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported is an estimate.

Table C-2. 216-T-26 Borehole – Inorganic (Metals) Analytical Data. (2 sheets)

Intervals (ft)	HEIS Number	Date	Aluminum (mg/kg)	Bismuth (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Hexavalent Chromium (mg/kg)	Iron (mg/kg)	Lead (mg/kg)
			CAS Number								
			7429-90-5	7440-69-9	7440-43-9	7440-70-2	7440-47-3	7440-50-8	18540-29-9	7439-89-6	7439-92-1
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	--	--	0.46	--	10.8	14	--	--	10.1
18-20.50	B125Y2	6/26/2001	7,580	5.7 U	0.44 U	9,230	16.5	13.5	0.41 U	23,300	4.6
22-24.50	B125X3	6/26/2001	5,970	--	0.67	9,590	15.4	13.7	0.41 U	24,900	5.6
27.50-30	B125Y4	6/27/2001	5,900	8.2	0.44 U	7,980	8.9	12.9	0.87 J	20,200	5.0
34-36.50	B125X2	6/27/2001	9,540	198 J	0.46 U	8,130 J	27.3	11.9	4.20 J	19,200	11.6
67.30-69.80	B125X5	7/2/2001	--	--	0.46 U	--	16.5	13.4	0.97	--	8.4
67.30-69.80 Duplicate	B125X6	7/2/2001	--	--	0.47	--	13.6	10.6	0.42 U	--	10.4
92-94.50	B125Y9	7/2/2001	--	--	0.49 U	--	24.2	18.1	1.60	--	13.7
147.50-148.50	B125X7	7/9/2001	--	--	0.43 U	--	37.8	17.3	0.41 U	--	7.8
197.50-198.80 Split	B12BW3	7/13/2001	--	--	0.17 U	--	88.9	16.4	0.239	--	4.0 B
197.50-198.80	B12CR8	7/13/2001	--	--	0.03 U	--	42	11.6	0.41 U	--	3.0
226-227	B12C15	7/18/2001	--	--	0.07	--	93.6	11.8	0.64	--	3.1

Table C-2. 216-T-26 Borehole – Inorganic (Metals) Analytical Data. (2 sheets)

Intervals (ft)	HEIS Number	Date	Magnesium (mg/kg)	Manganese (mg/kg)	Mercury (mg/kg)	Molybdenum (mg/kg)	Nickel (mg/kg)	Potassium (mg/kg)	Silver (mg/kg)	Sodium (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)
			CAS Number									
			7439-95-4	7439-96-5	7439-97-6	7439-98-7	7440-02-0	9/7/7440	7440-22-4	7440-23-5	7440-62-2	7440-66-6
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	--	--	0.02 U	--	13	--	0.3 U	--	--	--
18-20.50	B125Y2	6/26/2001	4,320	282	0.02 U	1.2 U	14	1,070	0.5	1,170	65.3	45
22-24.50	B125X3	6/26/2001	4,100	298	0.02 U	1.2 U	12	796	0.37 U	994	65.7	43.7
27.50-30	B125Y4	6/27/2001	4,080	272	0.02 U	10.3 U	9 J	771	0.29 U	832	52.3	38.4
34-36.50	B125X2	6/27/2001	5,460	318	0.18 J	10.6 U	38	1,720	0.3 U	1,510	39.8	39.9
67.30-69.80	B125X5	7/2/2001	--	--	0.02 U	--	13	--	0.3 U	--	--	--
67.30-69.80 Duplicate	B125X6	7/2/2001	--	--	0.02 U	--	12	--	0.29 U	--	--	--
92-94.50	B125Y9	7/2/2001	--	--	0.02 U	--	21	--	0.36	--	--	--
147.50-148.50	B125X7	7/9/2001	--	--	0.02 U	--	22	--	0.34 U	--	--	--
197.50-198.80 Split	B12BW3	7/13/2001	--	--	0.0072 U	--	45	--	0.94 U	--	--	--
197.50-198.80	B12CR8	7/13/2001	--	--	0.02 U	--	24	--	0.1 U	--	--	--
226-227	B12C15	7/18/2001	--	--	0.02 U	--	51	--	0.1 U	--	--	--

-- = Not analyzed.
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
U = Analyzed for but not detected. Value reported is the quantitation limit.
J = Value is an estimate.

Table C-3. 216-T-26 Borehole – General Chemistry Analytical Data. (2 sheets)

Intervals (ft)	HEIS Number	Date	Ammonia (mg/kg)	Chloride (mg/kg)	Cyanide (mg/kg)	Fluoride (mg/kg)	Nitrate (mg/kg)	Nitrite (mg/kg)
			CAS Number					
			7664-41-7	16887-00-6	57-12-5	16984-48-8	14797-55-8	14797-65-0
0-0.50	B12682	6/19/2001	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	--	3.2	--	2.6 U	10.2	1.29 U
18-20.50	B125Y2	6/26/2001	4.9 U	6.5	0.34 U	25.7	255	1.28 U
22-24.50	B125X3	6/26/2001	4.9 U	2.2	0.31 U	28.9	69	1.28 U
27.50-30	B125Y4	6/27/2001	5.3 UJ	2.6	0.41 UJ	9.5	33.4	1.32 U
34-36.50	B125X2	6/27/2001	5.3 U	3.6	0.43 U	168	12.1	1.34 U
67.30-69.80	B125X5	7/2/2001	25.8	13.8	0.9	14	1,030	21.2
67.30-69.80 Duplicate	B125X6	7/2/2001	24.8	11.2	1.99	13 U	803	17.1
92-94.50	B125Y9	7/2/2001	94.9	46	7.9	85.5	3,070	47.7
147.50-148.50	B125X7	7/9/2001	5.1 U	8.6	0.44 U	2.7	659	1.28 U
197.50-198.80 Split	B12BW3	7/13/2001	1.3	2.4	0.13 U	0.17 B	0.36 B	20.5 U
197.50-198.80	B12CR8	7/13/2001	5.1 U	4	0.49 U	2.6 U	2.15	1.28 U
226-227	B12C15	7/18/2001	5.2 U	6.3	0.4 U	2.6 U	5.56	1.32 U

Table C-3. 216-T-26 Borehole – General Chemistry Analytical Data. (2 sheets)

Intervals (ft)	HEIS Number	Date	Nitrogen in Nitrite and Nitrate (mg/kg)	Phosphate (mg/kg)	Sulfate (mg/kg)	pH Measurement (pH)	Total Organic Carbon (mg/kg)
			CAS Number				
			NO_2+NO_3-N	14265-44-2	14808-79-8	pH	TOC
0-0.50	B12682	6/19/2001	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	--	2.9	7.5	--	--
18-20.50	B125Y2	6/26/2001	62.7	1.3 U	106	8.9	281
22-24.50	B125X3	6/26/2001	16.7	4.8	29.4	9.9	191
27.50-30	B125Y4	6/27/2001	6.7	2.5 J	22	9.6	188 J
34-36.50	B125X2	6/27/2001	3.4 J	13.1	11.2	8.8	132 U
67.30-69.80	B125X5	7/2/2001	225	59.5	83.1	10.1	137 U
67.30-69.80 Duplicate	B125X6	7/2/2001	216	55.2	91	10.1	226
92-94.50	B125Y9	7/2/2001	672	213	250	9.49	132
147.50-148.50	B125X7	7/9/2001	151	1.3 U	28.7	8.3	204 U
197.50-198.80 Split	B12BW3	7/13/2001	0.72	2.6 B	9.4 B	9.3	622
197.50-198.80	B12CR8	7/13/2001	0.35	2.2	17	9	141 U
226-227	B12C15	7/18/2001	1.3	1.3 U	16.9	9.2	204

-- = Not analyzed.
B = Estimated result. Result is less than reporting limit.
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
J = Value is an estimate.
U = Analyzed for but not detected. Value reported is the quantitation limit.
UJ = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported is an estimate.

Table C-4. 216-T-26 Borehole – Herbicide Analytical Data.

Interval (ft)	HEIS Number	Date	2,4,5-T (µg/kg)	2,4,5-TP (µg/kg)	2,4-DB (µg/kg)	2,4-Dichloro-phenoxyacetic acid (µg/kg)	2-secButyl-4,6-dinitro-phenol(DNBP) (µg/kg)	Dalapon (µg/kg)	Dicamba (µg/kg)	Dichloroprop (µg/kg)
			CAS Number							
			93-76-5	93-72-1	94-82-6	94-75-7	88-85-7	75-99-0	1918-00-9	120-36-5
0-0.50	B12682	6/19/2001	18 U	18 U	180 U	35 U	18 U	180 U	70 U	180 U
10-12.50	B125Y3	6/25/2001	--	--	--	--	--	--	--	--
18-20.50	B125Y2	6/26/2001	--	--	--	--	--	--	--	--
22-24.50	B125X3	6/26/2001	--	--	--	--	--	--	--	--
27.50-30	B125Y4	6/27/2001	--	--	--	--	--	--	--	--
34-36.50	B125X2	6/27/2001	--	--	--	--	--	--	--	--
67.30-69.80	B125X5	7/2/2001	--	--	--	--	--	--	--	--
67.30-69.80 Duplicate	B125X6	7/2/2001	--	--	--	--	--	--	--	--
92-94.50	B125Y9	7/2/2001	--	--	--	--	--	--	--	--
147.50-148.50	B125X7	7/9/2001	--	--	--	--	--	--	--	--
197.50-198.80 Split	B12BW3	7/13/2001	--	--	--	--	--	--	--	--
197.50-198.80	B12CR8	7/13/2001	--	--	--	--	--	--	--	--
226-227	B12C15	7/18/2001	--	--	--	--	--	--	--	--

-- = Not analyzed.
CAS = Chemical Abstract Services registry number.
DB = 4-(2,4-Dichlorophenoxy)butanoic acid.
HEIS = Hanford Environmental Information System.
T = 2,4,5-Trichlorophenoxyacetic acid.
TP = 2-(2,4,5-Trichlorophenoxy)propionic acid.
U = Analyzed for but not detected. Value reported is the quantitation limit.

Table C-5. 216-T-26 Borehole – Volatile Organic Compound Analytical Data. (4 sheets)

Interval (ft)	HEIS Number	Date	1,1,1-Trichloro-ethane (µg/kg)	1,1,2,2-Tetrachloro-ethane (µg/kg)	1,1,2-Trichloro-ethane (µg/kg)	1,1-Dichloro-ethane (µg/kg)	1,1-Dichloro-ethene (µg/kg)	1,2-Dichloro-ethane (µg/kg)	1,2-Dichloro-ethene (Total) (µg/kg)	1,2-Dichloro-propane (µg/kg)
			CAS Number							
			71-55-6	79-34-5	79-00-5	75-34-3	75-35-4	107-06-2	540-59-0	78-87-5
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	--	--	--	--	--	--	--	--
18-20.50	B125Y2	6/26/2001	--	--	--	--	--	--	--	--
22-24.50	B125X3	6/26/2001	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
27.50-30	B125Y4	6/27/2001	--	--	--	--	--	--	--	--
34-36.50	B125X2	6/27/2001	--	--	--	--	--	--	--	--
67.30-69.80	B125X5	7/2/2001	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U
67.30-69.80 Duplicate	B125X6	7/2/2001	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
92-94.50	B125Y9	7/2/2001	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U
147.50-148.50	B125X7	7/9/2001	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
197.50-198.80 Split	B12BW3	7/13/2001	0.45 U	0.45 U	0.44 U	0.39 U	1.30 U	0.44 U	0.85 U	0.21 U
197.50-198.80	B12CR8	7/13/2001	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
226-227	B12C15	7/18/2001	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U

Table C-5. 216-T-26 Borehole – Volatile Organic Compound Analytical Data. (4 sheets)

Interval (ft)	HEIS Number	Date	2-Butanone (µg/kg)	2-Hexanone (µg/kg)	4-Methyl-2-Pentanone (µg/kg)	Acetone (µg/kg)	Benzene (µg/kg)	Bromo-dichloro-methane (µg/kg)	Bromoform (µg/kg)	Bromo-methane (µg/kg)	Carbon Disulfide (µg/kg)
			CAS Number								
			78-93-3	591-78-6	108-10-1	67-64-1	71-43-2	75-27-4	75-25-2	74-83-9	75-15-0
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	--	--	--	--	--	--	--	--	--
18-20.50	B125Y2	6/26/2001	--	--	--	--	--	--	--	--	--
22-24.50	B125X3	6/26/2001	10.00 U	10.00 U	10.00 U	10.00 U	5.00 U	5.00 U	5.00 U	10.00 U	5.00 U
27.50-30	B125Y4	6/27/2001	--	--	--	--	--	--	--	--	--
34-36.50	B125X2	6/27/2001	--	--	--	--	--	--	--	--	--
67.30-69.80	B125X5	7/2/2001	11.00 U	11.00 U	11.00 U	11.00 U	6.00 U	6.00 U	6.00 U	11.00 U	6.00 U
67.30-69.80 Duplicate	B125X6	7/2/2001	10.00 U	10.00 U	10.00 U	10.00 U	5.00 U	5.00 U	5.00 U	10.00 U	5.00 U
92-94.50	B125Y9	7/2/2001	12.00 U	12.00 U	12.00 U	12.00 U	6.00 U	6.00 U	6.00 U	12.00 U	6.00 U
147.50-148.50	B125X7	7/9/2001	10.00 U	10.00 U	10.00 U	10.00 U	5.00 U	5.00 U	5.00 U	10.00 U	5.00 U
197.50-198.80 Split	B12BW3	7/13/2001	6.80 U	1.70 U	1.30 U	35.00 B	0.38 U	0.46 U	0.63 U	0.61 U	0.47 U
197.50-198.80	B12CR8	7/13/2001	10.00 U	10.00 U	10.00 U	5.00 J	5.00 U	5.00 U	5.00 U	10.00 U	5.00 U
226-227	B12C15	7/18/2001	10.00 U	10.00 U	10.00 U	18	5.00 U	5.00 U	5.00 U	10.00 U	5.00 U

Table C-5. 216-T-26 Borehole – Volatile Organic Compound Analytical Data. (4 sheets)

Interval (ft)	HEIS Number	Date	Carbon Tetrachloride (µg/kg)	Chloro-benzene (µg/kg)	Chloro-ethane (µg/kg)	Chloroform (µg/kg)	Chloro-methane (µg/kg)	cis-1,3-Dichloro-propene (µg/kg)	Dibromo-chloro-methane (µg/kg)	Ethyl-benzene (µg/kg)
			CAS Number							
			56-23-5	108-90-7	75-00-3	67-66-3	74-87-3	10061-01-5	124-48-1	100-41-4
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	--	--	--	--	--	--	--	--
18-20.50	B125Y2	6/26/2001	--	--	--	--	--	--	--	--
22-24.50	B125X3	6/26/2001	5.00 U	5.00 U	10.00 U	5.00 U	10.00 U	5.00 U	5.00 U	5.00 U
27.50-30	B125Y4	6/27/2001	--	--	--	--	--	--	--	--
34-36.50	B125X2	6/27/2001	--	--	--	--	--	--	--	--
67.30-69.80	B125X5	7/2/2001	6.00 U	6.00 U	11.00 U	6.00 U	11.00 U	6.00 U	6.00 U	6.00 U
67.30-69.80 Duplicate	B125X6	7/2/2001	5.00 U	5.00 U	10.00 U	5.00 U	10.00 U	5.00 U	5.00 U	5.00 U
92-94.50	B125Y9	7/2/2001	6.00 U	6.00 U	12.00 U	6.00 U	12.00 U	6.00 U	6.00 U	6.00 U
147.50-148.50	B125X7	7/9/2001	5.00 U	5.00 U	10.00 U	5.00 U	10.00 U	5.00 U	5.00 U	5.00 U
197.50-198.80 Split	B12BW3	7/13/2001	0.67 U	0.35 U	2.20 U	0.25 U	0.79 U	0.53 U	0.39 U	0.91 U
197.50-198.80	B12CR8	7/13/2001	5.00 U	5.00 U	10.00 U	5.00 U	10.00 U	5.00 U	5.00 U	5.00 U
226-227	B12C15	7/18/2001	5.00 U	5.00 U	10.00 U	5.00 U	10.00 U	5.00 U	5.00 U	5.00 U

Table C-5. 216-T-26 Borehole – Volatile Organic Compound Analytical Data. (4 sheets)

Interval (ft)	HEIS Number	Date	Methylene-chloride (µg/kg)	Styrene (µg/kg)	Tetrachloro-ethene (µg/kg)	Toluene (µg/kg)	trans-1,3-Dichloro-propene (µg/kg)	Trichloro-ethene (µg/kg)	Vinyl Chloride (µg/kg)	Xylenes (Total) (µg/kg)
			CAS Number							
			75-09-2	100-42-5	127-18-4	108-88-3	10061-02-6	79-01-6	75-01-4	1330-20-7
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	--	--	--	--	--	--	--	--
18-20.50	B125Y2	6/26/2001	--	--	--	--	--	--	--	--
22-24.50	B125X3	6/26/2001	11.00 B	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	10.00 U	5.00 U
27.50-30	B125Y4	6/27/2001	--	--	--	--	--	--	--	--
34-36.50	B125X2	6/27/2001	--	--	--	--	--	--	--	--
67.30-69.80	B125X5	7/2/2001	24.00 B	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	11.00 U	6.00 U
67.30-69.80 Duplicate	B125X6	7/2/2001	13.00 B	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	10.00 U	5.00 U
92-94.50	B125Y9	7/2/2001	15.00 B	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	12.00 U	6.00 U
147.50-148.50	B125X7	7/9/2001	14.00 B	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	10.00 U	5.00 U
197.50-198.80 Split	B12BW3	7/13/2001	27.00 B	0.38 U	0.37 U	0.64 J	0.32 U	0.32 U	0.81 U	1.10 U
197.50-198.80	B12CR8	7/13/2001	14.00 B	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	10.00 U	5.00 U
226-227	B12C15	7/18/2001	16.00 B	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	10.00 U	5

-- = Not analyzed.
B = The associated QC sample blank has a result greater than two times the minimum detectable level (MDL).
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
J = Concentration is estimated.
MDL = Minimum detectable level.
QC = Quality control.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.

