DOE/RL-2002-42
Draft A

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

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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ACRONYMS

ARAR	applicable or relevant and appropriate requirement
ASTM	American Society of Testing and Materials
BCG	biota concentration guides
BDAC	Biota Dose Assessment Committee
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CLUP-EIS	*Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*
COC	contaminant of concern
COEC	contaminant of ecological concern
COPC	contaminant of potential concern
CPP	CERCLA past-practice
CSM	conceptual site model
CUL	cleanup level
CZ	contaminated zone
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
HI	hazard index
HQ	hazard quotient
HSRAM	*Hanford Site Risk Assessment Methodology*
ILCR	incremental lifetime cancer risk
K_d	distribution coefficient
MCL	maximum contamination level
MTCA	*Model Toxics Control Act*
NEPA	*National Environmental Policy Act of 1969*
ORNL	Oak Ridge National Laboratory
OU	operable unit
PUREX	plutonium/uranium extraction
QA/QC	quality assurance/quality control
QRA	qualitative risk assessment
RAO	remedial action objective
RAWP	remedial action work plan
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR	remedial design report
REDOX	Reduction/oxidation
RI	remedial investigation

RLS	radionuclide logging system
ROD	record of decision
RPP	RCRA past-practice
SVOC	semi-volatile organic compound
TAL	target analyte list
TCL	target compound list
TCLP	toxicity characteristic leaching potential
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

METRIC CONVERSION CHART

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

1.0 INTRODUCTION

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. 1998) 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 Area waste sites. The revised approach allows 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. The 200-TW-1 and 200-TW-2 OU 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 the M-013-23 and M-013-24 milestones. A single report will be prepared in fulfillment of Tri-Party Agreement milestone M-15-41B for submittal of RI reports for these OUs. Also, 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 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. 1998). 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 ensure that applicable regulatory requirements are met. Details of this integration for the 200 Areas are presented in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (hereinafter referred to as the Implementation Plan) (DOE-RL 1999) and in the *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan* (DOE-RL 2001).

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 one associated unplanned release (UPR) site as defined in the

Implementation Plan) (DOE-RL 1999). The 200-TW-2 OU consists of 27 RCRA past-practice (RPP) waste sites and one 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 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 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 2001 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 the Implementation Plan (DOE-RL 1999) and the 200-TW-1 and 2 Work Plan (DOE-RL 2001). 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 were also 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). 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

This RI report evaluates the data generated during the RI and other characterization activities to determine the need to proceed with a FS, and determines 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 applicable or relevant and appropriate requirements (ARARs), risk reduction, and potential significant data gaps, if any. The RI report includes an evaluation of the baseline risk using characterization data generated during the RI and significant data from other investigations. Risk is evaluated for nonradiological constituents using the *Hanford Site Risk Assessment Methodology* (HSRAM)

(DOE-RL 1995c), CERCLA, and *Model Toxics Control Act* (MTCA) (*Washington Administrative Code* [WAC] 173-340) guidance. Risk from radiological constituents is evaluated through the RESRAD computer dose model. Fate and transport modeling using the STOMP code are included in the RI report as an evaluation of the protection of groundwater.

1.2 SUPPORTING DOCUMENTS AND REMEDIAL INVESTIGATION BASIS

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

- *Waste Site Grouping for the 200 Areas Soil Investigations* (DOE-RL 1997) – 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.

- *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (DOE-RL 1999) – 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, 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 (RAOs), and presents a discussion of potentially feasible remedial technologies that may be used in the 200 Areas.

- *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan* (DOE-RL 2001) – 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; identifies preliminary remedial action alternatives that are likely to be considered for remediation of the OU.

- *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* (Todd 2000) – presents existing information and develops a strategy for data collection and quality, 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.

- *200-TW-1 Operable Unit Borehole Summary Report* (Todd and Kahler-Royer 2002) and *200-TW-2 Operable Unit Borehole Summary Report* (Todd and Trice 2002) –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 are also summarized in Section 2.0 of this RI report).

- *216-B-5 Reverse Well Characterization Study* (Smith 1980) – provides data on the nature and extent of contaminants at the waste site (Smith 1980).

- *Phase I Remedial Investigation Report for 200-BP-1 Operable Unit* (DOE-RL 1993b) – 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 waste site in 200-PW-5.

- *Hanford 200 Areas Spectral Gamma Baseline Characterization Project, 216-B-35 to 216-B-42 Trenches Waste Site Summary Report* (MACTEC-ERS 2002) – 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, 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 data quality assessment (DQA) was performed. The data were collected under the 200-TW-1 and 200-TW-2 Work Plan and Sampling and Analysis Plan (DOE-RL 2001) based on the DQOs established for these OUs (Todd 2000). In accordance with the quality assurance/quality control (QA/QC) procedures specified in the work plan, at least 10% of all data were validated. A detailed description of the data validation effort is presented in Appendix A.