Table C-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Interval (ft)	HEIS Number	Date	1,2,4-Trichloro-benzene (µg/kg)	1,2-Dichloro-benzene (µg/kg)	1,3-Dichloro-benzene (µg/kg)	1,4-Dichloro-benzene (µg/kg)	2,2-Oxybis (1-chloropropane) (µg/kg)	2,4,5-Trichloro-phenol (µg/kg)	2,4,6-Trichloro-phenol (µg/kg)
			CAS Number						
			120-82-1	95-50-1	541-73-1	106-46-7	108-60-1	95-95-4	88-06-2
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U	1,700.00 U	660.00 U
18-20.50	B125Y2	6/26/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	840.00 U	340.00 U
22-24.50	B125X3	6/26/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	850.00 U	340.00 U
27.50-30	B125Y4	6/27/2001	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	860.00 UJ	350.00 UJ
34-36.50	B125X2	6/27/2001	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	860.00 UJ	340.00 UJ
67.30-69.80	B125X5	7/2/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	890.00 U	350.00 U
67.30-69.80 Duplicate	B125X6	7/2/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	860.00 U	350.00 U
92-94.50	B125Y9	7/2/2001	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U	860.00 U	380.00 U
147.50-148.50	B125X7	7/9/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	850.00 U	340.00 U
197.50-198.80 Split	B12BW3	7/13/2001	--	--	--	--	--	--	--
197.50-198.80	B12CR8	7/13/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	850.00 U	340.00 U
226-227	B12C15	7/18/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	870.00 U	350.00 U

Table C-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Interval (ft)	HEIS Number	Date	2,4-Dichloro-phenol (µg/kg)	2,4-Dimethyl-phenol (µg/kg)	2,4-Dinitro-phenol (µg/kg)	2,4-Dinitro-toluene (µg/kg)	2,6-Dinitro-toluene (µg/kg)	2-Chloro-naphthalene (µg/kg)	2-Chloro-phenol (µg/kg)
			CAS Number						
			120-83-2	105-67-9	51-28-5	121-14-2	606-20-2	91-58-7	95-57-8
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	660.00 U	660.00 U	1,700.00 U	660.00 U	660.00 U	660.00 U	660.00 U
18-20.50	B125Y2	6/26/2001	340.00 U	340.00 U	840.00 U	340.00 U	340.00 U	340.00 U	340.00 U
22-24.50	B125X3	6/26/2001	340.00 U	340.00 U	850.00 U	340.00 U	340.00 U	340.00 U	340.00 U
27.50-30	B125Y4	6/27/2001	350.00 UJ	350.00 UJ	860.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ
34-36.50	B125X2	6/27/2001	340.00 UJ	340.00 UJ	860.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ
67.30-69.80	B125X5	7/2/2001	350.00 U	350.00 U	890.00 U	350.00 U	350.00 U	350.00 U	350.00 U
67.30-69.80 Duplicate	B125X6	7/2/2001	350.00 U	350.00 U	860.00 U	350.00 U	350.00 U	350.00 U	350.00 U
92-94.50	B125Y9	7/2/2001	380.00 U	380.00 U	950.00 U	380.00 U	380.00 U	380.00 U	380.00 U
147.50-148.50	B125X7	7/9/2001	340.00 U	340.00 U	850.00 U	340.00 U	340.00 U	340.00 U	340.00 U
197.50-198.80 Split	B12BW3	7/13/2001	--	--	--	--	--	--	--
197.50-198.80	B12CR8	7/13/2001	340.00 U	340.00 U	850.00 U	340.00 U	340.00 U	340.00 U	340.00 U
226-227	B12C15	7/18/2001	350.00 U	350.00 U	870.00 U	350.00 U	350.00 U	350.00 U	350.00 U

Table C-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Interval (ft)	HEIS Number	Date	2-Methyl-naphthalene (µg/kg)	2-Methyl-phenol (cresol, o-) (µg/kg)	2-Nitro-aniline (µg/kg)	2-Nitro-phenol (µg/kg)	3,3-Dichloro-benzidine (µg/kg)	3-Nitro-aniline (µg/kg)	4,6-Dinitro-2-methyl-phenol (µg/kg)	4-Bromo-phenyl-phenyl ether (µg/kg)
			CAS Number							
			91-57-6	95-48-7	88-74-4	88-75-5	91-94-1	99-09-2	534-52-1	101-55-3
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	660.00 U	660.00 U	1,700.00 U	660.00 U	660.00 U	1,700.00 U	1,700.00 U	660.00 U
18-20.50	B125Y2	6/26/2001	340.00 U	340.00 U	840.00 U	340.00 U	340.00 U	840.00 U	840.00 U	340.00 U
22-24.50	B125X3	6/26/2001	340.00 U	340.00 U	850.00 U	340.00 U	340.00 U	850.00 U	850.00 U	340.00 U
27.50-30	B125Y4	6/27/2001	350.00 UJ	350.00 UJ	860.00 UJ	350.00 UJ	350.00 UJ	860.00 UJ	860.00 UJ	350.00 UJ
34-36.50	B125X2	6/27/2001	340.00 UJ	340.00 UJ	860.00 UJ	340.00 UJ	340.00 UJ	860.00 UJ	860.00 UJ	340.00 UJ
67.30-69.80	B125X5	7/2/2001	350.00 U	350.00 U	890.00 U	350.00 U	350.00 U	890.00 U	890.00 U	350.00 U
67.30-69.80 Duplicate	B125X6	7/2/2001	350.00 U	350.00 U	860.00 U	350.00 U	350.00 U	860.00 U	860.00 U	350.00 U
92-94.50	B125Y9	7/2/2001	380.00 U	380.00 U	950.00 U	380.00 U	380.00 U	950.00 U	950.00 U	380.00 U
147.50-148.50	B125X7	7/9/2001	340.00 U	340.00 U	850.00 U	340.00 U	340.00 U	850.00 U	850.00 U	340.00 U
197.50-198.80 Split	B12BW3	7/13/2001	--	--	--	--	--	--	--	--
197.50-198.80	B12CR8	7/13/2001	340.00 U	340.00 U	850.00 U	340.00 U	340.00 U	850.00 U	850.00 U	340.00 U
226-227	B12C15	7/18/2001	350.00 U	350.00 U	870.00 U	350.00 U	350.00 U	870.00 U	870.00 U	350.00 U

Table C-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Interval (ft)	HEIS Number	Date	4-Chloro-3-methyl-phenol (µg/kg)	4-Chloro-aniline (µg/kg)	4-Chloro-phenyl-phenyl ether (µg/kg)	4-Methyl-phenol (cresol, p-) (µg/kg)	4-Nitro-aniline (µg/kg)	4-Nitro-phenol (µg/kg)	Acenaphthene (µg/kg)	Acenaph-thylene (µg/kg)
			CAS Number							
			59-50-7	106-47-8	7005-72-3	106-44-5	100-01-6	100-02-7	83-32-9	208-96-8
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	660.00 U	660.00 U	660.00 U	660.00 U	1,700.00 U	1,700.00 U	660.00 U	660.00 U
18-20.50	B125Y2	6/26/2001	340.00 U	340.00 U	340.00 U	340.00 U	840.00 U	840.00 U	340.00 U	340.00 U
22-24.50	B125X3	6/26/2001	340.00 U	340.00 U	340.00 U	340.00 U	850.00 U	850.00 U	340.00 U	340.00 U
27.50-30	B125Y4	6/27/2001	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	860.00 UJ	860.00 UJ	350.00 UJ	350.00 UJ
34-36.50	B125X2	6/27/2001	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	860.00 UJ	860.00 UJ	340.00 UJ	340.00 UJ
67.30-69.80	B125X5	7/2/2001	350.00 U	350.00 U	350.00 U	350.00 U	890.00 U	890.00 U	350.00 U	350.00 U
67.30-69.80 Duplicate	B125X6	7/2/2001	350.00 U	350.00 U	350.00 U	350.00 U	860.00 U	860.00 U	350.00 U	350.00 U
92-94.50	B125Y9	7/2/2001	380.00 U	380.00 U	380.00 U	380.00 U	950.00 U	950.00 U	380.00 U	380.00 U
147.50-148.50	B125X7	7/9/2001	340.00 U	340.00 U	340.00 U	340.00 U	850.00 U	850.00 U	340.00 U	340.00 U
197.50-198.80 Split	B12BW3	7/13/2001	--	--	--	--	--	--	--	--
197.50-198.80	B12CR8	7/13/2001	340.00 U	340.00 U	340.00 U	340.00 U	850.00 U	850.00 U	340.00 U	340.00 U
226-227	B12C15	7/18/2001	350.00 U	350.00 U	350.00 U	350.00 U	870.00 U	870.00 U	350.00 U	350.00 U

Table C-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Interval (ft)	HEIS Number	Date	Anthracene (µg/kg)	Benzo(a) anthracene (µg/kg)	Benzo(a) pyrene (µg/kg)	Benzo(b) fluoranthene (µg/kg)	Benzo(ghi) perylene (µg/kg)	Benzo(k) fluoranthene (µg/kg)	Bis(2-chloro-ethoxy) methane (µg/kg)	Bis(2-chloro-ethyl) ether (µg/kg)
			CAS Number							
			120-12-7	56-55-3	50-32-8	205-99-2	191-24-2	207-08-9	111-91-1	111-44-4
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U
18-20.50	B125Y2	6/26/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
22-24.50	B125X3	6/26/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
27.50-30	B125Y4	6/27/2001	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ
34-36.50	B125X2	6/27/2001	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ
67.30-69.80	B125X5	7/2/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U
67.30-69.80 Duplicate	B125X6	7/2/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U
92-94.50	B125Y9	7/2/2001	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U
147.50-148.50	B125X7	7/9/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
197.50-198.80 Split	B12BW3	7/13/2001	--	--	--	--	--	--	--	--
197.50-198.80	B12CR8	7/13/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
226-227	B12C15	7/18/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U

Table C-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Interval (ft)	HEIS Number	Date	Bis(2-ethyl-hexyl) phthalate (µg/kg)	Butylbenzyl phthalate (µg/kg)	Carbazole (µg/kg)	Chrysene (µg/kg)	Di-n-butyl-phthalate (µg/kg)	Di-n-octyl-phthalate (µg/kg)	Dibenz[a,h] anthracene (µg/kg)	Dibenzo-furan (µg/kg)	Diethyl-phthalate (µg/kg)
			CAS Number								
			117-81-7	85-68-7	86-74-8	218-01-9	84-74-2	117-84-0	53-70-3	132-64-9	84-66-2
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U
18-20.50	B125Y2	6/26/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
22-24.50	B125X3	6/26/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
27.50-30	B125Y4	6/27/2001	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ
34-36.50	B125X2	6/27/2001	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ
67.30-69.80	B125X5	7/2/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U
67.30-69.80 Duplicate	B125X6	7/2/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U
92-94.50	B125Y9	7/2/2001	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U
147.50-148.50	B125X7	7/9/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
197.50-198.80 Split	B12BW3	7/13/2001	--	--	--	--	--	--	--	--	--
197.50-198.80	B12CR8	7/13/2001	30.00 J	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
226-227	B12C15	7/18/2001	59.05 J	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U

Table C-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Interval (ft)	HEIS Number	Date	Dimethyl phthalate (µg/kg)	Fluor-anthene (µg/kg)	Fluorene (µg/kg)	Hexachloro-benzene (µg/kg)	Hexachloro-butadiene (µg/kg)	Hexachloro-cyclopenta-diene (µg/kg)	Hexachloro-ethane (µg/kg)	Indeno (1,2,3-cd) pyrene (µg/kg)	Isophorone (µg/kg)
			CAS Number								
			131-11-3	206-44-0	86-73-7	118-74-1	87-68-3	77-47-4	67-72-1	193-39-5	78-59-1
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U	660.00 U
18-20.50	B125Y2	6/26/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
22-24.50	B125X3	6/26/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
27.50-30	B125Y4	6/27/2001	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ
34-36.50	B125X2	6/27/2001	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ
67.30-69.80	B125X5	7/2/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U
67.30-69.80 Duplicate	B125X6	7/2/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U
92-94.50	B125Y9	7/2/2001	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U	380.00 U
147.50-148.50	B125X7	7/9/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
197.50-198.80 Split	B12BW3	7/13/2001	--	--	--	--	--	--	--	--	--
197.50-198.80	B12CR8	7/13/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
226-227	B12C15	7/18/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U

Table C-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Interval (ft)	HEIS Number	Date	N-Nitroso-di-n-dipropylamine (µg/kg)	N-Nitroso-diphenylamine (µg/kg)	Naphthalene (µg/kg)	Nitrobenzene (µg/kg)	Pentachlorophenol (µg/kg)	Phenanthrene (µg/kg)	Phenol (µg/kg)	Pyrene (µg/kg)	Tributyl Phosphate (µg/kg)
			CAS Number								
			621-64-7	86-30-6	91-20-3	98-95-3	87-86-5	85-01-8	108-95-2	129-00-0	126-73-8
0-0.50	B12682	6/19/2001	--	--	--	--	--	--	--	--	--
10-12.50	B125Y3	6/25/2001	660.00 U	660.00 U	660.00 U	660.00 U	1,700.00 U	660.00 U	110.00 J	660.00 U	660.00 U
18-20.50	B125Y2	6/26/2001	340.00 U	340.00 U	340.00 U	340.00 U	840.00 U	340.00 U	340.00 U	340.00 U	340.00 U
22-24.50	B125X3	6/26/2001	340.00 U	340.00 U	340.00 U	340.00 U	850.00 U	340.00 U	340.00 U	340.00 U	340.00 U
27.50-30	B125Y4	6/27/2001	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	860.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ	350.00 UJ
34-36.50	B125X2	6/27/2001	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	860.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ	340.00 UJ
67.30-69.80	B125X5	7/2/2001	350.00 U	350.00 U	350.00 U	350.00 U	890.00 U	350.00 U	350.00 U	350.00 U	90.99 J
67.30-69.80 Duplicate	B125X6	7/2/2001	350.00 U	350.00 U	350.00 U	350.00 U	860.00 U	350.00 U	350.00 U	350.00 U	89.04 J
92-94.50	B125Y9	7/2/2001	380.00 U	380.00 U	380.00 U	380.00 U	950.00 U	380.00 U	380.00 U	380.00 U	380.00 U
147.50-148.50	B125X7	7/9/2001	340.00 U	340.00 U	340.00 U	340.00 U	850.00 U	340.00 U	340.00 U	340.00 U	340.00 U
197.50-198.80 Split	B12BW3	7/13/2001	--	--	--	--	--	--	--	--	340.00 U
197.50-198.80	B12CR8	7/13/2001	340.00 U	340.00 U	340.00 U	340.00 U	850.00 U	340.00 U	340.00 U	340.00 U	340.00 U
226-227	B12C15	7/18/2001	350.00 U	350.00 U	350.00 U	350.00 U	870.00 U	350.00 U	350.00 U	350.00 U	350.00 U

-- = Not analyzed.
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
J = Concentration is estimated.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.
UJ = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported is an estimate.

Table C-7. 216-T-26 Borehole - Diesel Range Organic Analytical Data.

Sample Interval (ft)	HEIS Number	Date	Diesel Oil (mg/kg)
			CAS Number
			68334-30-5
0-0.50	B12682	6/19/2001	–
10-12.50	B125Y3	6/25/2001	11.9 U
18-20.50	B125Y2	6/26/2001	11.6 U
22-24.50	B125X3	6/26/2001	11.9 U
27.50-30	B125Y4	6/27/2001	12.7 UJ
34-36.50	B125X2	6/27/2001	12.8 UJ
67.30-69.80	B125X5	7/2/2001	12.6 U
67.30-69.80 Duplicate	B125X6	7/2/2001	12.2 U
92-94.50	B125Y9	7/2/2001	13.2 U
147.50-148.50	B125X7	7/9/2001	12.2 U
197.50-198.80 Split	B12BW3	7/13/2001	3.3 U
197.50-198.80	B12CR8	7/13/2001	12.3 U
226-227	B12C15	7/18/2001	12.6 U

– = Not analyzed.
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
U = Analyzed for but not detected above the minimum detectable. activity in the sample. The value reported as the result.
UJ = Analyzed for but not detected above the minimum detectable. activity in the sample. The value reported is an estimate.

Table C-8. 216-B-38 Borehole - Radionuclide Analytical Results. (3 sheets)

Sample Interval (ft)	HEIS Number	Date	Americium-241 (pCi/g)	Carbon-14 (pCi/g)	Cesium-137 (pCi/g)	Cobalt-60 (pCi/g)	Europium-152 (pCi/g)	Europium-154 (pCi/g)	Europium-155 (pCi/g)	Neptunium-237 (pCi/g)
			CAS Number							
			14596-10-2	14762-75-5	10045-97-3	10198-40-0	14683-23-9	15585-10-1	14391-16-3	13994-20-2
0-0.50	B12684	7/18/2001	--	--	--	--	--	--	--	--
3.50-5	B12C67	8/1/2001	0.035 U	0.766 U	1.82	0.066 U	0.15 U	0.22 U	0.12 U	0.046 U
9.50-12	B12C68	8/2/2001	0.022 U	-0.971 U	0.036 U	0.035 U	0.079 U	0.12 U	0.08 U	0 U
14.50-15.50	B12C63	8/2/2001	43.9	3.02 U	226,000	4.8 U	180 U	15 U	86 U	3.61 U
18-20.50	B12C64	8/2/2001	24.1	2.83 U	226,000	12 U	250 U	23 U	120 U	0 U
22.50-25	B12DB8	8/3/2001	7.43	-0.564 U	17,900	0.35 U	12 U	1.1 U	5.1 U	0 U
29-31.50	B12DB9	8/3/2001	6.72	.16 U	95,700	5.2 U	220 U	22 U	100 U	-0.543 U
37.50-40	B12C88	8/5/2001	1.37	3.66 U	31,600	0.77 U	36 U	2.5 U	17 U	0.568 U
37.50-40 Split	B12DC0	8/5/2001	0.562 J	0.629 U	25,800	0.43 U	17 U	1.3 U	9.5 U	-0.284 U
52-54.50	B12C69	8/6/2001	0.007 U	-1.17 U	0.102	0.056	0.07 U	0.1 U	0.088 U	0 U
52-54.50 Duplicate	B12C70	8/6/2001	0.018 U	2.11 U	0.11	0.039 U	0.074 U	0.1U	0.12 U	0 U
97.50-100	B12C71	8/7/2001	-0.019 U	2.53 U	0.047 U	0.054 U	0.1 U	0.18 U	0.093 U	0.047 U
147.50-150	B12C72	8/8/2001	0.038 U	0.978 U	0.028 U	0.036 U	0.061 U	0.095 U	0.068 U	-0.128 U
197.50-200	B12C73	8/9/2001	0.235 J	0.707 U	0.165	0.047 J	0.092 U	0.14 U	0.12 U	-0.062 U
264-265.50	B12C74	8/10/2001	0.037 U	-0.857 U	.062 J	0.029 U	0.071 U	0.1 U	0.091 U	0 U

Table C-8. 216-B-38 Borehole - Radionuclide Analytical Results. (3 sheets)

Sample Interval (ft)	HEIS Number	Date	Nickel-63 (pCi/g)	Plutonium-238 (pCi/g)	Plutonium-239/240 (pCi/g)	Potassium-40 (pCi/g)	Radium-226 (pCi/g)	Radium-228 (pCi/g)	Technetium-99 (pCi/g)	Thorium-228 (pCi/g)
			CAS Number							
			13981-37-8	13981-16-3	PU-239/240	13966-00-2	13982-63-3	15262-20-1	14133-76-7	14274-82-9
0-0.50	B12684	7/18/2001	--	--	--	--	--	--	--	--
3.50-5	B12C67	8/1/2001	0.31 U	0 U	0.029 U	14	0.594	0.695	-0.1 U	0.431
9.50-12	B12C68	8/2/2001	0.517 U	0 U	0 U	14.5	0.12 U	0.974	-0.04 U	0.839
14.50-15.50	B12C63	8/2/2001	-45.4 U	7.85	106	87 U	62 U	45 U	0.20 U	6.44 U
18-20.50	B12C64	8/2/2001	3.01 U	3.36	159	273	86 U	54 U	0.007 U	1.41 U
22.50-25	B12DB8	8/3/2001	2.91 U	3.66 U	64.6	19.3	4.4 U	1.7 U	-0.209 U	-1.74 U
29-31.50	B12DB9	8/3/2001	-15.6 U	3.48	4.64	93 U	85 U	40 U	-0.07 U	-0.171 U
37.50-40	B12C88	8/5/2001	-3.05 U	0.657 J	0.776 J	34.2	12 U	4.6 U	0.128 U	-0.989 U
37.50-40 Split	B12DC0	8/5/2001	-0.298 U	0.324 U	0.883 J	32.9	6.7 U	2.59	0.037 U	-0.258 U
52-54.50	B12C69	8/6/2001	0.814 U	0.051 U	0.051 U	15.4	0.438	0.741	1.9 J	1.26
52-54.50 Duplicate	B12C70	8/6/2001	0.932 U	-0.038 U	0 U	16.8	0.479	0.827	1.93 J	1.84
97.50-100	B12C71	8/7/2001	0.844 U	0 U	-0.045 U	14.3	0.575	0.751	0.184 U	0.933
147.50-150	B12C72	8/8/2001	-0.581 U	-0.052 U	0 U	16.1	0.089 U	0.61	0.888 J	0.777
197.50-200	B12C73	8/9/2001	-0.347 U	0 U	0 U	16	0.489	0.687	-0.043 U	0.778
264-265.50	B12C74	8/10/2001	0 U	0 U	0.028 U	11.2	0.447	0.626	0.094 U	0.774

Table C-8. 216-B-38 Borehole - Radionuclide Analytical Results. (3 sheets)

Sample Interval (ft)	HEIS Number	Date	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Total Beta Radiostrontium (pCi/g)	Tritium (pCi/g)	Total Uranium (µg/kg)	Uranium-233/234 (pCi/g)	Uranium-235 (pCi/g)	Uranium-238 (pCi/g)
			CAS Number							
			14269-63-7	TH-232	SR-RAD	10028-17-8	7440-61-1	U-233/234	15117-96-1	U-238
0-0.50	B12684	7/18/2001	--	--	--	--	--	--	--	--
3.50-5	B12C67	8/1/2001	0.621 J	0.621 J	0.175 U	-0.051 U	1,600	0.667 J	0 U	0.667 J
9.50-12	B12C68	8/2/2001	0.587 J	0.587 J	-0.06 U	-0.008 U	1,690	0.448 J	0 U	0.544 J
14.50-15.50	B12C63	8/2/2001	-6.44 U	9.65 U	1,390	-0.043 U	11,300 B	8.15 U	0 U	5.82 U
18-20.50	B12C64	8/2/2001	-3.26 U	0.93 U	2,050	-0.009 U	32,500	9	0 U	5.63 U
22.50-25	B12DB8	8/3/2001	0 U	2.06 U	288	0.043 U	19,100	8.52 U	0 U	7.31 U
29-31.50	B12DB9	8/3/2001	-0.854 U	0.525 U	50.9	2.21 J	14,800	5.16	0.48 U	6.35
37.50-40	B12C88	8/5/2001	0.329 U	0 U	0.129 U	15.3 J	7,740	2.72	0.137 U	2.83
37.50-40 Split	B12DC0	8/5/2001	-0.321 U	0.193 U	0.164 U	14.2 J	8,090	2.73	0.602 U	2.48
52-54.50	B12C69	8/6/2001	0.496 J	0.382 J	0.033 U	28.7 J	2,900	0.754 J	0.07 U	0.782 J
52-54.50 Duplicate	B12C70	8/6/2001	0.894 J	0.988 J	-0.032 U	29 J	3,500	1.08	0.151 U	1.23
97.50-100	B12C71	8/7/2001	0.632 J	0.366 J	-0.182 U	2.86 J	934	0.512 J	-0.005 U	0.456 J
147.50-150	B12C72	8/8/2001	0 U	0.443 J	-0.051 U	1.9 J	901	0.272 J	0.055 U	0.431 J
197.50-200	B12C73	8/9/2001	0.068 U	0.405 J	-0.007 U	0.087 U	862	0.482 J	0.061 U	0.38 J
264-265.50	B12C74	8/10/2001	0.665 J	0.558 J	-0.018 U	0.204 J	790	0.262 J	0 U	0.314 J

-- = Not analyzed.
B = Estimated result. Result is less than reporting limit.
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
J = concentration is estimated.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.

Table C-9. 216-B-38 Borehole – Inorganic (Metals) Analytical Data. (2 sheets)

Sample Interval (ft)	HEIS Number	Date	Aluminum (mg/kg)	Bismuth (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Hexavalent Chromium (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)
			CAS Number									
			7429-90-5	7440-69-9	7440-43-9	7440-70-2	7440-47-3	7440-50-8	18540-29-9	7439-89-6	7439-92-1	7439-95-4
0-0.50	B12684	7/18/2001	--	--	--	--	--	--	--	--	--	--
3.50-5	B12C67	8/1/2001	--	--	0.06	--	11.6	12.9	0.42 U	--	6.8	--
9.50-12	B12C68	8/2/2001	--	--	0.1	--	11.5	15.1	0.43 U	--	8	--
14.50-15.50	B12C63	8/2/2001	7,600	2.2 U	0.021 U	9,610	7.1	12.20	0.08 U	18,100	4.5 B	3,820
18-20.50	B12C64	8/2/2001	7,830	2.2 U	0.021 U	8,030	10	13.00	0.08 U	19,800	5.9 B	4,580
22.50-25	B12DB8	8/3/2001	--	--	0.18 U	--	11.1	11.7	0.08 U	--	4.2 B	--
29-31.50	B12DB9	8/3/2001	--	--	0.18 U	--	9.2	9.9	0.08 U	--	3.9 B	--
37.50-40	B12C88	8/5/2001	--	--	0.18 U	--	8	11.4	0.08 U	--	3.4 U	--
37.50-40 Split	B12DC0	8/5/2001	--	--	0.18 U	--	8	11.8	0.08 U	--	3.3 U	--
52-54.50	B12C69	8/6/2001	--	--	0.07	--	8.4	8.8	0.49	--	3.4	--
52-54.50 Duplicate	B12C70	8/6/2001	--	--	0.09	--	12.7	13.4	0.62	--	3.1	--
97.50-100	B12C71	8/7/2001	--	--	0.03 U	--	18	12.1	0.41 U	--	3.6	--
147.50-150	B12C72	8/8/2001	--	--	0.03 U	--	14.5	9.4	0.41 U	--	2.9	--
197.50-200	B12C73	8/9/2001	--	--	0.03 U	--	14.4	10.4	0.41 U	--	2.7	--
264-265.50	B12C74	8/10/2001	--	--	0.03 U	--	14	18.8	0.42 U	--	3.1	--

Table C-9. 216-B-38 Borehole – Inorganic (Metals) Analytical Data. (2 sheets)

Sample Interval (ft)	HEIS Number	Date	Manganese (mg/kg)	Mercury (mg/kg)	Molybdenum (mg/kg)	Nickel (mg/kg)	Potassium (mg/kg)	Silver (mg/kg)	Sodium (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)
			CAS Number								
			7439-96-5	7439-97-6	7439-98-7	7440-02-0	7440-09-07	7440-22-4	7440-23-5	7440-62-2	7440-66-6
0-0.5	B12684	7/18/2001	--	--	--	--	--	--	--	--	--
3.50-5	B12C67	8/1/2001	--	0.02 U	--	12.1	--	0.05 U	--	--	--
9.50-12	B12C68	8/2/2001	--	0.02 U	--	10.7	--	0.05 U	--	--	--
14.50-15.50	B12C63	8/2/2001	287	0.089 B	0.92 U	6.3	1,140	0.11 U	551	55.1	43.9
18-20.50	B12C64	8/2/2001	317	0.035 B	0.91 U	6.6	1,120	0.1 U	848	63.9	54.9
22.50-25	B12DB8	8/3/2001	--	0.025 B	--	8.1	--	0.95 U	--	--	--
29-31.50	B12DB9	8/3/2001	--	0.025 U	--	9.9	--	0.96 U	--	--	--
37.50-40	B12C88	8/5/2001	--	0.025 U	--	5.8	--	0.95 U	--	--	--
37.50-40 Split	B12DC0	8/5/2001	--	0.025 U	--	5.6	--	0.95 U	--	--	--
52-54.50	B12C69	8/6/2001	--	0.02 U	--	8	--	0.05 U	--	--	--
52-54.50 Duplicate	B12C70	8/6/2001	--	0.01 U	--	15.4	--	0.05 U	--	--	--
97.50-100	B12C71	8/7/2001	--	0.02 U	--	22	--	0.05 U	--	--	--
147.50-150	B12C72	8/8/2001	--	0.02 U	--	13.3	--	0.05 U	--	--	--
197.50-200	B12C73	8/9/2001	--	0.02 U	--	14.5	--	0.05 U	--	--	--
264-265.50	B12C74	8/10/2001	--	0.02 U	--	12.1	--	0.05 U	--	--	--

-- = Not analyzed.
B = Estimated result. Result is less than reporting limit.
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.

Table C-10. 216-B-38 Borehole - General Chemistry Analytical Data.

Sample Interval (ft)	HEIS Number	Date	Ammonia (mg/kg)	Chloride (mg/kg)	Cyanide (mg/kg)	Fluoride (mg/kg)	Nitrate (mg/kg)	Nitrite (mg/kg)	Nitrogen in Nitrite and Nitrate (mg/kg)	pH (pH)	Phosphate (mg/kg)	Sulfate (mg/kg)	Total organic carbon (mg/kg)
			CAS Number										
			7664-41-7	16887-00-6	57-12-5	16984-48-8	14797-55-8	14797-65-0	NO_2+ NO_3-N	PH	14265-44-2	14808-79-8	TOC
0-0.50	B12684	7/18/2001	--	--	--	--	--	--	--	--	--	--	--
3.50-5	B12C67	8/1/2001	3.2	5.0	0.43 U	5.2 U	94.4	2.62 U	23.1	8.7	8.2	51.1	274
9.50-12	B12C68	8/2/2001	2.4	6.9	0.44 U	2.7 U	208	1.34 U	59.1	8.8	1.6	248	1,060
14.50-15.50	B12C63	8/2/2001	0.53 U	0.11 U	0.13 U	7.4 B	45.3	1.1 U	39.5	8.9	0.266 U	114 B	1,510
18-20.50	B12C64	8/2/2001	0.52 U	0.10 U	0.13 U	14.2 B	12.3	1.1 U	6.1	9.6	27.1 B	35 B	988
22.50-25	B12DB8	8/3/2001	0.52 U	0.10 U	0.42	20 B	15.3	1.1 U	8.4	9.4	34.1 B	49.1 B	1,380
29-31.50	B12DB9	8/3/2001	0.52 U	11.7 B	0.31	33.4 B	31.8	1.1 U	25.3	9.6	67.4 B	151 B	2,760
37.50-40	B12C88	8/5/2001	29.3	24.6 B	0.13 U	32.9 B	139	1.1 U	110	9.5	137 B	69.8 B	1,610
37.50-40 Split	B12DC0	8/5/2001	26	20.5 B	0.13 U	28.9 B	118	1.1 U	146	8.8	106 B	60.6 B	1,550
52-54.50	B12C69	8/6/2001	65.2	25.6	0.50 U	12.9 U	2,090	34.3	464	9.6	149	106	889
52-54.50 Duplicate	B12C70	8/6/2001	123	26.4	0.48 U	12.9 U	2,140	34.7	486	9.5	121	110	151
97.50-100	B12C71	8/7/2001	3.7	31	0.47 U	6.4 U	1,880	35.2	449	9.3	6.4 U	131	166
147.50-150	B12C72	8/8/2001	2.3 U	41.1	0.47 U	6.4 U	3,180	41.2	753	8.3	6.4 U	48.2	133
197.50-200	B12C73	8/9/2001	2.4 U	6.6	0.41 U	2.6 U	57.6	2.56 U	17.8	8.8	2.6 U	38.1	191
264-265.50	B12C74	8/10/2001	2.5 U	2.8	0.45 U	1.3 U	1.48	1.31 U	0.2 U	8.9	1.3 U	13.5	127

-- = Not analyzed.
B = Estimated result. Result is less than reporting limit.
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.

Table C-11. 216-B-38 Borehole - Herbicide Analytical Data.

Sample Interval (ft)	HEIS Number	Date	2,4,5-T (µg/kg)	2,4,5-TP (µg/kg)	2,4-DB (µg/kg)	2,4-Dichlorophenoxyacetic acid (µg/kg)	2-secButyl-4,6-dinitrophenol (DNBP) (µg/kg)	Dalapon (µg/kg)	Dicamba (µg/kg)	Dichloroprop (µg/kg)
			CAS Number							
			93-76-5	93-72-1	94-82-6	94-75-7	88-85-7	75-99-0	1918-00-9	120-36-5
0-0.50	B12684	7/18/2001	17.00 U	17.00 U	170.00 U	35.00 U	17.00 U	170.00 U	69.00 U	170.00 U
3.50-5	B12C67	8/1/2001	--	--	--	--	--	--	--	--
9.50-12	B12C68	8/2/2001	--	--	--	--	--	--	--	--
14.50-15.50	B12C63	8/2/2001	--	--	--	--	--	--	--	--
18-20.50	B12C64	8/2/2001	--	--	--	--	--	--	--	--
22.50-25	B12DB8	8/3/2001	--	--	--	--	--	--	--	--
29-31.50	B12DB9	8/3/2001	--	--	--	--	--	--	--	--
37.50-40	B12C88	8/5/2001	--	--	--	--	--	--	--	--
37.50-40 Split	B12DC0	8/5/2001	--	--	--	--	--	--	--	--
52-54.50	B12C69	8/6/2001	--	--	--	--	--	--	--	--
52-54.50 Duplicate	B12C70	8/6/2001	--	--	--	--	--	--	--	--
97.50-100	B12C71	8/7/2001	--	--	--	--	--	--	--	--
147.50-150	B12C72	8/8/2001	--	--	--	--	--	--	--	--
197.50-200	B12C73	8/9/2001	--	--	--	--	--	--	--	--
264-265.50	B12C74	8/10/2001	--	--	--	--	--	--	--	--

-- = Not analyzed.
CAS = Chemical Abstract Services registry number.
DB = 4-(2,4-Dichlorophenoxy)butanoic acid.
HEIS = Hanford Environmental Information System.
T = 2,4,5-Trichlorophenoxyacetic acid.
TP = 2-(2,4,5-Trichlorophenoxy)propionic acid.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.

Table C-12. 216-B-7A Borehole – Radionuclide Analytical Data. (3 sheets)

Sample Interval (ft)	HEIS Number	Date	Americium-241 (pCi/g)	Carbon-14 (pCi/g)	Cesium-137 (pCi/g)	Cobalt-60 (pCi/g)	Europium-152 (pCi/g)	Europium-154 (pCi/g)	Europium-155 (pCi/g)	Neptunium-237 (pCi/g)
			CAS Number							
			14596-10-2	14762-75-5	10045-97-3	10198-40-0	14683-23-9	15585-10-1	14391-16-3	13994-20-2
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	0 U	2.85 U	6.67	0.042 U	0.15 U	0.14 U	0.13 U	0 U
5.50-8	B12MH6	8/22/2001	0.018 U	6.3 J	42.5	0.019 U	0.15 U	0.068 U	0.15 U	0 U
10-12.50	B12MH7	8/22/2001	-0.017 U	2.22 U	1.52	0.005 U	0.017 U	0.015 U	0.018 U	0 U
12.50-15	B12MH4	8/23/2001	0.034 U	3.72 U	4.54	0.045 U	0.11 U	0.13 U	0.09 U	0.037 U
18.50-21	B12C89	8/23/2001	5,690	1.4 U	102,000	6.1 U	110 U	200	200 U	24.3 U
22.50-25	B12DC1	8/24/2001	2,620	0.361 U	153,000	12 U	210 U	44 U	180 U	-17.9 U
25-27.50	B12ML4	8/26/2001	770	3.15 U	67,300	35 U	390 U	98 U	490 U	3.71 U
30-32.50	B12ML5	8/27/2001	21.8	1.86 U	6,190	0.92 U	15 U	3.1 U	14 U	0 U
35-37.50	B12ML6	8/27/2001	0.133 U	1.67 U	5,910	0.99 U	22 U	3.4 U	8.9 U	-0.065 U
48-50.50	B12ML7	8/28/2001	0.0764	-0.0247 UJ	5.06	0.0111 U	0.0224 U	0.0177 U	-0.0425 U	0 U
48-50.50 Split	B12C91	8/28/2001	0.023 U	0.609 U	4.28	0.058 U	0.18 U	0.2 U	0.16 U	0.063 U
72.50-75	B12MH8	9/21/2001	0.142 U	-1.44 U	0.013 U	0.016 U	0.029 U	0.056 U	0.046 U	0.029 U
72.50-75 Duplicate	B12MH9	9/21/2001	0.091 U	-1.79 U	0.009 U	0.01 U	0.021 U	0.033 U	0.025 U	0 U
97.50-100	B12MJ0	9/21/2001	0 U	1.28 U	0.014 U	0.018 U	0.036 U	0.055 U	0.041 U	0 U
147.50-150	B12MJ1	9/25/2001	0 U	2.8 U	0.007 U	0.009 U	0.017 U	0.03 U	0.037 U	0.025 U
219-221.50	B12MJ2	9/26/2001	-0.026 U	-0.746 U	0.053 U	0.063 U	0.11 U	0.21 U	0.099 U	0.027 U

Table C-12. 216-B-7A Borehole – Radionuclide Analytical Data. (3 sheets)

Sample Interval (ft)	HEIS Number	Date	Nickel-63 (pCi/g)	Plutonium-238 (pCi/g)	Plutonium-239/240 (pCi/g)	Potassium-40 (pCi/g)	Radium-226 (pCi/g)	Radium-228 (pCi/g)	Technetium-99 (pCi/g)	Thorium-228 (pCi/g)
			CAS Number							
			13981-37-8	13981-16-3	PU-239/240	13966-00-2	13982-63-3	15262-20-1	14133-76-7	14274-82-9
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	-1.25 U	0 U	0 U	10.8	0.396	0.654	0.071 U	0.676 U
5.50-8	B12MH6	8/22/2001	-0.101 U	0 U	0.172 U	14.5	0.584	0.763	-0.048 U	0.687
10-12.50	B12MH7	8/22/2001	0 U	-0.025 U	0.025 U	2.27	0.094 J	0.132 J	-0.076 U	0.884
12.50-15	B12MH4	8/23/2001	-1.16 U	0.126 U	0 U	12.2	0.544	0.646	-0.15 U	0.54
18.50-21	B12C89	8/23/2001	-175 U	481 U	153,000	236	49 U	31 U	32.9	0 U
22.50-25	B12DC1	8/24/2001	-136 U	755 U	77,300	244	93 U	62 U	4.27 J	6.24 U
25-27.50	B12ML4	8/26/2001	585 U	140	25,800	572	170 U	200 U	1.56 J	6.78 U
30-32.50	B12ML5	8/27/2001	6.4 U	4.12 U	1,360	16.4	6.3 U	5.8 U	0.098 U	0.767 U
35-37.50	B12ML6	8/27/2001	-0.545 U	0 U	1.56	20 U	8.9 U	5.1 U	-0.034 U	0.564
48-50.50	B12ML7	8/28/2001	-0.129 U	0 U	0.451	NA	0.575	0.971	-0.441 UJ	0.693
48-50.50 Split	B12C91	8/28/2001	-0.078 U	0.009 U	0.138 J	10.8	0.302	0.706	-0.074 U	1.14
72.50-75	B12MH8	9/21/2001	-1.47 U	0 U	0 U	14	0.405	0.632	0.093 U	0.481 U
72.50-75 Duplicate	B12MH9	9/21/2001	-0.333 U	-0.039 U	0 U	16.6	0.03 U	0.706	0.185 U	0.731
97.50-100	B12MJ0	9/21/2001	-1.21 U	0 U	0 U	15.3	0.429	0.681	0.184 U	0.701
147.50-150	B12MJ1	9/25/2001	0.252 U	0 U	0 U	15.2	0.349	0.519	0.155 U	0.446
219-221.50	B12MJ2	9/26/2001	-0.639 U	0.061 U	0.02 U	15.5	0.682	1.07	0.591 U	1.28