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 MTCA and other human health regulatory standards
- Evaluation of impacts to groundwater through fate and transport modeling.

Details of this evaluation are provided in Section 5.0.

1.3.1 Initial Data Screening

The entire data set was initially screened and nondetected constituents were eliminated from further consideration. Because of the limited number of samples, 95% 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 the *Hanford Site Background: Part 1, Soil Background for Inorganics* (DOE-RL 1995a); the *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE-RL 1996); and *Natural Background Soil Metals Concentrations in Washington State* (Ecology 1994). 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 Risk Evaluation

The risk evaluation for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs is based on EPA, HSRAM, and MTCA risk assessment guidance. Radiological constituents are addressed through a dose evaluation as described in Section 1.3.3, and the dose is then 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 area around the 200 East and 200 West Areas has been designated as industrial-exclusive in the *Final Hanford Comprehensive Land Use Plan Environmental Impact Statement* (CLUP-EIS) (DOE 1999a). All of the 200-TW-1, 200-TW-2, and 200-PW-5 OU waste sites are located within this exclusive-use boundary. The industrial exposure scenario is used to evaluate each representative site.

Risks from nonradiological noncarcinogens are evaluated by calculating hazard quotients (HQs) 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 are also evaluated by comparison to risk-based standards such as the MTCA cleanup levels. Radionuclides are also evaluated for dose rates through time.

Data collected during the RI directly support human health and ecological evaluations. Contaminant data from the soil sampling conducted in the RI are compared against MTCA ecological soil indicator concentrations as the beginning step of a screening-level evaluation of ecological risk from nonradiological constituents. For radiological constituents, no promulgated screening or cleanup levels are available. Biota concentration guides from the U.S. Department of Energy's (DOE) *Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE-ORNL 2000) are used in this evaluation of radiological constituents.

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 RESRAD. The direct exposure modeling is meant to evaluate dose in relation to direct exposure standards for the public and workers. The dose was also converted to a risk value for comparison to accepted EPA and MTCA risk ranges. Input parameters were developed based on previous Hanford Site RESRAD modeling activities, 200 Area-specific geologic and hydrogeologic information sources, and data collected as part of the RI report.

Protection of groundwater was evaluated for nonradiological constituents based on existing regulatory requirements (i.e., MTCA protection of groundwater standards). Fate and transport modeling for nonradiological constituents was conducted for those constituents with no MTCA standard or if the MTCA standard is exceeded and additional evaluation is warranted. Protection of groundwater was evaluated for radiological constituents through fate and transport modeling using the STOMP code developed by the Pacific Northwest National Laboratory.

1.3.4 Analogous Site Approach

The representative waste sites evaluated in this RI report were identified as being representative of sites within their respective OUs; 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 can be performed at the analogous waste sites rather than full characterization efforts, thereby optimizing investigations in support of RI/FS decision making.

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 (Section 3.3). 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 selection of a preferred alternative (or alternatives if site conditions warrant different actions). The analogous sites will then be compared to the revised models within the FS, and the preferred alternative will be assumed for those sites conforming to the contaminant distribution models.

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. A separate DQO process will be conducted to identify data needs and quality requirements to support the confirmatory sampling design. A permit modification will also be prepared to incorporate the corrective action of the RPP sites into the Hanford 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 the *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan* (DOE-RL 2001).

1.4.1 216-B-46 Crib

The 216-B-46 Crib is an inactive liquid waste disposal site that received effluent from U Plant via the 241-BY Tank between September and December of 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 1991). The crib was fed by a central pipe that branched into a chevron pattern to feed 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 (Stenner et al. 1988).

The crib received approximately 6,700,000 L (1,800,000 gal) of uranium recovery process bismuth/phosphate waste that had also 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 (Maxfield 1979, WHC 1991, Brown et al. 1990). 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 T Plant as metal waste and first-cycle waste that had been recovered through the URP and scavenged at U Plant. The waste was transferred back to the TY Tank Farm to allow the sludge to settle; the liquid effluent was then discharged to the crib (WHC 1992, Stenner et al. 1988). 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 241-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 (WHC 1991). 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 302 ft (92 m) and perforated from 74 m 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&B 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&B Crib.

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 gallons) 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&B 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 of 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.