Table C-12. 216-B-7A Borehole – Radionuclide Analytical Data. (3 sheets)

Sample Interval (ft)	HEIS Number	Date	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Total Beta Radiostrontium (pCi/g)	Tritium (pCi/g)	Uranium (µg/kg)	Uranium-233/234 (pCi/g)	Uranium-235 (pCi/g)	Uranium-238 (pCi/g)
			CAS Number							
			14269-63-7	TH-232	SR-RAD	10028-17-8	7440-61-1	U-233/234	15117-96-1	U-238
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	0.352 U	0.302 U	0.689 J	0.058 U	930	0.474 J	0.016 J	0.464 J
5.50-8	B12MH6	8/22/2001	0.414 J	0.644 J	2.66	0.027 U	995	0.467 J	0.029 J	0.458 J
10-12.50	B12MH7	8/22/2001	0.729 J	0.265 J	9.44	-0.011 U	939	0.47 J	0.023 J	0.465 J
12.50-15	B12MH4	8/23/2001	0.685 J	0.381 J	13.5	0.051 U	964	0.463 J	0.023 J	0.463 J
18.50-21	B12C89	8/23/2001	-11.2 U	5.61 U	940,000	11.6 U	51,300 B	-40 U	0 U	60 U
22.50-25	B12DC1	8/24/2001	68.1 U	-6.19 U	2,340,000	3.65 U	147,000 B	19.5 U	0 U	19.5 U
25-27.50	B12ML4	8/26/2001	16.8 U	0 U	5,710,000	0.872 U	139,000 B	46.9 U	0 U	26.8 U
30-32.50	B12ML5	8/27/2001	-3.99 U	0.38 U	128,000	0.12 U	346,000	117	3.77 U	108
35-37.50	B12ML6	8/27/2001	0.397 U	0.86 J	98.3	0.328 J	24,200	8.11	0.586 J	7.5
48-50.50	B12ML7	8/28/2001	0.516	0.562	39.5	1.68 UJ	2,020	0.884	0.0698	0.789
48-50.50 Split	B12C91	8/28/2001	0.332 U	0.705 J	18.8	0.038 U	1,060	0.673 J	0 U	0.607 J
72.50-75	B12MH8	9/21/2001	0.11 U	0.439 J	-0.043 U	0.288 J	2,390	0.928 J	0 U	0.943 J
72.50-75 Duplicate	B12MH9	9/21/2001	0.182 U	0.773 J	-0.025 U	0.313 J	2,590	1.04	0.023 U	0.812 J
97.50-100	B12MJ0	9/21/2001	0.308 U	0.411 J	0.079 U	0.308 J	1,210	0.425 J	0.047 U	0.503 J
147.50-150	B12MJ1	9/25/2001	-0.047 U	0.357 J	-0.078 U	0.221 J	1,250	0.44 J	0 U	0.5 J
219-221.50	B12MJ2	9/26/2001	0.936 J	0.720 J	0.025 U	0.053 U	1,800	0.407 J	0.052 U	0.686 J

-- = Not analyzed.
B = The associated QC sample blank has a result greater than two times the minimum detectable activity (MDA).
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
J = Concentration is estimated.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.
UJ = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported is an estimate.

Table C-13. 216-B-7A Borehole – Inorganic (Metals) Analytical Data. (3 sheets)

Sample Interval (ft)	HEIS Number	Date	Aluminum (mg/kg)	Bismuth (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Hexavalent Chromium (mg/kg)
			CAS Number						
			7429-90-5	7440-69-9	7440-43-9	7440-70-2	7440-47-3	7440-50-8	18540-29-9
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	0.03 U	--	12.9	12.8	0.425 U
5.50-8	B12MH6	8/22/2001	--	--	0.03 U	--	13.5	13.7	0.44 U
10-12.50	B12MH7	8/22/2001	--	--	0.06	--	14.0	13.7	0.42 U
12.50-15	B12MH4	8/23/2001	--	--	0.07	--	12.4	15	0.42 U
18.50-21	B12C89	8/23/2001	--	--	0.2 UJ	--	142 J	13.6 J	15.1 J
22.50-25	B12DC1	8/24/2001	9,630 J	3,300 J	0.022 UJ	11,900 J	73.2 J	20.5 J	17.8 J
25-27.50	B12ML4	8/26/2001	--	--	0.21 UJ	--	46.2 J	23.4 J	NA
30-32.50	B12ML5	8/27/2001	--	--	0.2 UJ	--	27.4 J	16.6 J	NA
35-37.50	B12ML6	8/27/2001	--	--	0.19 UJ	--	12.4 J	15 J	0.08 U
48-50.50	B12ML7	8/28/2001	--	--	0.2 U	--	9.3	11.1	0.08 U
48-50.50 Split	B12C91	8/28/2001	--	--	0.07	--	12.1	13.5	0.41 U
72.50-75	B12MH8	9/21/2001	--	--	0.65 U	--	9.4	12.1	0.96
72.50-75 Duplicate	B12MH9	9/21/2001	--	--	0.65 U	--	8.4	8.9	0.97
97.50-100	B12MJ0	9/21/2001	--	--	0.62 U	--	16.9	9.8	1.1
147.50-150	B12MJ1	9/25/2001	--	--	0.61 U	--	22.2	9.8	1.3
219-221.50	B12MJ2	9/26/2001	--	--	0.81 U	--	44.2	29.5	3.8

Table C-13. 216-B-7A Borehole – Inorganic (Metals) Analytical Data. (3 sheets)

Sample Interval (ft)	HEIS Number	Date	Iron (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)	Mercury (mg/kg)	Molybdenum (mg/kg)
			CAS Number					
			7439-89-6	7439-92-1	7439-95-4	7439-96-5	7439-97-6	7439-98-7
0-0.50	B12683	6/19/2001	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	5.9	--	--	0.02 U	--
5.50-8	B12MH6	8/22/2001	--	6.9	--	--	0.01 U	--
10-12.50	B12MH7	8/22/2001	--	23.3	--	--	0.02 U	--
12.50-15	B12MH4	8/23/2001	--	10	--	--	0.02 U	--
18.50-21	B12C89	8/23/2001	--	349 J	--	--	0.12 J	--
22.50-25	B12DC1	8/24/2001	34,900 J	308 J	6,460 J	1,650 J	0.42 J	0.97 UJ
25-27.50	B12ML4	8/26/2001	--	285 J	--	--	0.13 J	--
30-32.50	B12ML5	8/27/2001	--	76.5 J	--	--	0.051 J	--
35-37.50	B12ML6	8/27/2001	--	5.6 J	--	--	0.027 U	--
48-50.50	B12ML7	8/28/2001	--	3.7 U	--	--	0.028 U	--
48-50.50 Split	B12C91	8/28/2001	--	3	--	--	0.02 U	--
72.50-75	B12MH8	9/21/2001	--	5.3	--	--	0.05	--
72.50-75 Duplicate	B12MH9	9/21/2001	--	6.1	--	--	0.03	--
97.50-100	B12MJ0	9/21/2001	--	2.2 U	--	--	0.02	--
147.50-150	B12MJ1	9/25/2001	--	2.2 U	--	--	0.02 U	--
219-221.50	B12MJ2	9/26/2001	--	11.3	--	--	0.04	--

Table C-13. 216-B-7A Borehole – Inorganic (Metals) Analytical Data. (3 sheets)

Sample Interval (ft)	HEIS Number	Date	Nickel (mg/kg)	Potassium (mg/kg)	Silver (mg/kg)	Sodium (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)
			CAS Number					
			7440-02-0	9/7/7440	7440-22-4	7440-23-5	7440-62-2	7440-66-6
0-0.50	B12683	6/19/2001	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	10.9	--	0.05 U	--	--	--
5.50-8	B12MH6	8/22/2001	13.7	--	0.05 U	--	--	--
10-12.50	B12MH7	8/22/2001	11.7	--	0.05 U	--	--	--
12.50-15	B12MH4	8/23/2001	10.1	--	0.05 U	--	--	--
18.50-21	B12C89	8/23/2001	22.7 J	--	3.1 J	--	--	--
22.50-25	B12DC1	8/24/2001	66.6 J	1,900 J	1.90 J	1,310 J	88.4 J	127 J
25-27.50	B12ML4	8/26/2001	39.6 J	--	1.1 UJ	--	--	--
30-32.50	B12ML5	8/27/2001	13.9 J	--	1.1 UJ	--	--	--
35-37.50	B12ML6	8/27/2001	10 J	--	1 UJ	--	--	--
48-50.50	B12ML7	8/28/2001	10.1	--	1.1 U	--	--	--
48-50.50 Split	B12C91	8/28/2001	8.5	--	0.05 U	--	--	--
72.50-75	B12MH8	9/21/2001	8.9	--	0.99 U	--	--	--
72.50-75 Duplicate	B12MH9	9/21/2001	8	--	0.98 U	--	--	--
97.50-100	B12MJ0	9/21/2001	13.3	--	0.94 U	--	--	--
147.50-150	B12MJ1	9/25/2001	17.2	--	0.94 U	--	--	--
219-221.50	B12MJ2	9/26/2001	36.4	--	1.2 U	--	--	--

-- = Not analyzed.
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
J = Concentration is estimated.
NA = Not Applicable.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.

Table C-14. 216-B-7A Borehole - General Chemistry Analytical Data. (2 sheets)

Sample Interval (ft)	HEIS Number	Date	Ammonia (mg/kg)	Chloride (mg/kg)	Cyanide (mg/kg)	Fluoride (mg/kg)	Nitrate (mg/kg)	Nitrite (mg/kg)
			CAS Number					
			7664-41-7	16887-00-6	57-12-5	16984-48-8	14797-55-8	14797-65-0
0-0.50	B12683	6/19/2001	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	2.5 U	6.5	0.451 U	2.66 U	110	2.66 U
5.50-8	B12MH6	8/22/2001	21.3	9.04	0.476 U	2.75 U	193	2.75 U
10-12.50	B12MH7	8/22/2001	2.5 U	11.1	0.37 U	5.3 U	77.3	2.65 U
12.50-15	B12MH4	8/23/2001	2.4 U	12.8	0.44 U	5.3 U	65.3	2.65 U
18.50-21	B12C89	8/23/2001	2.9 U	7.4	0.80 J	23.6	22.9 J	2.3 UJ
22.50-25	B12DC1	8/24/2001	0.61 B	9.9	0.31 J	38.8	21.2 J	0.22 UJ
25-27.50	B12ML4	8/26/2001	1.7 B	7.6	0.15 UR	38.6	22.1 J	2.4 UJ
30-32.50	B12ML5	8/27/2001	1.8 B	6.3	0.56 J	70	11.5 J	2.3 UJ
35-37.50	B12ML6	8/27/2001	5.3	7.4	0.38 J	205	28.5 J	2.3 UJ
48-50.50	B12ML7	8/28/2001	5.3	5.4	0.47 J	28.8	5.4 J	2.3 UJ
48-50.50 Split	B12C91	8/28/2001	2.5 U	2.8	0.40 U	23.4	21.3	1.29 U
72.50-75	B12MH8	9/21/2001	2.4 U	3	0.44 U	11.6	8.51	1.30 U
72.50-75 Duplicate	B12MH9	9/21/2001	2.6 U	2.9	0.42 U	11.8	7.57	1.30 U
97.50-100	B12MJ0	9/21/2001	2.7 U	8.5	0.38 U	5.1 U	133	2.53 U
147.50-150	B12MJ1	9/25/2001	3.1	12.2	0.38 U	5.1 U	493	2.56 U
219-221.50	B12MJ2	9/26/2001	2.7 U	24.8	0.58 U	101	263	3.20 U

Table C-14. 216-B-7A Borehole - General Chemistry Analytical Data. (2 sheets)

Sample Interval (ft)	HEIS Number	Date	Nitrogen in Nitrite and Nitrate (mg/kg)	Phosphate (mg/kg)	Sulfate (mg/kg)	pH Measurement (pH)	Total Organic Carbon (mg/kg)
			CAS Number				
			NO_2+NO_3-N	14265-44-2	14808-79-8	pH	TOC
0-0.50	B12683	6/19/2001	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	24.9	7.33	45.9	9.04	1,050
5.50-8	B12MH6	8/22/2001	46.2	3.1	185	8.31	3,850
10-12.50	B12MH7	8/22/2001	19.4	3.3	67.5	8.7	1,370
12.50-15	B12MH4	8/23/2001	15.6	3	38.3	8.7	900
18.50-21	B12C89	8/23/2001	30.1	22.4 J	40	8.5 J	1,590 J
22.50-25	B12DC1	8/24/2001	0.04 U	28.2 J	48.2	8.6 J	847 J
25-27.50	B12ML4	8/26/2001	24.9	66.5 J	25	8.6 J	541 J
30-32.50	B12ML5	8/27/2001	14.8	30.4 J	35.4	9.6 J	668 J
35-37.50	B12ML6	8/27/2001	33.4	105 J	42.9	9.5 J	771 J
48-50.50	B12ML7	8/28/2001	10.2	12.7 J	20.4	10.1 J	2,680 J
48-50.50 Split	B12C91	8/28/2001	5.5	4.5	11	10.4	189 U
72.50-75	B12MH8	9/21/2001	2.1	2.3	6.1	10.2	225
72.50-75 Duplicate	B12MH9	9/21/2001	1.6	2.5	6	10.4	163
97.50-100	B12MJ0	9/21/2001	25.2	2.5 U	14.2	9.9	157
147.50-150	B12MJ1	9/25/2001	114	2.6 U	14.6	6.8	143
219-221.50	B12MJ2	9/26/2001	62.2	17.8	121	10.2	273

-- = Not analyzed.
B = The associated QC sample blank has a result greater than two times the minimum detectable activity (MDA).
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
J = Concentration is estimated.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.
UJ = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported is an estimate.
UR = The data are unrecoverable.

Table C-15. 216-B-7A Borehole - Herbicide Analytical Data.

Sample Interval (ft)	HEIS Number	Date	2,4,5-T (µg/kg)	2,4,5-TP (µg/kg)	2,4-DB (µg/kg)	2,4-Dichloro-phenoxyacetic acid (µg/kg)	2-secButyl-4,6-dinitrophenol (DNBP) (µg/kg)	Dalapon (µg/kg)	Dicamba (µg/kg)	Dichloroprop (µg/kg)
			CAS Number							
			93-76-5	93-72-1	94-82-6	94-75-7	88-85-7	75-99-0	1918-00-9	120-36-5
0-0.50	B12683	6/19/2001	17 U	17 U	170 U	35 U	17 U	170 U	69 U	170 U
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--	--	--
30-32.50	B12ML5	8/27/2001	--	--	--	--	--	--	--	--
35-37.50	B12ML6	8/27/2001	--	--	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--	--	--
48-50.50 Split	B12C91	8/28/2001	--	--	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	--	--	--	--	--	--	--	--
72.50-75 Duplicate	B12MH9	9/21/2001	--	--	--	--	--	--	--	--
97.50-100	B12MJ0	9/21/2001	--	--	--	--	--	--	--	--
147.50-150	B12MJ1	9/25/2001	--	--	--	--	--	--	--	--
219-221.50	B12MJ2	9/26/2001	--	--	--	--	--	--	--	--

-- = Not analyzed.
DB = 4-(2,4-Dichlorophenoxy)butanoic acid.
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
T = 2,4,5-Trichlorophenoxyacetic acid.
TP = 2-(2,4,5-Trichlorophenoxy)propionic acid.

Table C-16. 216-B-7A Borehole – Volatile Organic Compound Analytical Data. (5 sheets)

Sample Interval (ft)	HEIS Number	Date	1,1,1-Trichloroethane (µg/kg)	1,1,2,2-Tetrachloroethane (µg/kg)	1,1,2-Trichloroethane (µg/kg)	1,1-Dichloroethane (µg/kg)	1,1-Dichloroethene (µg/kg)	1,2-Dichloroethane (µg/kg)
			CAS Number					
			71-55-6	79-34-5	79-00-5	75-34-3	75-35-4	107-06-2
0-0.50	B12683	6/19/2001	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--
30-32.50	B12ML5	8/27/2001	--	--	--	--	--	--
35-37.50	B12ML6	8/27/2001	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--
48-50.50 Split	B12C91	8/28/2001	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U
72.50-75 Duplicate	B12MH9	9/21/2001	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
97.50-100	B12MJ0	9/21/2001	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U
147.50-150	B12MJ1	9/25/2001	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U	6.00 U
219-221.50	B12MJ2	9/26/2001	7.00 U	7.00 U	7.00 U	7.00 U	7.00 U	7.00 U

Table C-16. 216-B-7A Borehole – Volatile Organic Compound Analytical Data. (5 sheets)

Sample Interval (ft)	HEIS Number	Date	1,2-Dichloroethene (Total) (µg/kg)	1,2-Dichloropropane (µg/kg)	2-Butanone (µg/kg)	2-Hexanone (µg/kg)	4-Methyl-2-Pentanone (µg/kg)	Acetone (µg/kg)	Benzene (µg/kg)
			CAS Number						
			540-59-0	78-87-5	78-93-3	591-78-6	108-10-1	67-64-1	71-43-2
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--	--
10-12.5	B12MH7	8/22/2001	--	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--	--
30-32.50	B12ML5	8/27/2001	--	--	--	--	--	--	--
35-37.50	B12ML6	8/27/2001	--	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--	--
48-50.50 Split	B12C91	8/28/2001	--	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	6.00 U	6.00 U	11.00 U	11.00 U	11.00 U	6.00 J	6.00 U
72.50-75 Duplicate	B12MH9	9/21/2001	5.00 U	5.00 U	10.00 U	10.00 U	10.00 U	4.00 J	5.00 U
97.50-100	B12MJ0	9/21/2001	6.00 U	6.00 U	11.00 U	11.00 U	11.00 U	5.00 J	6.00 U
147.50-150	B12MJ1	9/25/2001	6.00 U	6.00 U	11.00 U	11.00 U	11.00 U	8.00 J	6.00 U
219-221.50	B12MJ2	9/26/2001	7.00 U	7.00 U	14.00 U	14.00 U	14.00 U	13.00 JB	7.00 U

Table C-16. 216-B-7A Borehole – Volatile Organic Compound Analytical Data. (5 sheets)