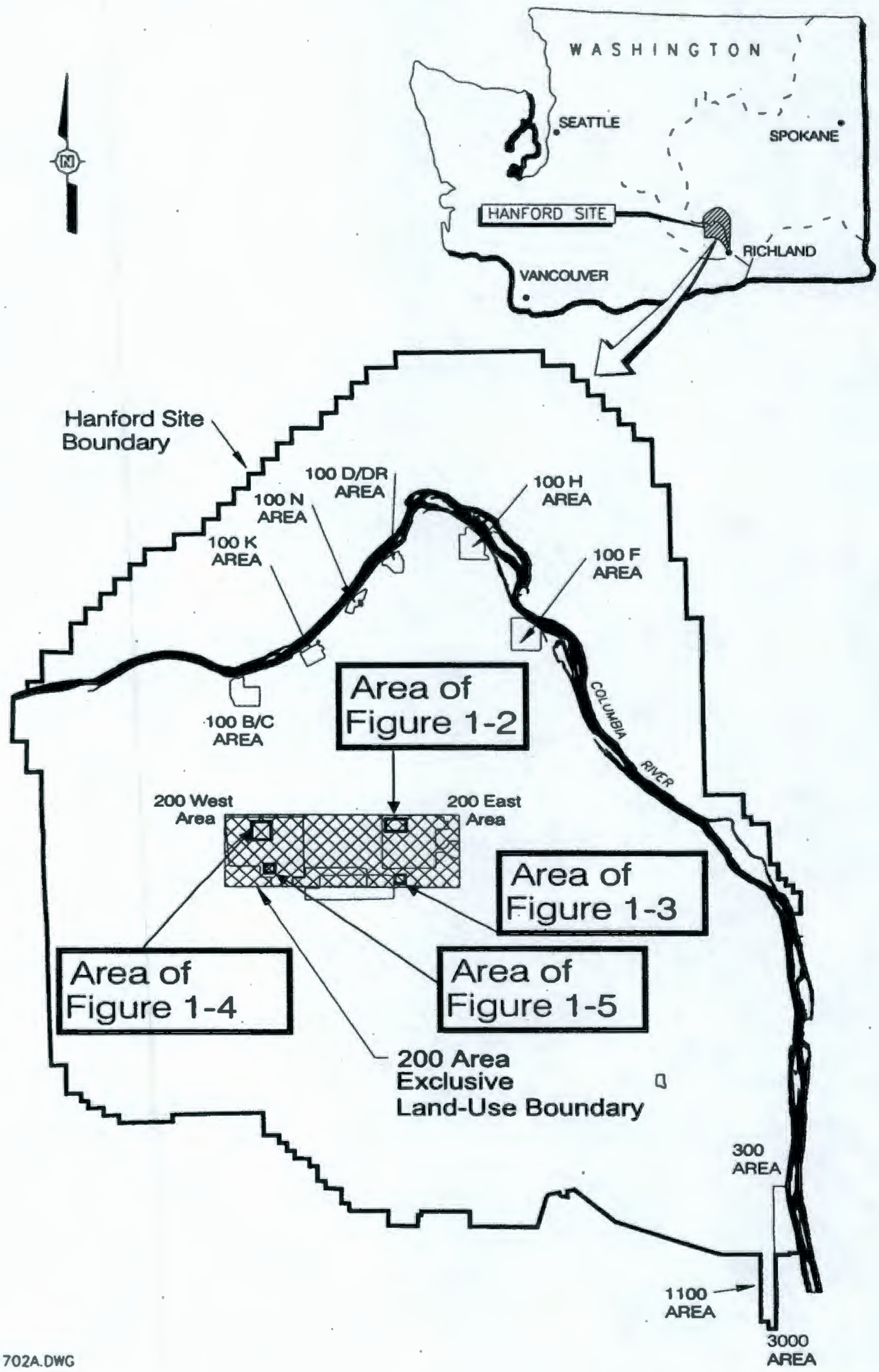

Figure 1-2. Location of 200-TW-1, 200-TW-2, and 200-PW-5 Operable Unit Waste Sites in the 200 East Area.