Sample Interval (ft)	HEIS Number	Date	Bromodi-chloromethane (µg/kg)	Bromoform (µg/kg)	Bromomethane (µg/kg)	Carbon Disulfide (µg/kg)	Carbon Tetrachloride (µg/kg)	Chlorobenzene (µg/kg)	Chloroethane (µg/kg)
			CAS Number						
			75-27-4	75-25-2	74-83-9	75-15-0	56-23-5	108-90-7	75-00-3
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--	--
30-32.50	B12ML5	8/27/2001	--	--	--	--	--	--	--
35-37.50	B12ML6	8/27/2001	--	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--	--
48-50.50 Split	B12C91	8/28/2001	--	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	6.00 U	6.00 U	11.00 U	6.00 U	6.00 U	6.00 U	11.00 U
72.50-75 Duplicate	B12MH9	9/21/2001	5.00 U	5.00 U	10.00 U	5.00 U	5.00 U	5.00 U	10.00 U
97.50-100	B12MJ0	9/21/2001	6.00 U	6.00 U	11.00 U	6.00 U	6.00 U	6.00 U	11.00 U
147.50-150	B12MJ1	9/25/2001	6.00 U	6.00 U	11.00 U	6.00 U	6.00 U	6.00 U	11.00 U
219-221.50	B12MJ2	9/26/2001	7.00 U	7.00 U	14.00 U	7.00 U	7.00 U	7.00 U	14.00 U

Table C-16. 216-B-7A Borehole – Volatile Organic Compound Analytical Data. (5 sheets)

Sample Interval (ft)	HEIS Number	Date	Chloroform (µg/kg)	Chloro-methane (µg/kg)	cis-1,3-Dichloropropene (µg/kg)	Dibromo-chloromethane (µg/kg)	Ethyl-benzene (µg/kg)	Hexachloro-ethane (µg/kg)	Methyl-enechloride (µg/kg)	Styrene (µg/kg)
			CAS Number							
			67-66-3	74-87-3	10061-01-5	124-48-1	100-41-4	67-72-1	75-09-2	100-42-5
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--	--	--
30-32.50	B12ML5	8/27/2001	--	--	--	--	--	--	--	--
35-37.50	B12ML6	8/27/2001	--	--	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--	--	--
48-50.50 Split	B12C91	8/28/2001	--	--	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	6.00 U	11.00 U	6.00 U	6.00 U	6.00 U	350.00 U	16.00 B	6.00 U
72.50-75 Duplicate	B12MH9	9/21/2001	5.00 U	10.00 U	5.00 U	5.00 U	5.00 U	350.00 U	14.00 B	5.00 U
97.50-100	B12MJ0	9/21/2001	6.00 U	11.00 U	6.00 U	6.00 U	6.00 U	340.00 U	17.00 B	6.00 U
147.50-150	B12MJ1	9/25/2001	6.00 U	11.00 U	6.00 U	6.00 U	6.00 U	340.00 U	15.00 B	6.00 U
219-221.50	B12MJ2	9/26/2001	7.00 U	14.00 U	7.00 U	7.00 U	7.00 U	430.00 U	17.00 B	7.00 U

Table C-16. 216-B-7A Borehole – Volatile Organic Compound Analytical Data. (5 sheets)

Sample Interval (ft)	HEIS Number	Date	Tetrachloroethene (µg/kg)	Toluene (µg/kg)	trans-1,3-Dichloropropene (µg/kg)	Trichloroethene (µg/kg)	Vinyl Chloride (µg/kg)	Xylenes (total) (µg/kg)
			CAS Number					
			127-18-4	108-88-3	10061-02-6	79-01-6	75-01-4	1330-20-7
0-0.50	B12683	6/19/2001	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--
30-32.50	B12ML5	8/27/2001	--	--	--	--	--	--
35-37.50	B12ML6	8/27/2001	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--
48-50.50 Split	B12C91	8/28/2001	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	6.00 U	6.00 U	6.00 U	6.00 U	11.00 U	6.00 U
72.50-75 Duplicate	B12MH9	9/21/2001	5.00 U	5.00 U	5.00 U	5.00 U	10.00 U	5.00 U
97.50-100	B12MJ0	9/21/2001	6.00 U	6.00 U	6.00 U	6.00 U	11.00 U	6.00 U
147.50-150	B12MJ1	9/25/2001	6.00 U	6.00 U	6.00 U	6.00 U	11.00 U	6.00 U
219-221.50	B12MJ2	9/26/2001	7.00 U	7.00 U	7.00 U	7.00 U	14.00 U	7.00 U

-- = Not analyzed.
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.

Table C-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Intervals (ft)	HEIS Number	Date	1,2,4-Trichloro-benzene (µg/kg)	1,2-Dichloro-benzene (µg/kg)	1,3-Dichloro-benzene (µg/kg)	1,4-Dichloro-benzene (µg/kg)	2,2-Oxybis (1-chloro-propane) (µg/kg)	2,4,5-Trichloro-phenol (µg/kg)	2,4,6-Trichloro-phenol (µg/kg)
			CAS Number						
			120-82-1	95-50-1	541-73-1	106-46-7	108-60-1	95-95-4	88-06-2
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--	--
25-27.50	B12ML5	8/27/2001	--	--	--	--	--	--	--
25-27.50	B12ML6	8/27/2001	--	--	--	--	--	--	--
37.50-40	B12C89	8/23/2001	--	--	--	--	--	--	--
48-50.50	B12C91	8/28/2001	--	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	860.00 U	350.00 U
72.50-75	B12MH9	9/21/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	860.00 U	350.00 U
97.50-100	B12MJ0	9/21/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	840.00 U	340.00 U
147.50-150	B12MJ1	9/25/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	850.00 U	340.00 U
219-221.50	B12MJ2	9/26/2001	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U	1,100.00 U	430.00 U

Table C-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Intervals (ft)	HEIS Number	Date	2,4-Dichloro-phenol (µg/kg)	2,4-Dimethyl-phenol (µg/kg)	2,4-Dinitro-phenol (µg/kg)	2,4-Dinitro-toluene (µg/kg)	2,6-Dinitro-toluene (µg/kg)	2-Chloro-naphthalene (µg/kg)	2-Chloro-phenol (µg/kg)
			CAS Number						
			120-83-2	105-67-9	51-28-5	121-14-2	606-20-2	91-58-7	95-57-8
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--	--
25-27.50	B12ML5	8/27/2001	--	--	--	--	--	--	--
25-27.50	B12ML6	8/27/2001	--	--	--	--	--	--	--
37.50-40	B12C89	8/23/2001	--	--	--	--	--	--	--
48-50.50	B12C91	8/28/2001	--	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	350.00 U	350.00 U	860.00 U	350.00 U	350.00 U	350.00 U	350.00 U
72.50-75	B12MH9	9/21/2001	350.00 U	350.00 U	860.00 U	350.00 U	350.00 U	350.00 U	350.00 U
97.50-100	B12MJ0	9/21/2001	340.00 U	340.00 U	840.00 U	340.00 U	340.00 U	340.00 U	340.00 U
147.50-150	B12MJ1	9/25/2001	340.00 U	340.00 U	850.00 U	340.00 U	340.00 U	340.00 U	340.00 U
219-221.50	B12MJ2	9/26/2001	430.00 U	430.00 U	1,100.00 U	430.00 U	430.00 U	430.00 U	430.00 U

Table C-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Intervals (ft)	HEIS Number	Date	2-Methyl-naphthalene (µg/kg)	2-Methyl-phenol (cresol, o-) (µg/kg)	2-Nitroaniline (µg/kg)	2-Nitro-phenol (µg/kg)	3,3-Dichloro-benzidine (µg/kg)	3-Nitroaniline (µg/kg)	4,6-Dinitro-2-methylphenol (µg/kg)	4-Bromo-phenyl-phenyl ether (µg/kg)
			CAS Number							
			91-57-6	95-48-7	88-74-4	88-75-5	91-94-1	99-09-2	534-52-1	101-55-3
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--	--	--
25-27.50	B12ML5	8/27/2001	--	--	--	--	--	--	--	--
25-27.50	B12ML6	8/27/2001	--	--	--	--	--	--	--	--
37.50-40	B12C89	8/23/2001	--	--	--	--	--	--	--	--
48-50.50	B12C91	8/28/2001	--	--	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	350.00 U	350.00 U	860.00 U	350.00 U	350.00 U	860.00 U	860.00 U	350.00 U
72.50-75	B12MH9	9/21/2001	350.00 U	350.00 U	860.00 U	350.00 U	350.00 U	860.00 U	860.00 U	350.00 U
97.50-100	B12MJ0	9/21/2001	340.00 U	340.00 U	840.00 U	340.00 U	340.00 U	840.00 U	840.00 U	340.00 U
147.50-150	B12MJ1	9/25/2001	340.00 U	340.00 U	850.00 U	340.00 U	340.00 U	850.00 U	850.00 U	340.00 U
219-221.50	B12MJ2	9/26/2001	430.00 U	430.00 U	1,100.00 U	430.00 U	430.00 U	1,100.00 U	1,100.00 U	430.00 U

Table C-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Intervals (ft)	HEIS Number	Date	4-Chloro-3-methyl-phenol (µg/kg)	4-Chloro-aniline (µg/kg)	4-Chloro-phenyl-phenyl ether (µg/kg)	4-Methyl-phenol (cresol, p-) (µg/kg)	4-Nitro-aniline (µg/kg)	4-Nitro-phenol (µg/kg)	Acena-phthene (µg/kg)	Acena-phthylene (µg/kg)
			CAS Number							
			59-50-7	106-47-8	7005-72-3	106-44-5	100-01-6	100-02-7	83-32-9	208-96-8
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--	--	--
25-27.50	B12ML5	8/27/2001	--	--	--	--	--	--	--	--
25-27.50	B12ML6	8/27/2001	--	--	--	--	--	--	--	--
37.50-40	B12C89	8/23/2001	--	--	--	--	--	--	--	--
48-50.50	B12C91	8/28/2001	--	--	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	350.00 U	350.00 U	350.00 U	350.00 U	860.00 U	860.00 U	350.00 U	350.00 U
72.50-75	B12MH9	9/21/2001	350.00 U	350.00 U	350.00 U	350.00 U	860.00 U	860.00 U	350.00 U	350.00 U
97.50-100	B12MJ0	9/21/2001	340.00 U	340.00 U	340.00 U	340.00 U	840.00 U	840.00 U	340.00 U	340.00 U
147.50-150	B12MJ1	9/25/2001	340.00 U	340.00 U	340.00 U	340.00 U	850.00 U	850.00 U	340.00 U	340.00 U
219-221.50	B12MJ2	9/26/2001	430.00 U	430.00 U	430.00 U	430.00 U	1,100.00 U	1,100.00 U	430.00 U	430.00 U

Table C-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Intervals (ft)	HEIS Number	Date	Anthracene (µg/kg)	Benzo(a)-anthracene (µg/kg)	Benzo(a)-pyrene (µg/kg)	Benzo(b)-fluoranthene (µg/kg)	Benzo(ghi)-perylene (µg/kg)	Benzo(k)-fluoranthene (µg/kg)	Bis(2-Chloroethoxy) methane (µg/kg)	Bis(2-chloro-ethyl) ether (µg/kg)
			CAS Number							
			120-12-7	56-55-3	50-32-8	205-99-2	191-24-2	207-08-9	111-91-1	111-44-4
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--	--	--
25-27.50	B12ML5	8/27/2001	--	--	--	--	--	--	--	--
25-27.50	B12ML6	8/27/2001	--	--	--	--	--	--	--	--
37.50-40	B12C89	8/23/2001	--	--	--	--	--	--	--	--
48-50.50	B12C91	8/28/2001	--	--	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U
72.50-75	B12MH9	9/21/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U
97.50-100	B12MJ0	9/21/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
147.50-150	B12MJ1	9/25/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
219-221.50	B12MJ2	9/26/2001	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U

Table C-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Intervals (ft)	HEIS Number	Date	Bis(2-ethylhexyl) phthalate (µg/kg)	Butylbenzyl phthalate (µg/kg)	Carbazole (µg/kg)	Chrysene (µg/kg)	Di-n-butyl-phthalate (µg/kg)	Di-n-octyl-phthalate (µg/kg)	Dibenz[a,h] anthracene (µg/kg)	Dibenzo-furan (µg/kg)	Diethyl-phthalate (µg/kg)
			CAS Number								
			117-81-7	85-68-7	86-74-8	218-01-9	84-74-2	117-84-0	53-70-3	132-64-9	84-66-2
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--	--	--	--
25-27.50	B12ML5	8/27/2001	--	--	--	--	--	--	--	--	--
25-27.50	B12ML6	8/27/2001	--	--	--	--	--	--	--	--	--
37.50-40	B12C89	8/23/2001	--	--	--	--	--	--	--	--	--
48-50.50	B12C91	8/28/2001	--	--	--	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U
72.50-75	B12MH9	9/21/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U
97.50-100	B12MJ0	9/21/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
147.50-150	B12MJ1	9/25/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
219-221.50	B12MJ2	9/26/2001	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U

Table C-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Intervals (ft)	HEIS Number	Date	Dimethyl phthalate (µg/kg)	Fluor-anthene (µg/kg)	Fluorene (µg/kg)	Hexachloro-benzene (µg/kg)	Hexachloro-butadiene (µg/kg)	Hexachloro-cyclopenta-diene (µg/kg)	Hexachloro-ethane (µg/kg)	Indeno (1,2,3-cd) pyrene (µg/kg)	Isophorone (µg/kg)
			CAS Number								
			131-11-3	206-44-0	86-73-7	118-74-1	87-68-3	77-47-4	67-72-1	193-39-5	78-59-1
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--	--	--	--
25-27.50	B12ML5	8/27/2001	--	--	--	--	--	--	--	--	--
25-27.50	B12ML6	8/27/2001	--	--	--	--	--	--	--	--	--
37.50-40	B12C89	8/23/2001	--	--	--	--	--	--	--	--	--
48-50.50	B12C91	8/28/2001	--	--	--	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U
72.50-75	B12MH9	9/21/2001	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U	350.00 U
97.50-100	B12MJ0	9/21/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
147.50-150	B12MJ1	9/25/2001	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U	340.00 U
219-221.50	B12MJ2	9/26/2001	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U	430.00 U

Table C-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (8 sheets)

Intervals (ft)	HEIS Number	Date	N-Nitroso-di-n-dipropyl-amine (µg/kg)	N-Nitrosodi-phenylamine (µg/kg)	Naphthalene (µg/kg)	Nitro-benzene (µg/kg)	Pentachloro-phenol (µg/kg)	Phenan-threne (µg/kg)	Phenol (µg/kg)	Pyrene (µg/kg)	Tributyl phosphate (µg/kg)
			CAS Number								
			621-64-7	86-30-6	91-20-3	98-95-3	87-86-5	85-01-8	108-95-2	129-00-0	126-73-8
0-0.50	B12683	6/19/2001	--	--	--	--	--	--	--	--	--
2.50-5	B12MH5	8/22/2001	--	--	--	--	--	--	--	--	--
5.50-8	B12MH6	8/22/2001	--	--	--	--	--	--	--	--	--
10-12.50	B12MH7	8/22/2001	--	--	--	--	--	--	--	--	--
12.50-15	B12MH4	8/23/2001	--	--	--	--	--	--	--	--	--
18.50-21	B12C89	8/23/2001	--	--	--	--	--	--	--	--	--
22.50-25	B12DC1	8/24/2001	--	--	--	--	--	--	--	--	--
25-27.50	B12ML4	8/26/2001	--	--	--	--	--	--	--	--	--
25-27.50	B12ML5	8/27/2001	--	--	--	--	--	--	--	--	--
25-27.50	B12ML6	8/27/2001	--	--	--	--	--	--	--	--	--
37.50-40	B12C89	8/23/2001	--	--	--	--	--	--	--	--	--
48-50.50	B12C91	8/28/2001	--	--	--	--	--	--	--	--	--
48-50.50	B12ML7	8/28/2001	--	--	--	--	--	--	--	--	--
72.50-75	B12MH8	9/21/2001	350.00 U	350.00 U	350.00 U	350.00 U	860.00 U	350.00 U	350.00 U	350.00 U	350.00 U
72.50-75	B12MH9	9/21/2001	350.00 U	350.00 U	350.00 U	350.00 U	860.00 U	350.00 U	350.00 U	350.00 U	350.00 U
97.50-100	B12MJ0	9/21/2001	340.00 U	340.00 U	340.00 U	340.00 U	840.00 U	340.00 U	340.00 U	340.00 U	340.00 U
147.50-150	B12MJ1	9/25/2001	340.00 U	340.00 U	340.00 U	340.00 U	850.00 U	340.00 U	340.00 U	340.00 U	340.00 U
219-221.50	B12MJ2	9/26/2001	430.00 U	430.00 U	430.00 U	430.00 U	1,100.00 U	430.00 U	430.00 U	430.00 U	430.00 U

-- = Not analyzed.
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.

Table C-18. 216-B-7A Borehole - Diesel Range Organic Analytical Data.

Sample Interval (ft)	HEIS Number	Date	Diesel Oil (mg/kg)	Total Petroleum Hydrocarbons - Motor Oil (high boiling) (mg/kg)
			CAS Number	
			68334-30-5	TPH/OILH
0-0.50	B12683	6/19/2001	--	--
2.50-5	B12MH5	8/22/2001	--	--
5.50-8	B12MH6	8/22/2001	--	--
10-12.50	B12MH7	8/22/2001	--	--
12.50-15	B12MH4	8/23/2001	--	--
18.50-21	B12C89	8/23/2001	--	--
22.50-25	B12DC1	8/24/2001	--	--
25-27.50	B12ML4	8/26/2001	--	--
30-32.50	B12ML5	8/27/2001	--	--
35-37.50	B12ML6	8/27/2001	--	--
48-50.50	B12ML7	8/28/2001	--	--
48-50.50 Split	B12C91	8/28/2001	--	--
72.50-75	B12MH8	9/21/2001	12 U	--
72.50-75 Duplicate	B12MH9	9/21/2001	12 U	--
97.50-100	B12MJ0	9/21/2001	12 U	--
147.50-150	B12MJ1	9/25/2001	12 U	--
219-221.50	B12MJ2	9/26/2001	12 U	12 U

-- = Not analyzed.
CAS = Chemical Abstract Services registry number.
HEIS = Hanford Environmental Information System.
U = Analyzed for but not detected above the minimum detectable activity in the sample. The value reported as the result.

Table C-19. Summary of TCLP Results for the 216-B-7A Crib Borehole.

Constituent	Sample Number	Maximum Concentration of Contaminants for the Toxicity Characteristic (mg/L)[a]	TCLP Concentration (mg/L)
Lead	B12C89	5.0	0.0796 B
	B12DC1		0.023 B
	B12ML4		0.0461 B
Chromium	B12C89	5.0	0.0238 B

[a]WAC 173-303-090.
B = The associated QC sample blank has a result greater than two times the minimum detectable level (MDL).
MDL = minimum detectable level.
QC = quality control.

APPENDIX D

MODELING

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APPENDIX D

MODELING

Figure D-1. 216-B-46 Crib Contaminant Profile Data and Matching Model Input for Cesium-137, Total Beta Radiostrontium, Cobalt-60, and Plutonium-238.