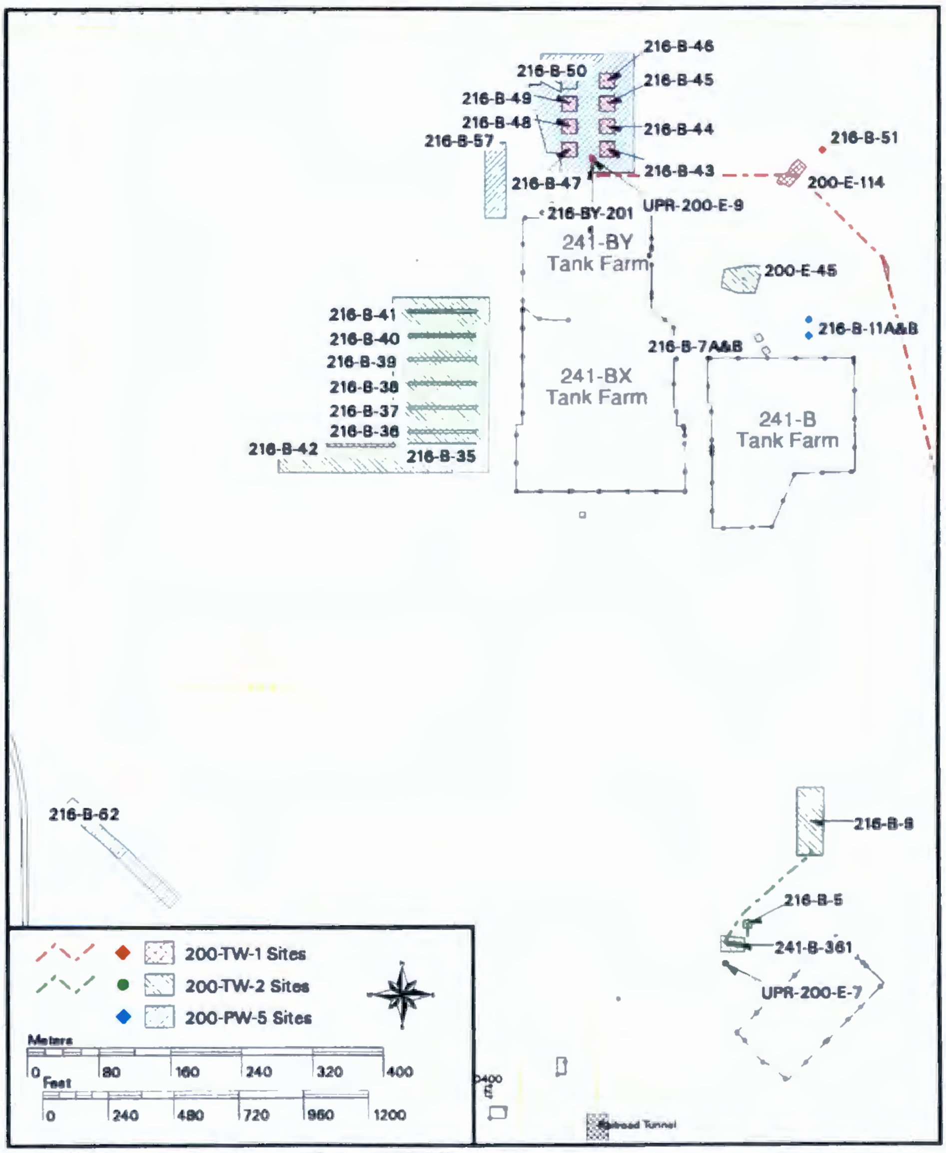

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Figure 1-3. Location of the 200-TW-1 Operable Unit Waste Sites South of the 200 East Area.