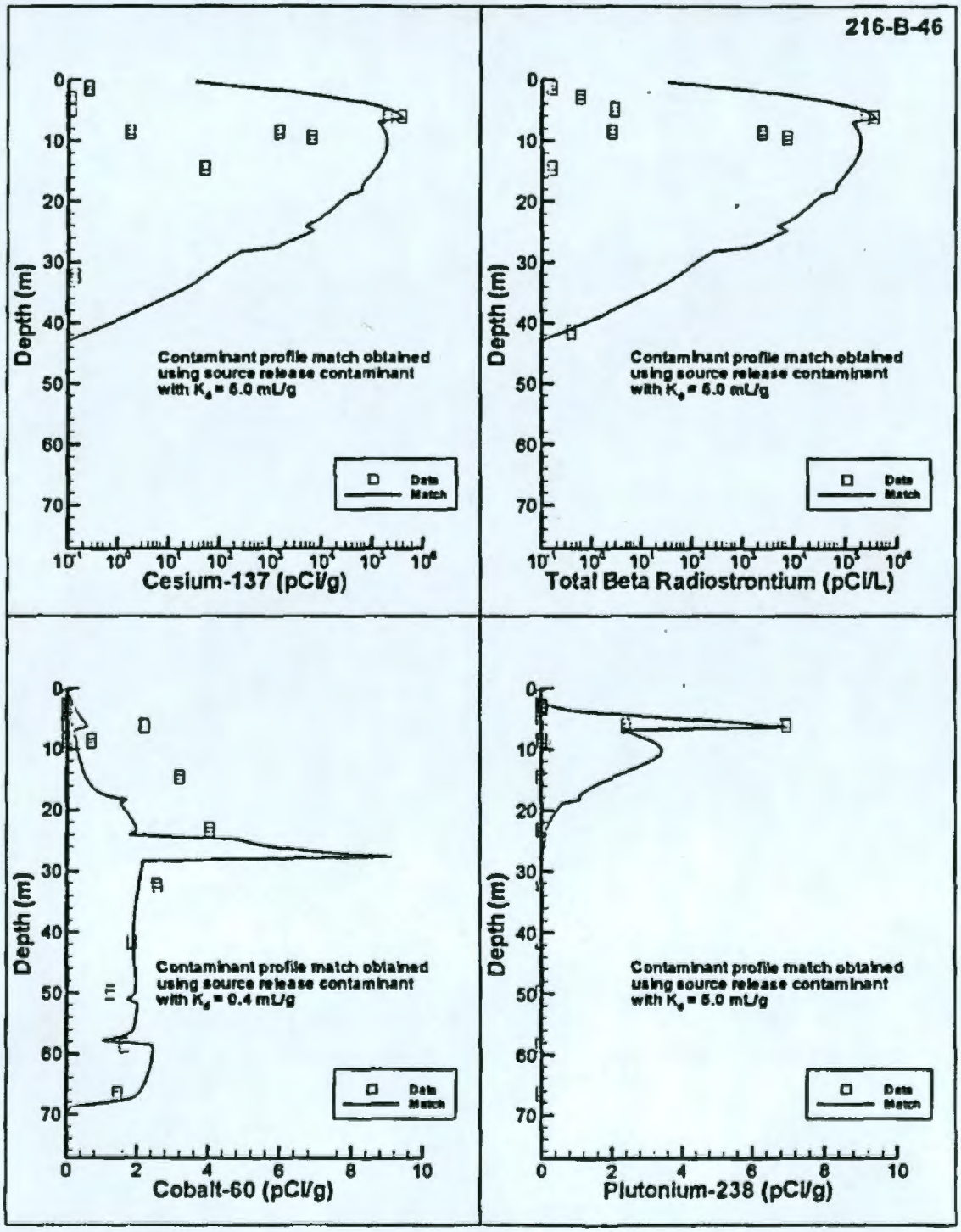


Figure D-2. 216-B-46 Crib Contaminant Profile Data and Matching Model Input for Total Uranium, Technetium-99, Radium-226, and Plutonium-239/240.

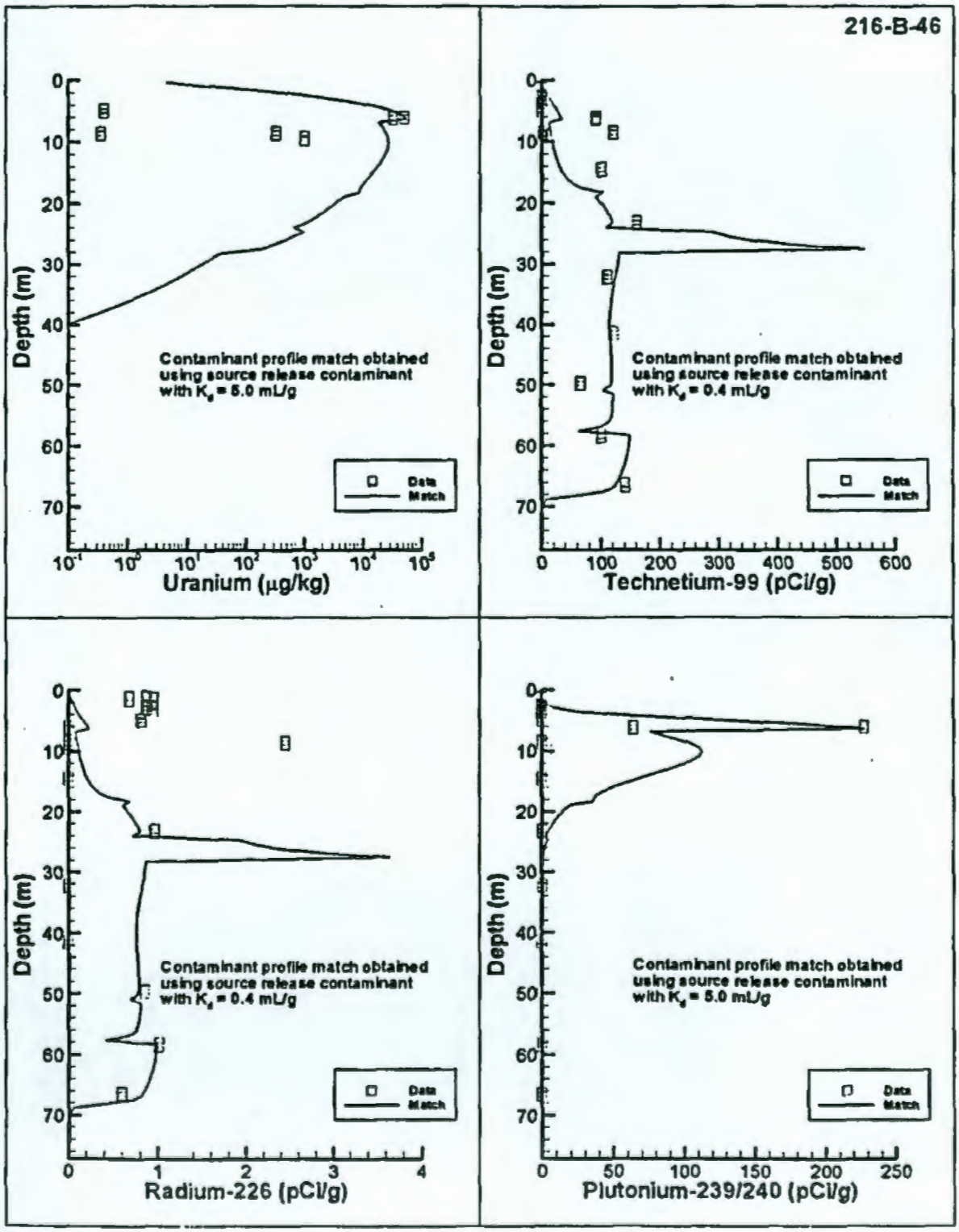


Figure D-3. 216-B-46 Crib Contaminant Profile Data and Matching Model Input for Cyanide, Nitrate, Nitrite, and Sulfate.

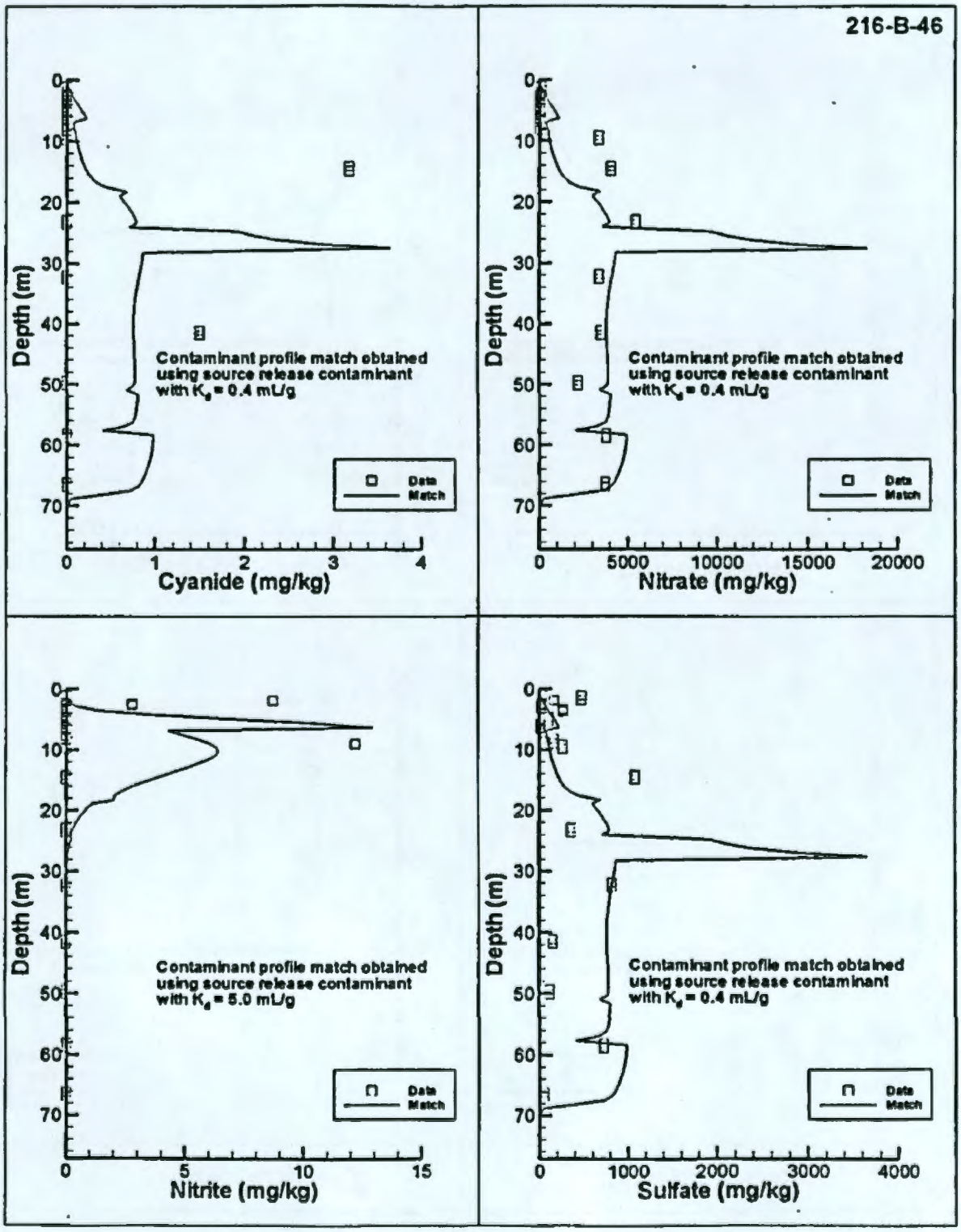


Figure D-4. 216-B-46 Crib Contaminant Profile Data and Matching Model Input for Tritium.

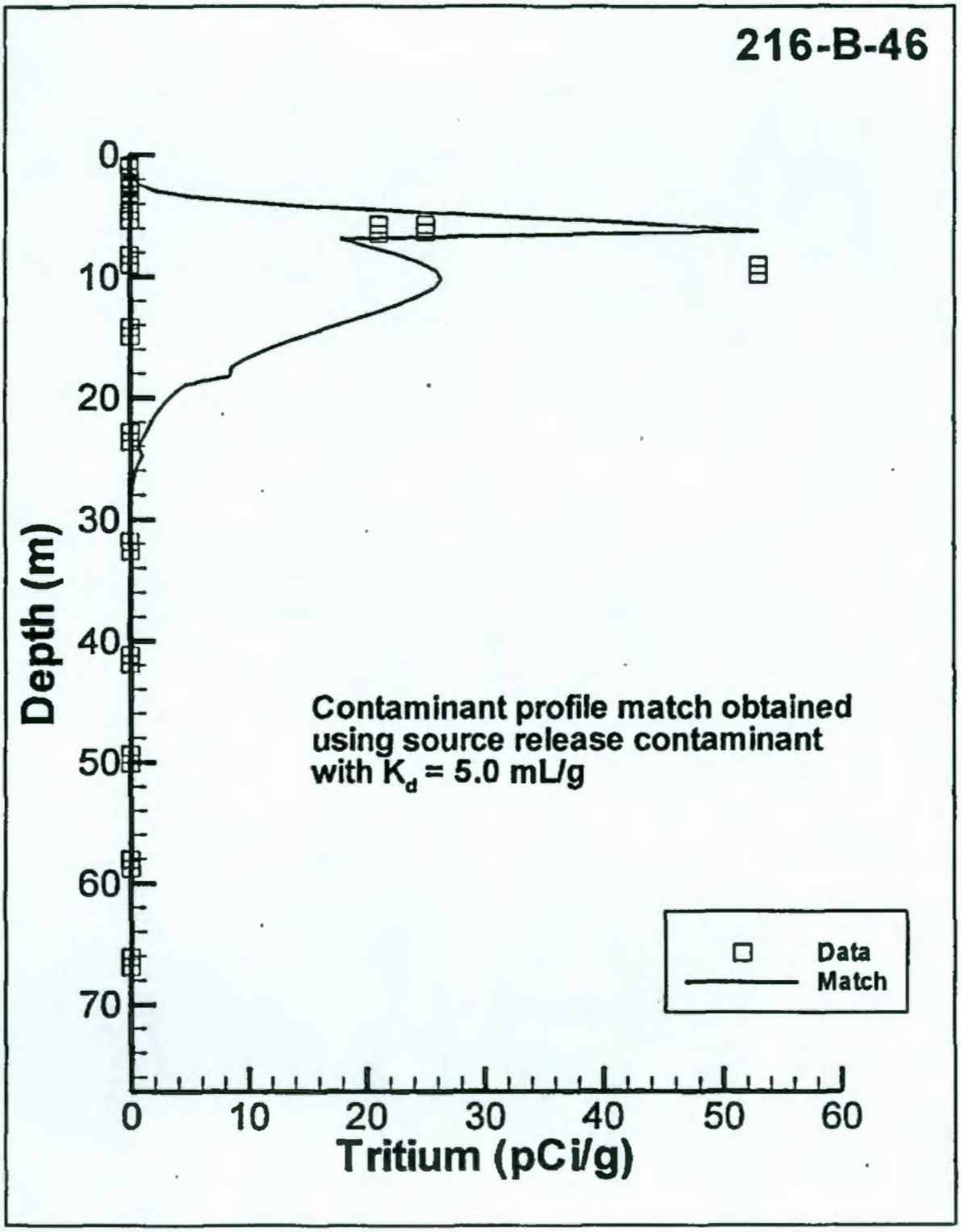


Figure D-5. 216-T-26 Crib Contaminant Profile Data and Matching Model Input for Tritium, Total Beta Radiostrontium, Americium-241, and Cesium-137.

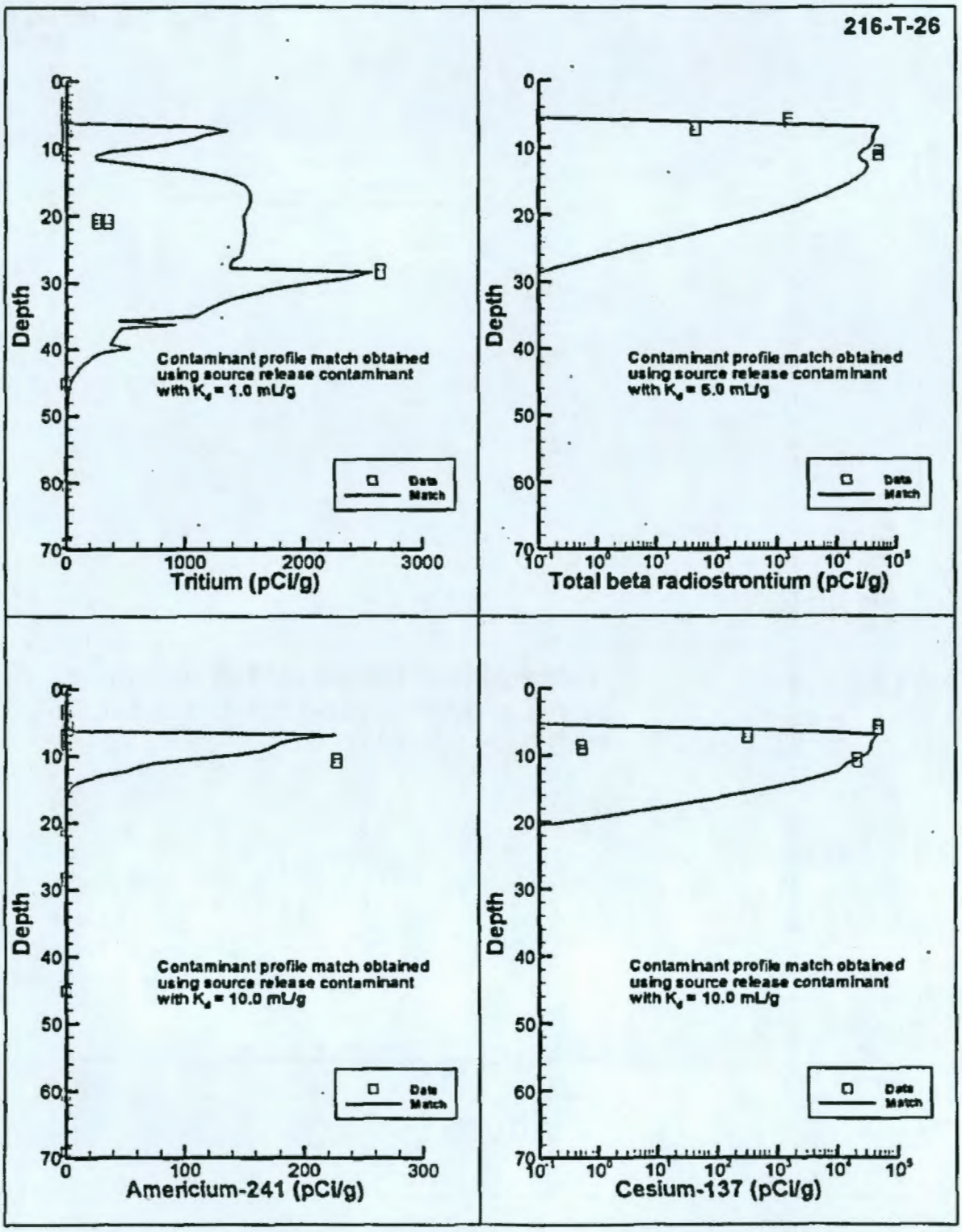


Figure D-6. 216-T-26 Crib Contaminant Profile Data and Matching Model Input for Technetium-99, Uranium-233/234, Uranium-235, and Uranium-238.