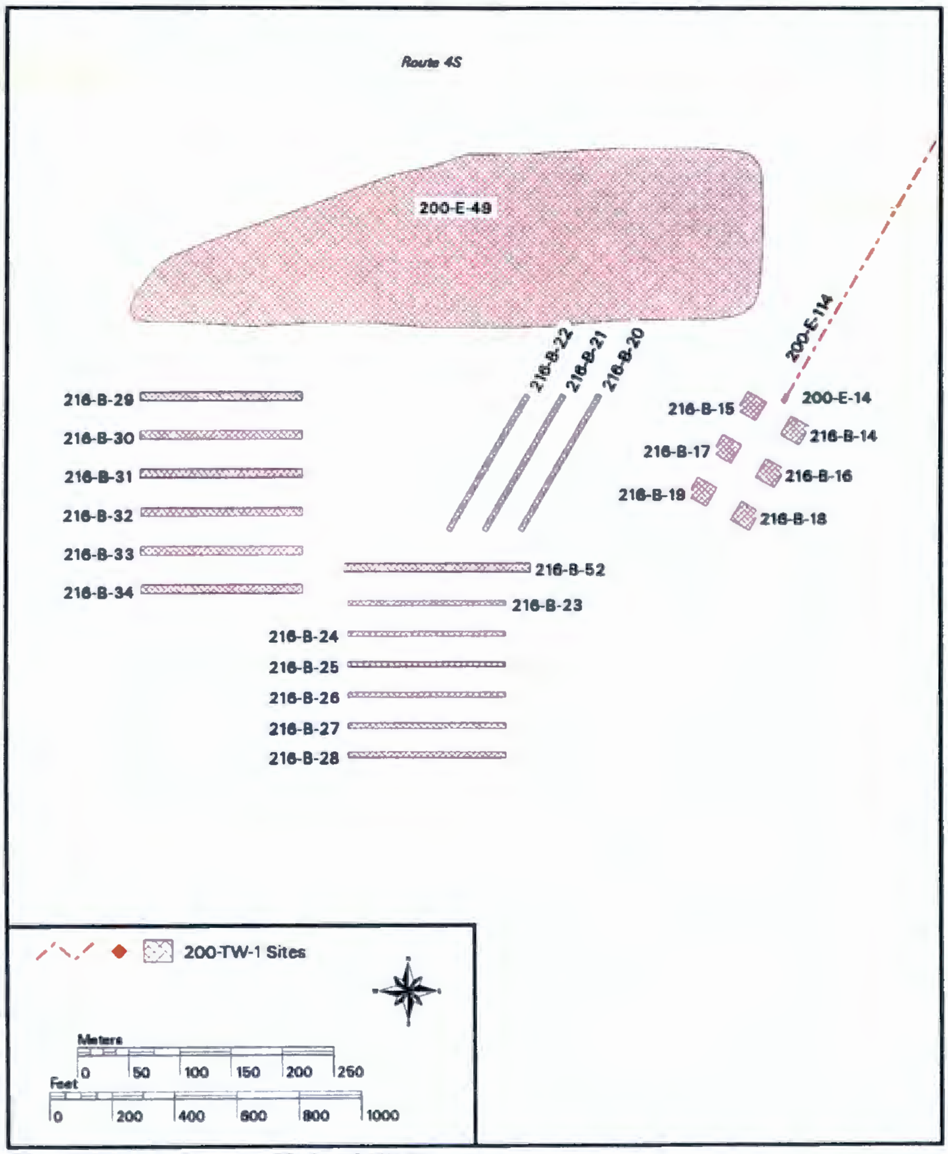

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Figure 1-4. Location of the 200-TW-1 and 200-TW-2 Operable Unit Waste Sites in the 200 West Area.

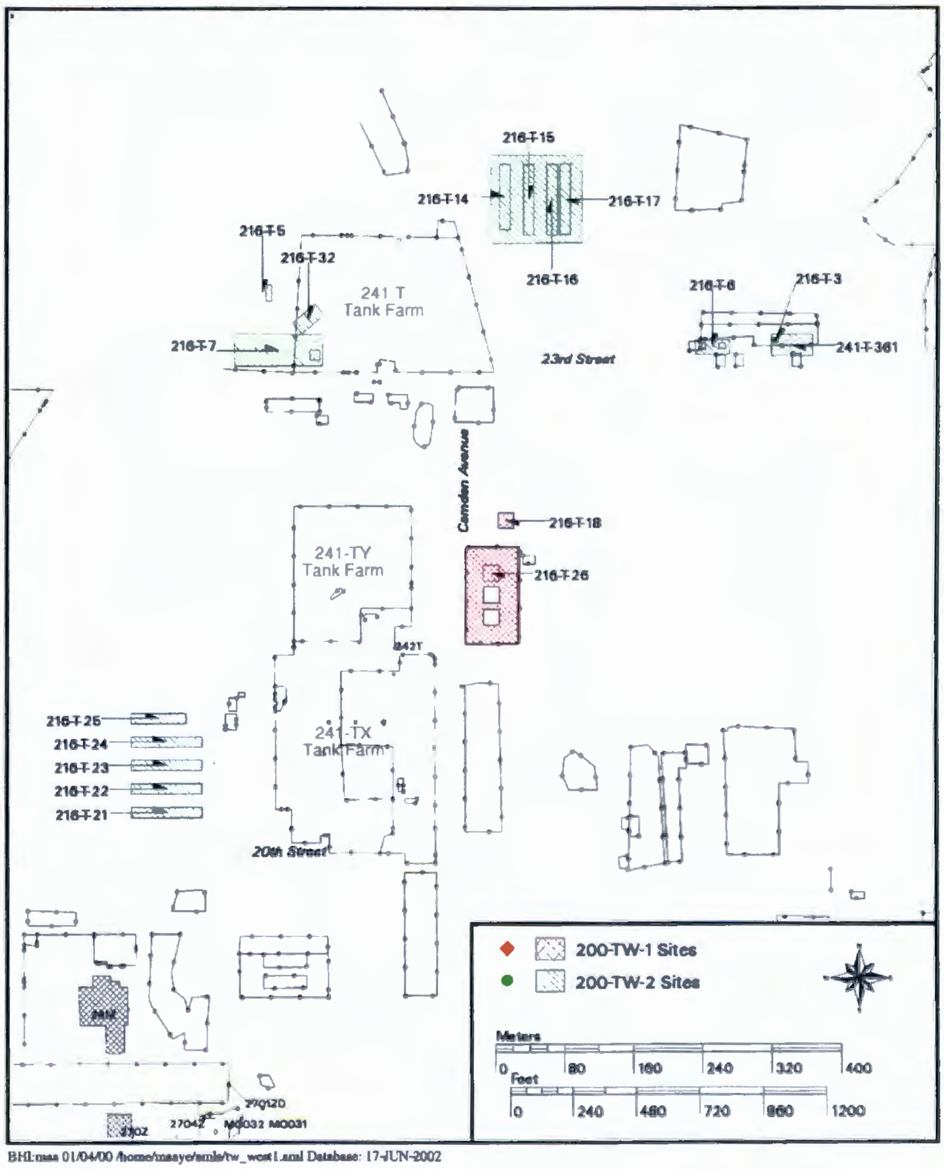
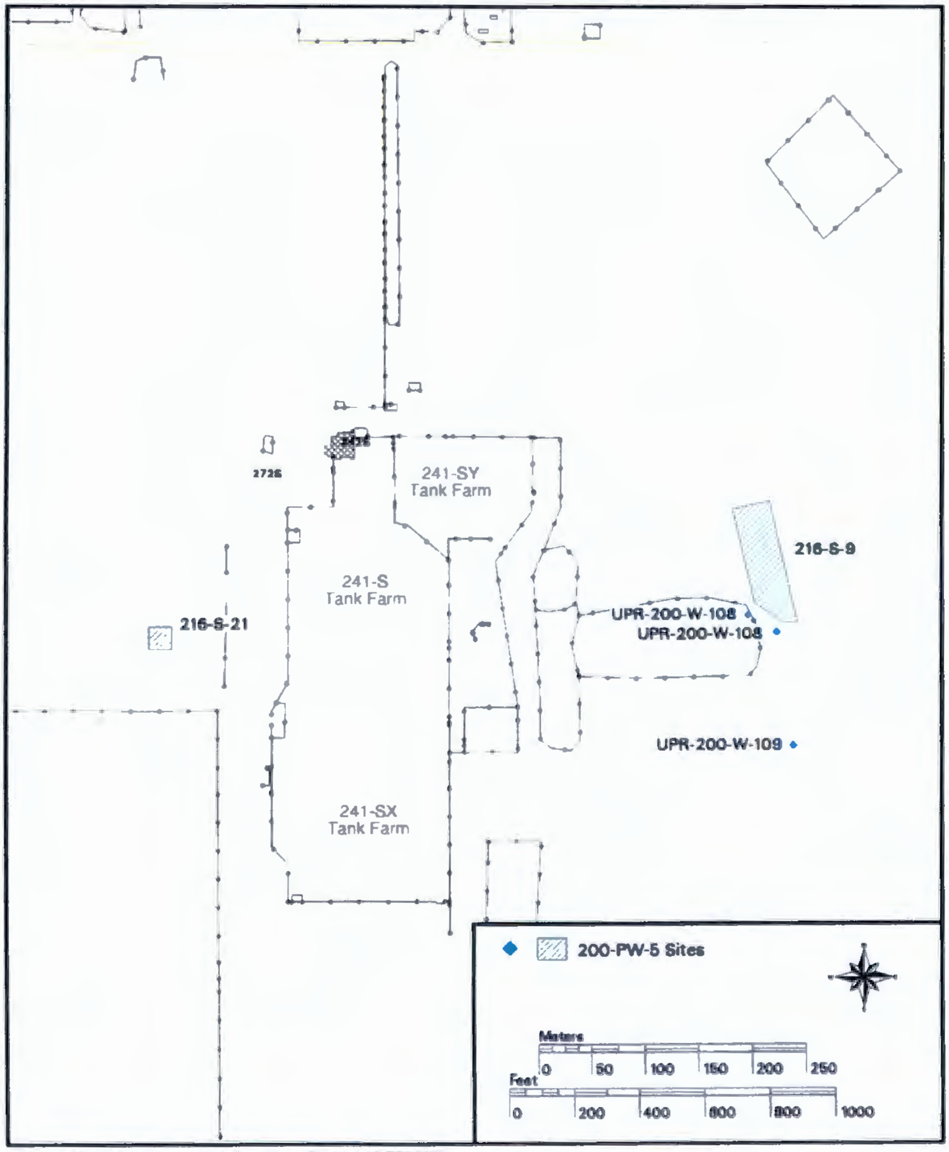