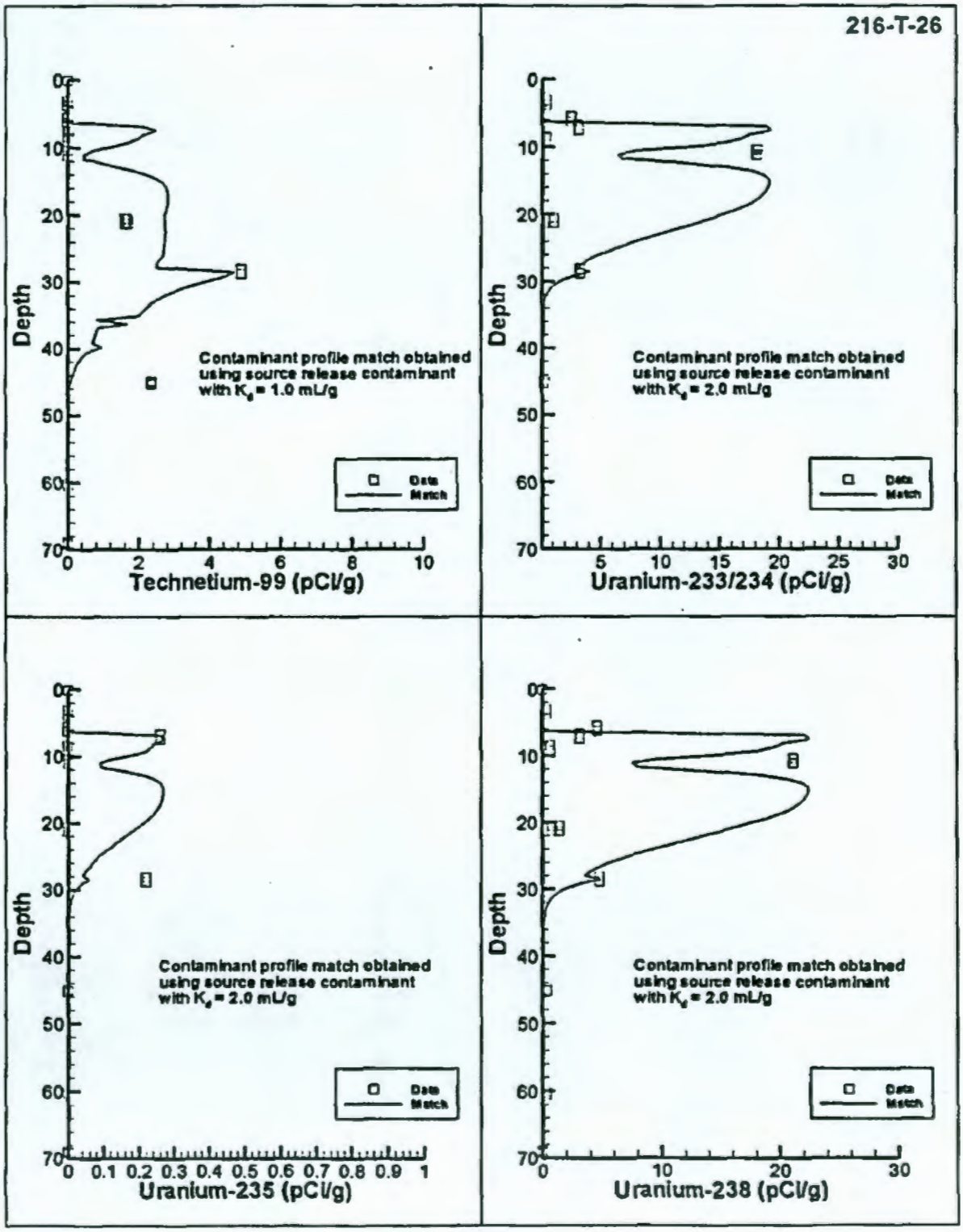


Figure D-7. 216-T-26 Crib Contaminant Profile Data and Matching Model Input for Europium-154, Europium-155, Plutonium-238, and Plutonium-239/240.

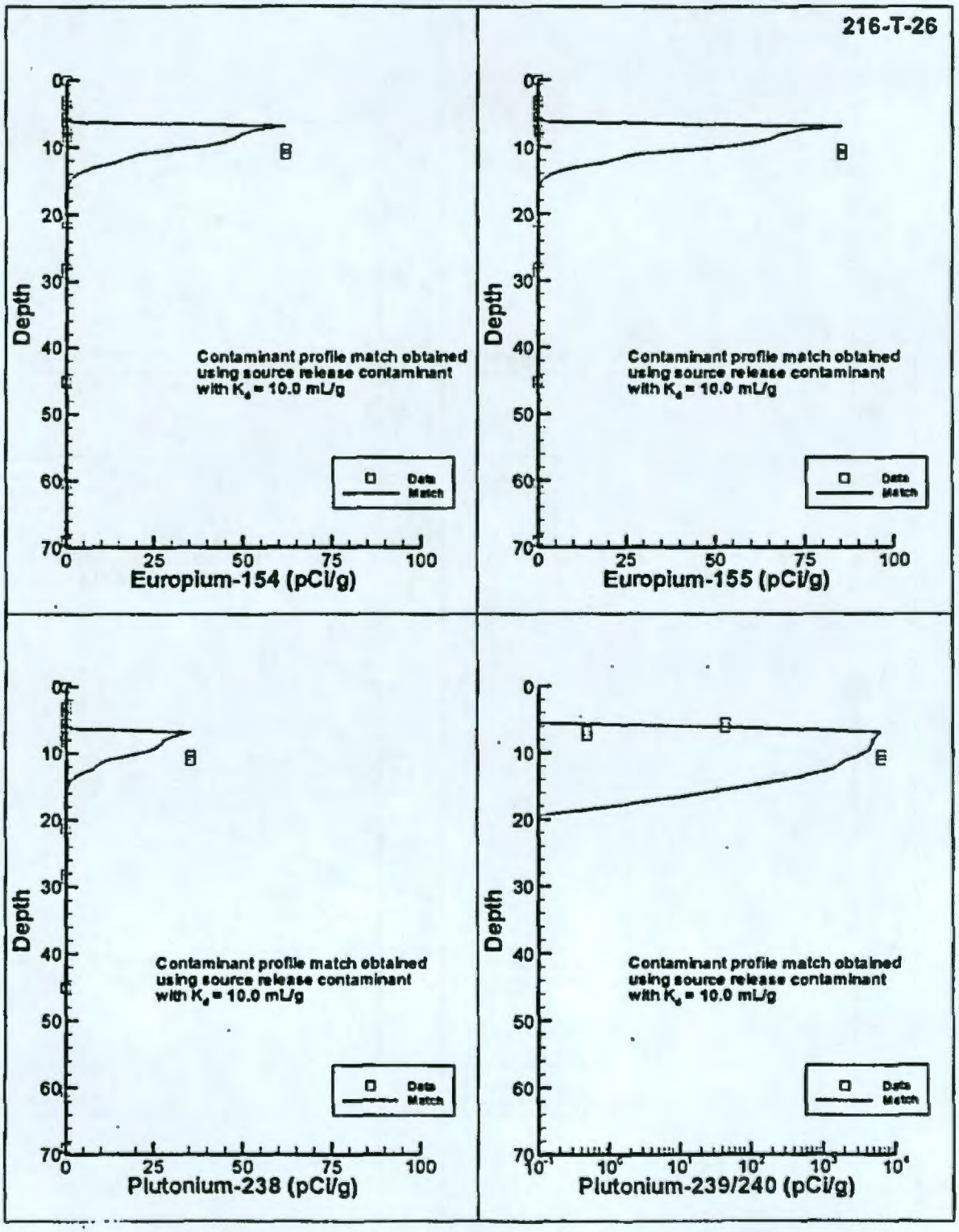


Figure D-8. Crib Contaminant Profile Data and Matching Input for Cyanide, Nitrate, and Nitrite.

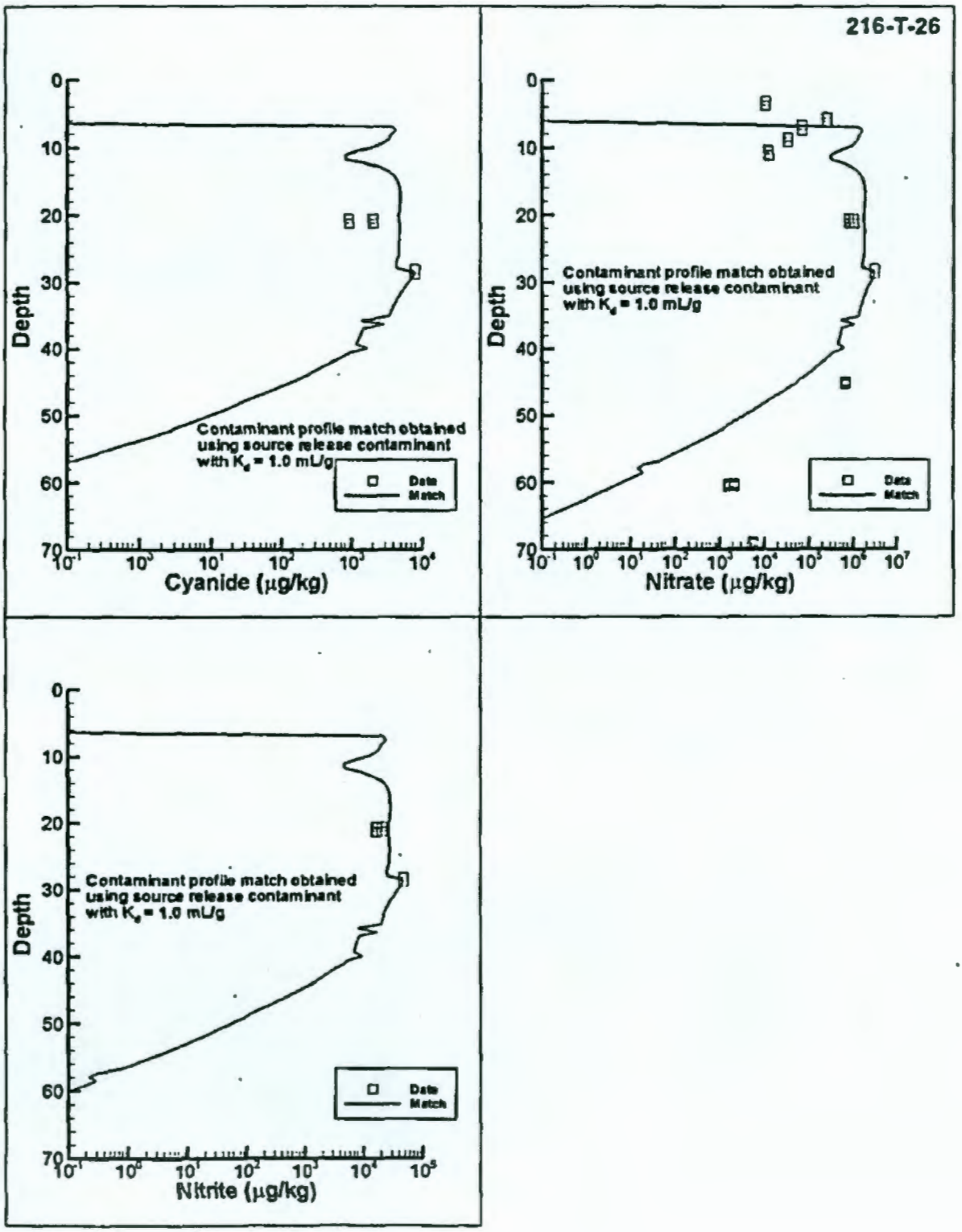


Figure D-9. 216-B-7A Crib Contaminant Profile Data and Matching Model Input for Carbon-14, Cesium-137, Plutonium-238, and Plutonium-239/240.

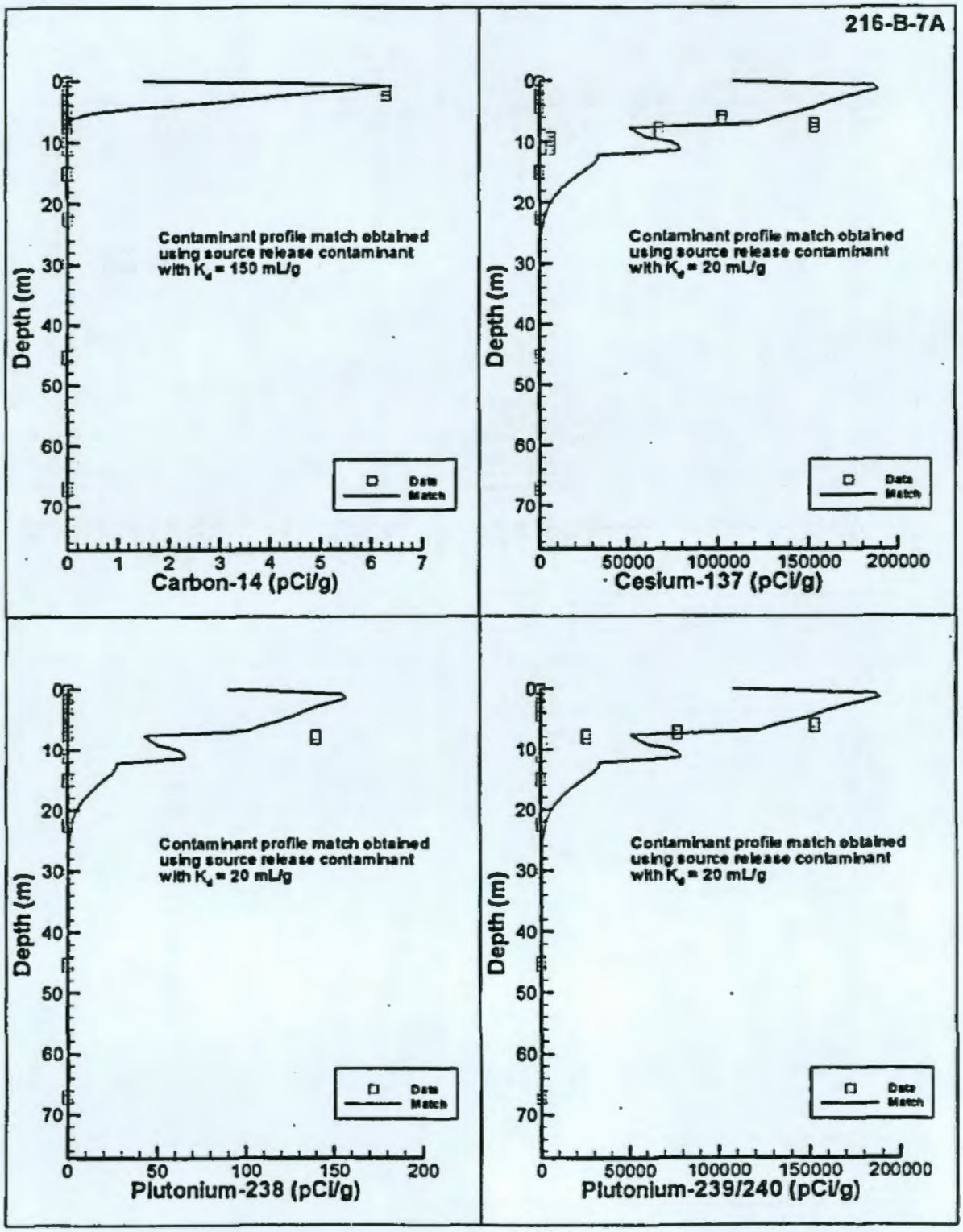


Figure D-10. 216-B-7A Crib Contaminant Profile Data and Matching Model Input for Technetium-99, Total Beta Radiostrontium, Fluoride, and Nitrate.

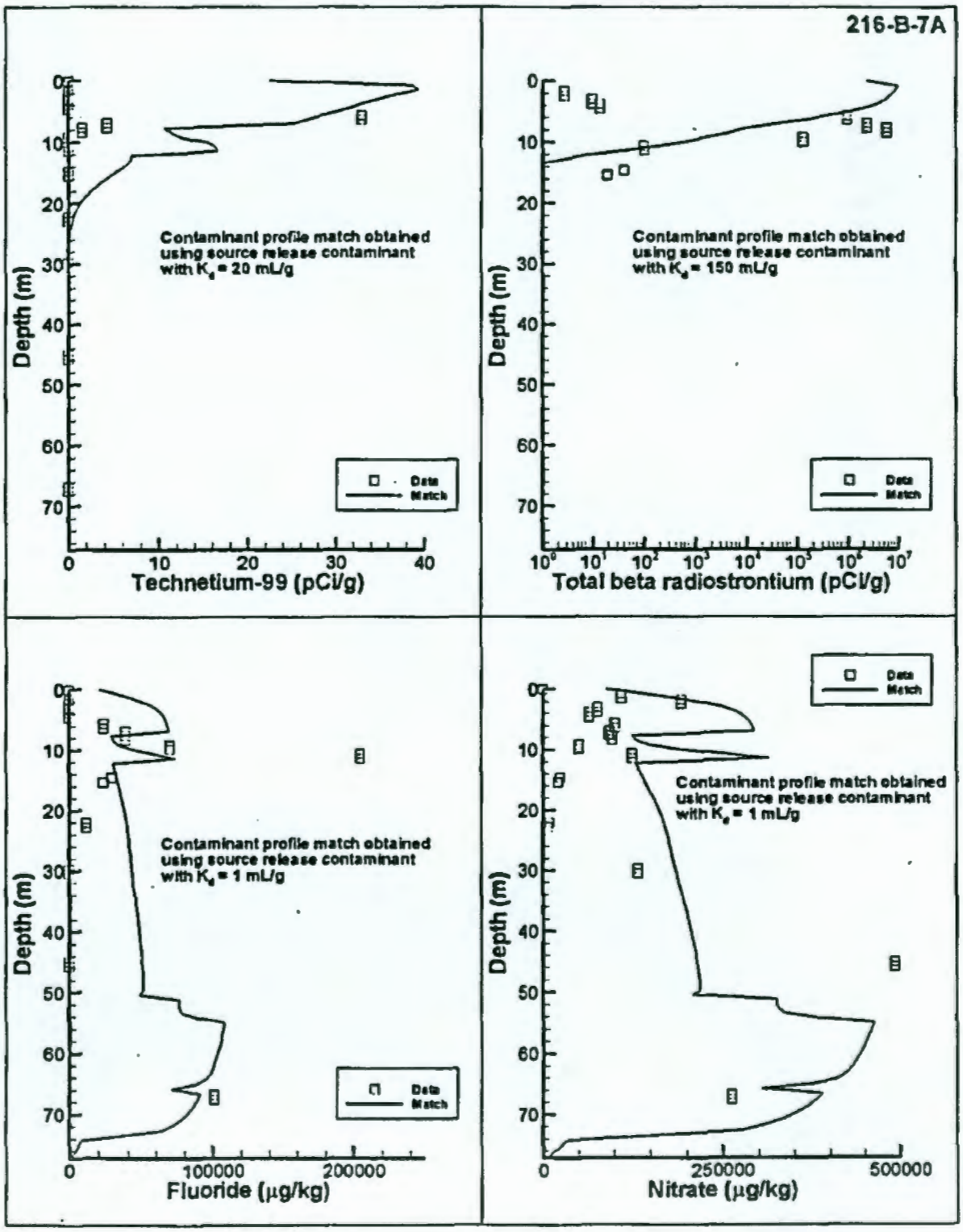


Figure D-11. 216-B-7A Crib Contaminant Profile Data and Matching Model Input for Tritium, Uranium-233/234, Uranium-235, and Uranium-238.