Figure 1-5. Location of the 200-PW-5 Operable Unit Waste Sites in the 200 West Area.



BHI:maa 01/04/00 /home/maayo/amls/tw_west2.aml Database: 18-JUN-2002

2.0 INVESTIGATION APPROACH AND ACTIVITIES

This section summarizes the data collection activities performed during the 200-TW-1 and 200-TW-2 RI. These activities are described in detail in Todd and Kahler-Royer (2002) and Todd and Trice (2002). The RI was conducted in accordance with the *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan* (DOE-RL 2001). 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 the *Remedial Investigation/Feasibility Study Work Plan for the 200-BP-1 Operable Unit, Hanford Site, Richland, Washington* (DOE-RL 1990). The *Phase I Remedial Investigation Report for the 200-BP-1 Operable Unit* (DOE-RL 1993b) 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 Smith (1980). 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 as 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 2001). Sections 2.2, 2.3 and 2.4, respectively, briefly describe data collection efforts presented in existing reports (mainly DOE-RL 1993b and Smith 1980) 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 RI 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 226 ft (69 m) and 263 ft (80 m), respectively. Drilling at the 216-B-7A Crib terminated within a significantly thick silt horizon at a depth of 222.5 ft (68 m), approximately 23 ft (7 m) 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 was also 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 was occasionally used to collect moisture samples. The three boreholes were decommissioned with bentonite and cement after reaching total depth, in accordance with *Washington Administrative Code* (WAC) 173-160.

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 60 ft (18.3 m). 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 in the vicinity of 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 (Todd and Kahler-Royer 2002, Todd and Trice 2002).

2.1.1 200-TW-1 and 200-TW-2 RI Sampling and Analysis

Soil samples collected from boreholes were screened in the field prior to sample collection for indications of contamination and to assist with determining of 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 Todd and Kahler-Royer (2002) and Todd and Trice (2002).

Soil samples were collected for chemical and radiological analysis and determination of physical properties. Sample collection was guided by the sample schedule in Appendix A (Tables A-4 through A-6) of the 200-TW-1 and 200-TW-2 work plan (DOE-RL 2001). 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, due to 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 15 and 25 ft (4.6 and 7.6 m) bgs. Sample frequency was generally reduced to 25- to 50-ft (7.6 to 15.2 m) intervals below a depth of 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 were generally analyzed for tributyl phosphate, metals, herbicides, diesel range organic compounds, general chemistry parameters, and radionuclides. Several samples were also analyzed for volatile organic compounds (VOCs) 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 the *Data Quality Objectives Summary Report for 200-TW-1 and 200-TW-2 Waste Designation* (BHI 2001). 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 RI Geophysical Logging

Borehole geophysical logging was performed in a total of 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 at each of the new boreholes and drive casings and at existing monitoring well/borings in the vicinity of the waste sites. In addition to the wells/borings identified in the work plan, several additional well/borings in the vicinity of the waste site were logged as part of 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 Todd and Kahler-Royer (2002) and Todd and Trice (2002). The reports include summaries of the calibration requirements, processing data, log plots, and results.

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

2.2.1 Surface Geophysical Surveys

Surface geophysical surveys were conducted at each site using ground-penetrating radar prior to excavation. The surveys were performed to verify the location of waste sites and 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 (Todd and Kahler-Royer 2002, Todd and Trice 2002).

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 site-wide 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 the North American Vertical Datum of 1988 (NAVD 1988) and the Washington State Plane (South Zone) North American Datum of 1983, with the 1991 adjustment for horizontal coordinates. Survey data are presented in the borehole summary reports (Todd and Kayler-Royer 2002, Todd and Trice 2002).

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 29.5 ft (9 m) and 35 ft (10.7 m) 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 (1993b). The subject boreholes were also 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 in the vicinity of the 216-B-5 Reverse Well. The boreholes were also 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 the 299-E28-23 borehole (Smith 1980). The samples were collected in the vadose zone from near the surface to a depth of 284 ft. Twenty-three saturated sediment samples were also collected from the water table 284 ft bgs in 1980 to a depth of 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 Smith (1980).

2.2.6 216-B-57 Crib 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 50 ft and 233 ft (15.2 m and 71 m) 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 were also 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 (1993b). 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