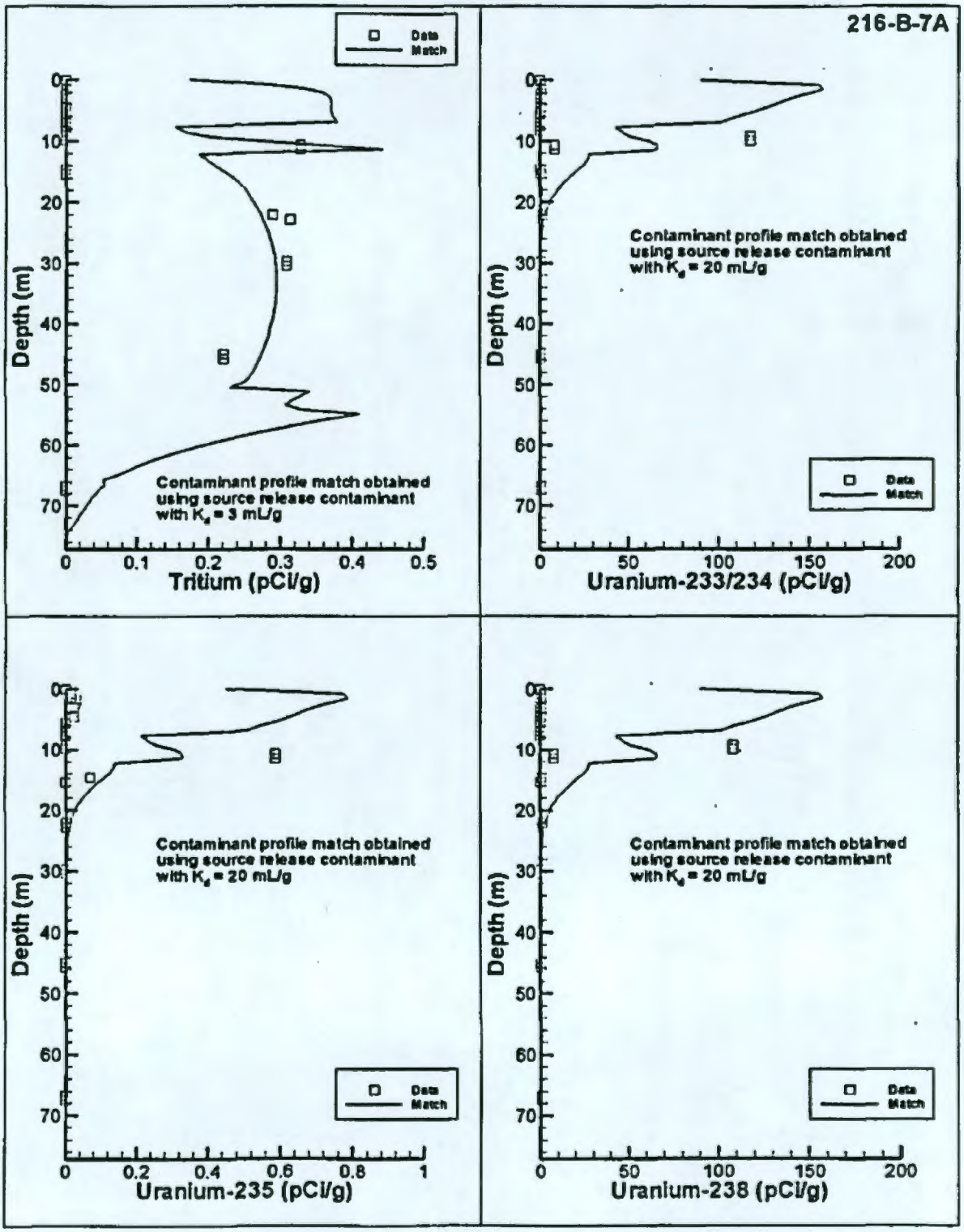


Figure D-12. 216-B-7A Crib Contaminant Profile Data and Matching Model Input for Americium-241, Europium-154, and Potassium-40.

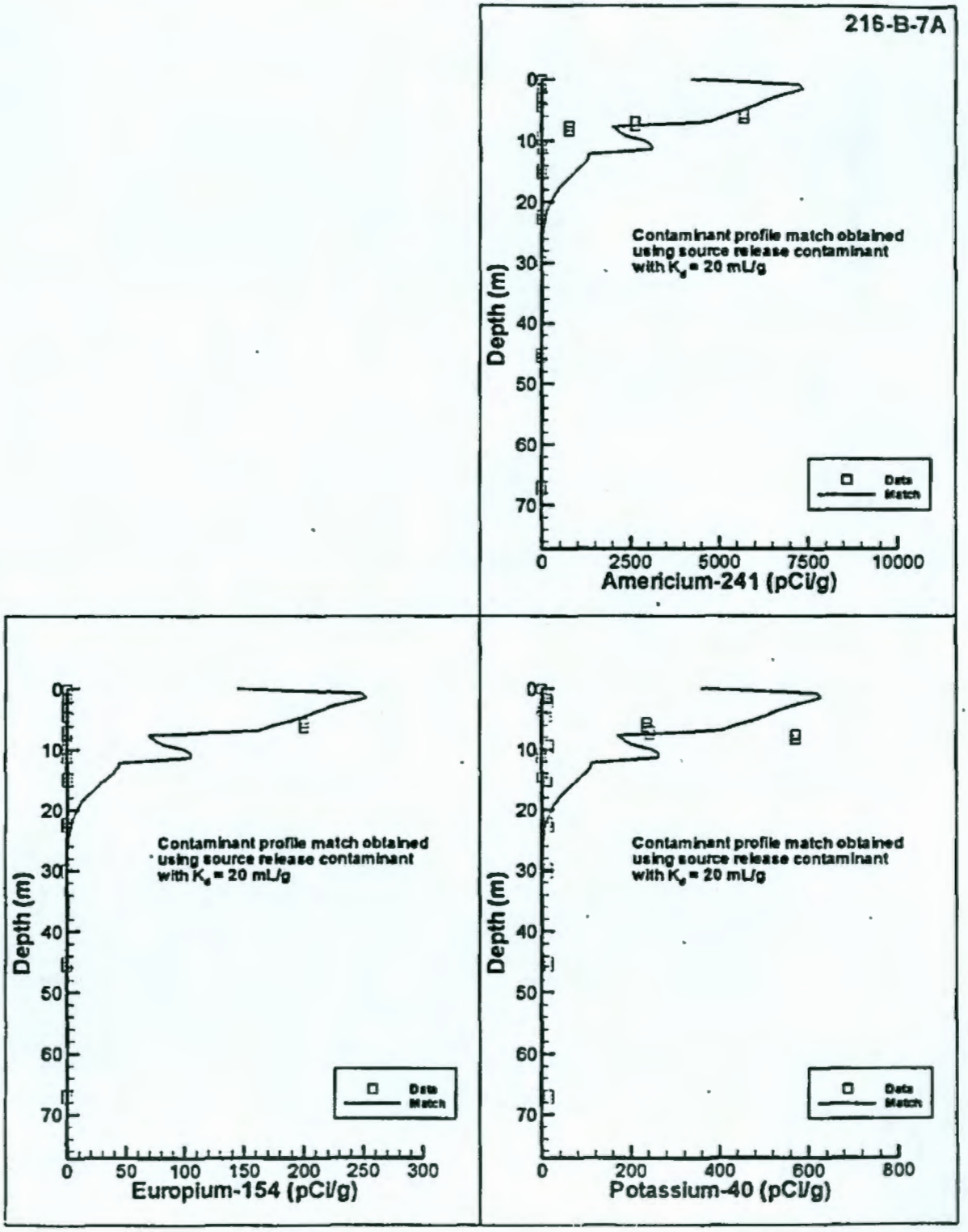


Figure D-13. 216-B-38 Trench Contaminant Profile Data and Matching Model Input for Technetium-99, Tritium, Uranium-233/234, and Uranium-238.

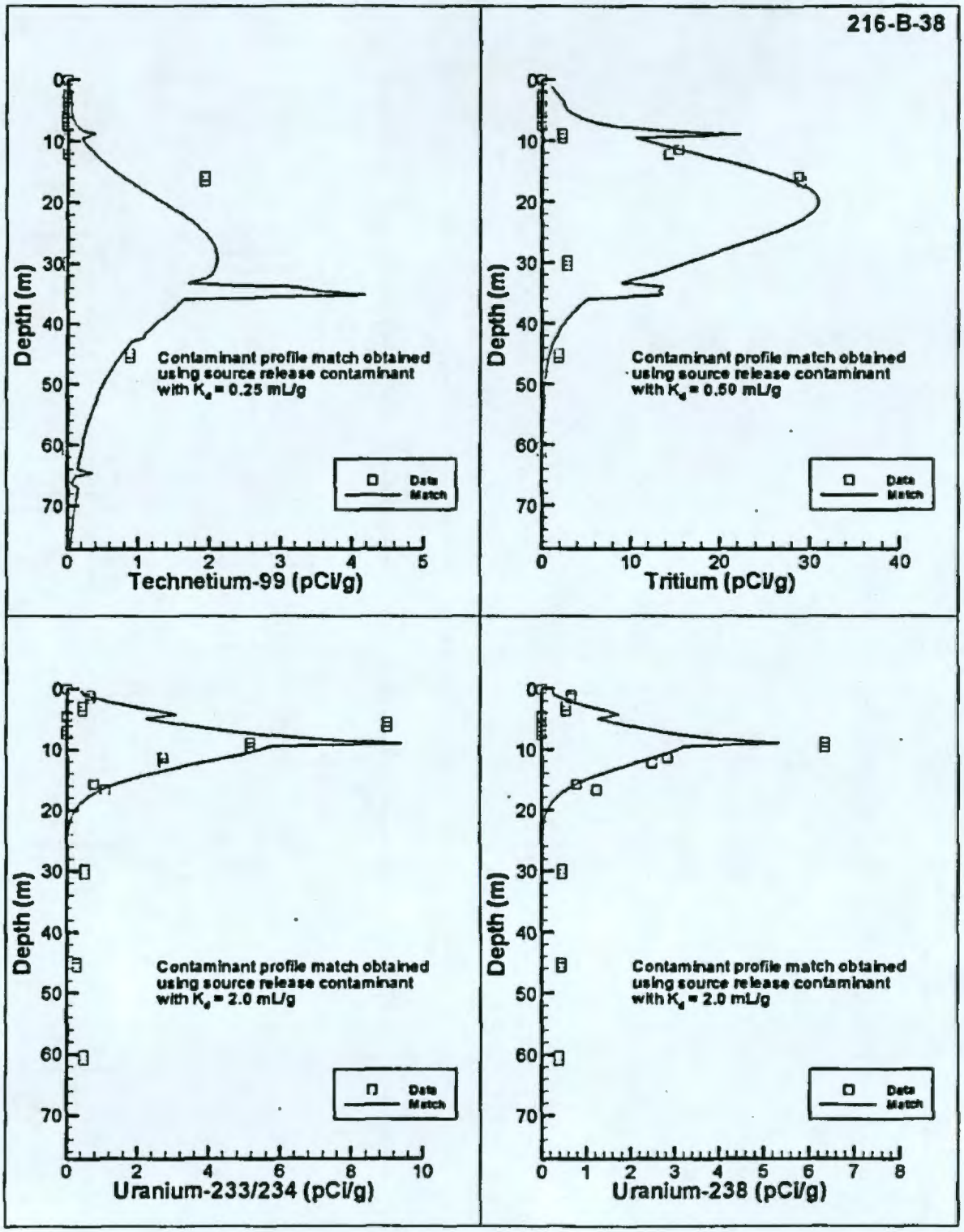


Figure D-14. 216-B-38 Trench Contaminant Profile Data and Matching Model Input for Fluoride, Nitrate, Nitrite, and Potassium-40.

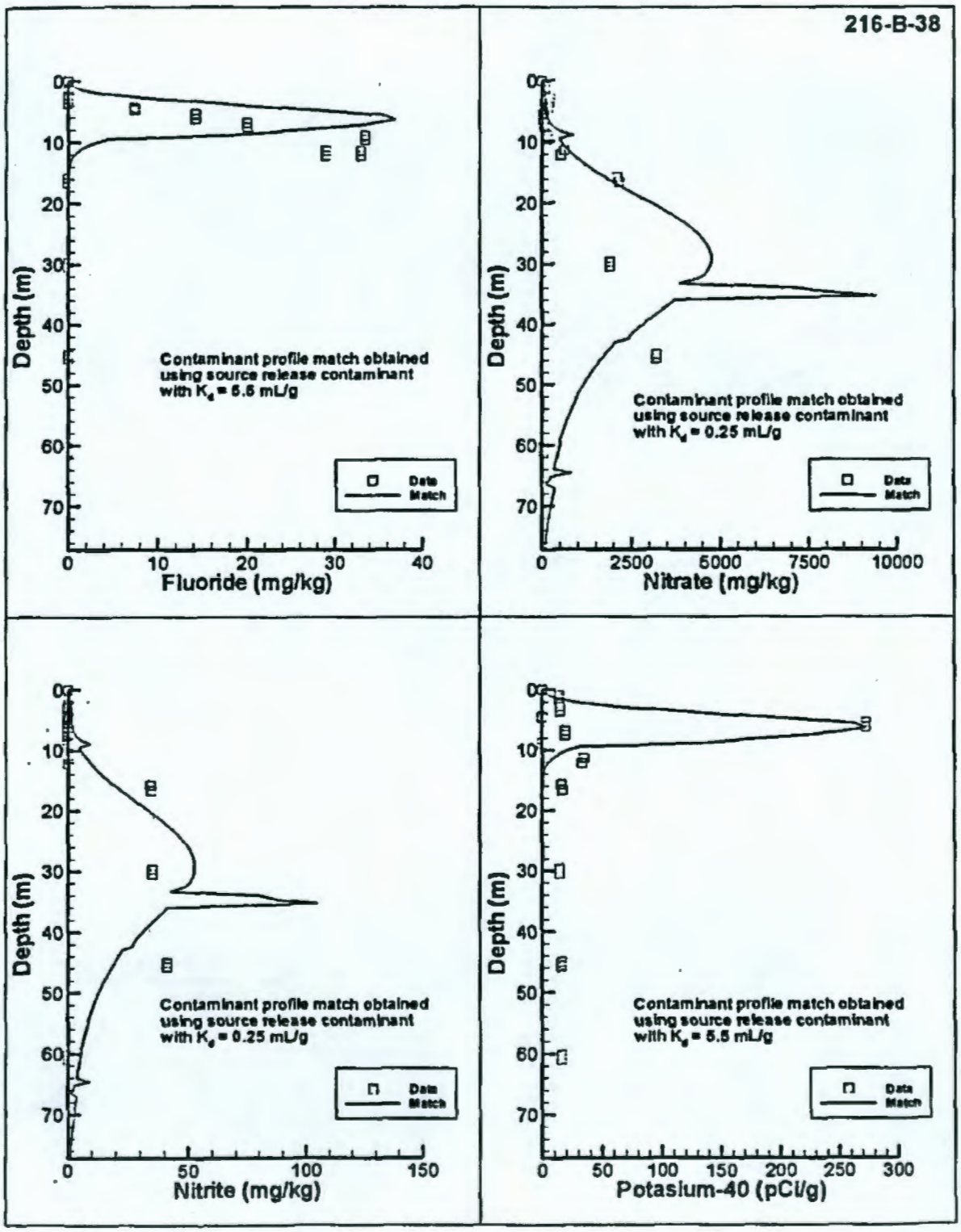
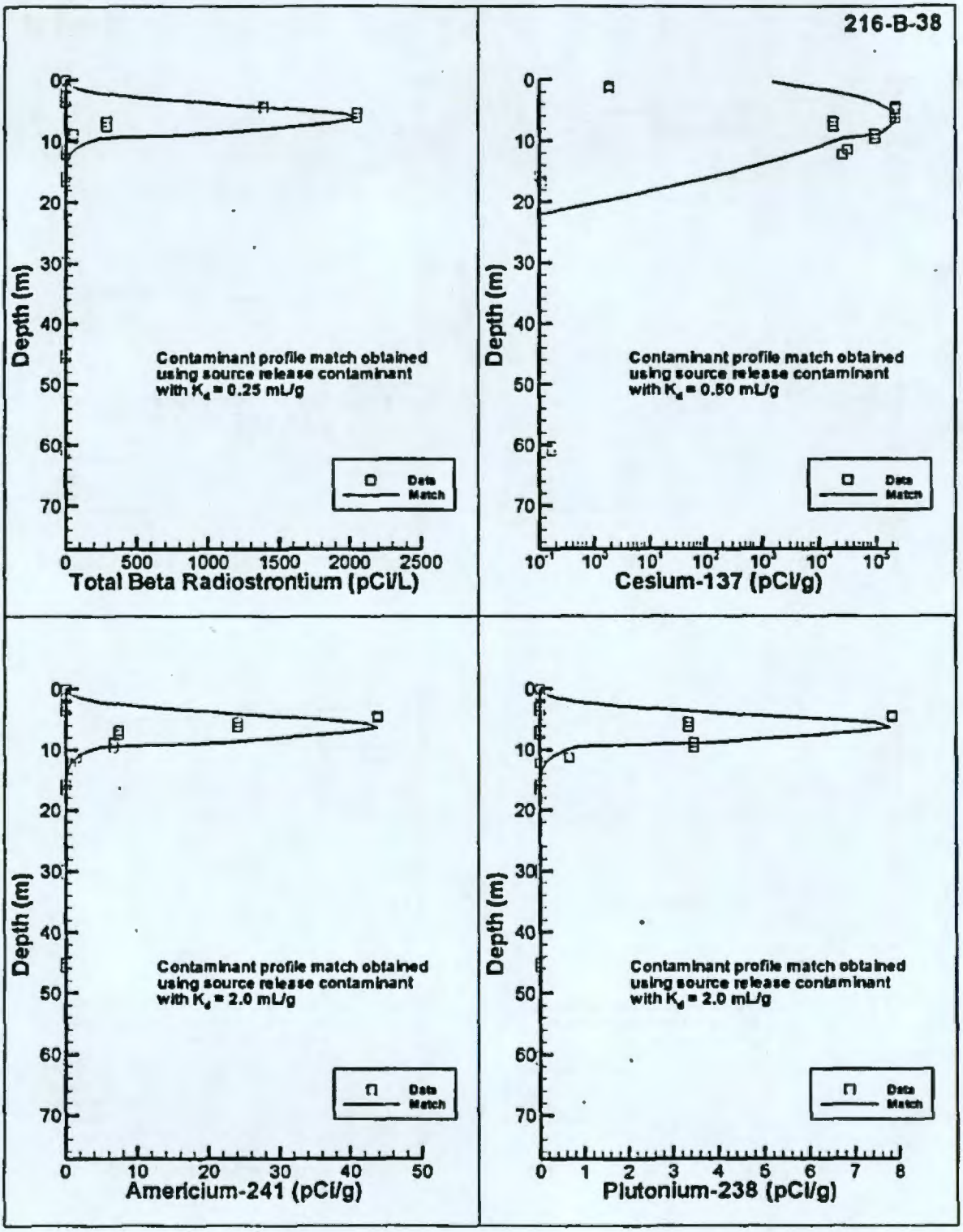


Figure D-15. 216-B-38 Trench Contaminant Profile Data and Matching Model Input for Total Beta Radiostrontium, Cesium-137, Americium-241, and Plutonium-238.



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