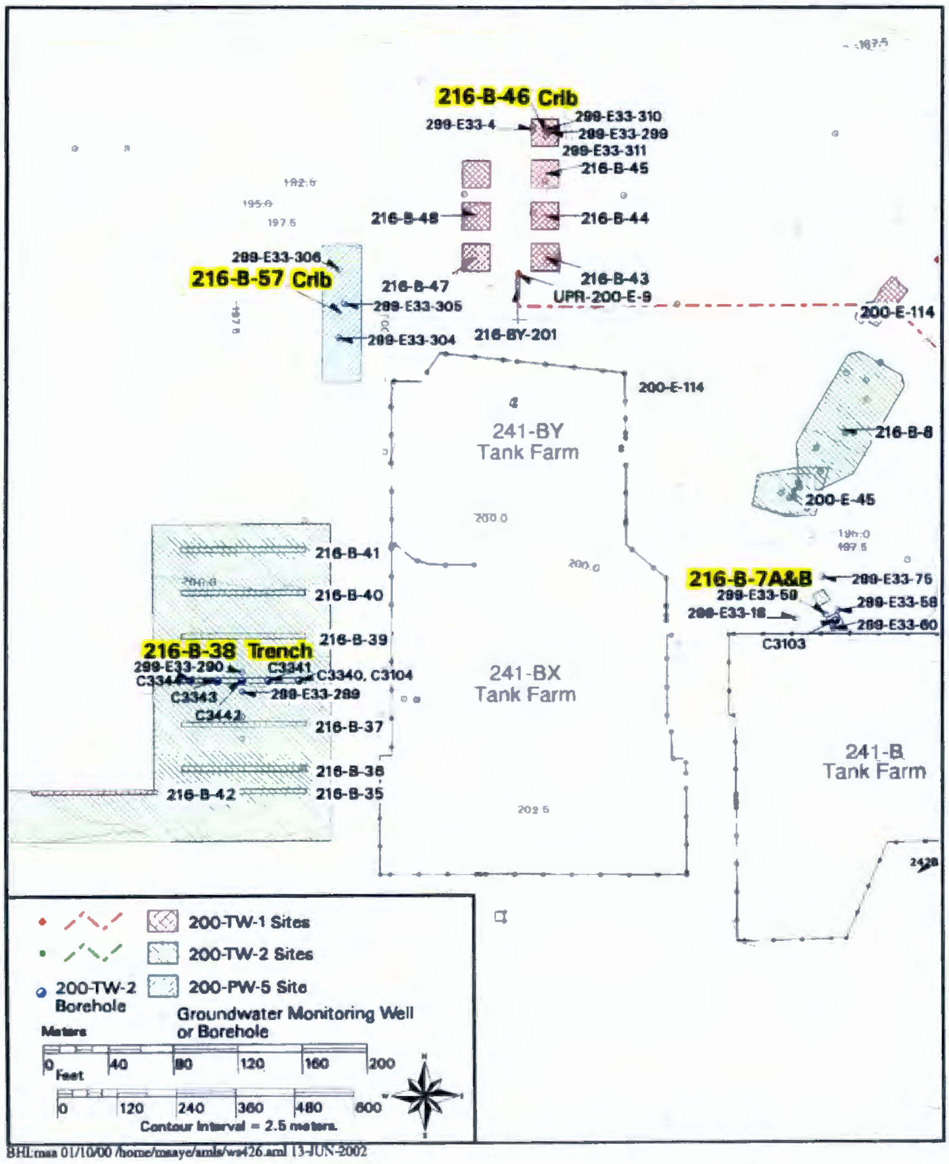


Figure 2-2. Borehole Location Map for 216-T-26 Crib

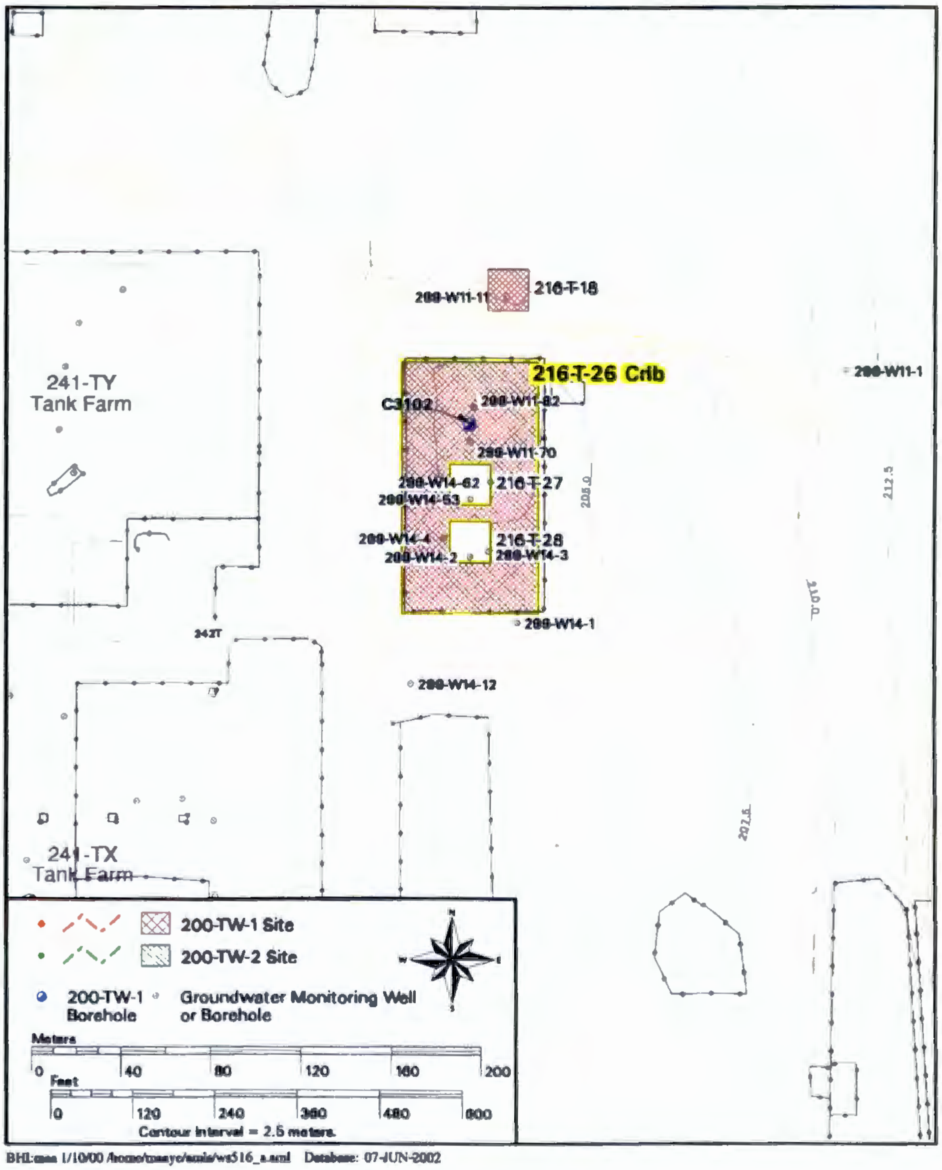


Figure 2-3. Borehole Location Map for the 216-B-5 Reverse Well

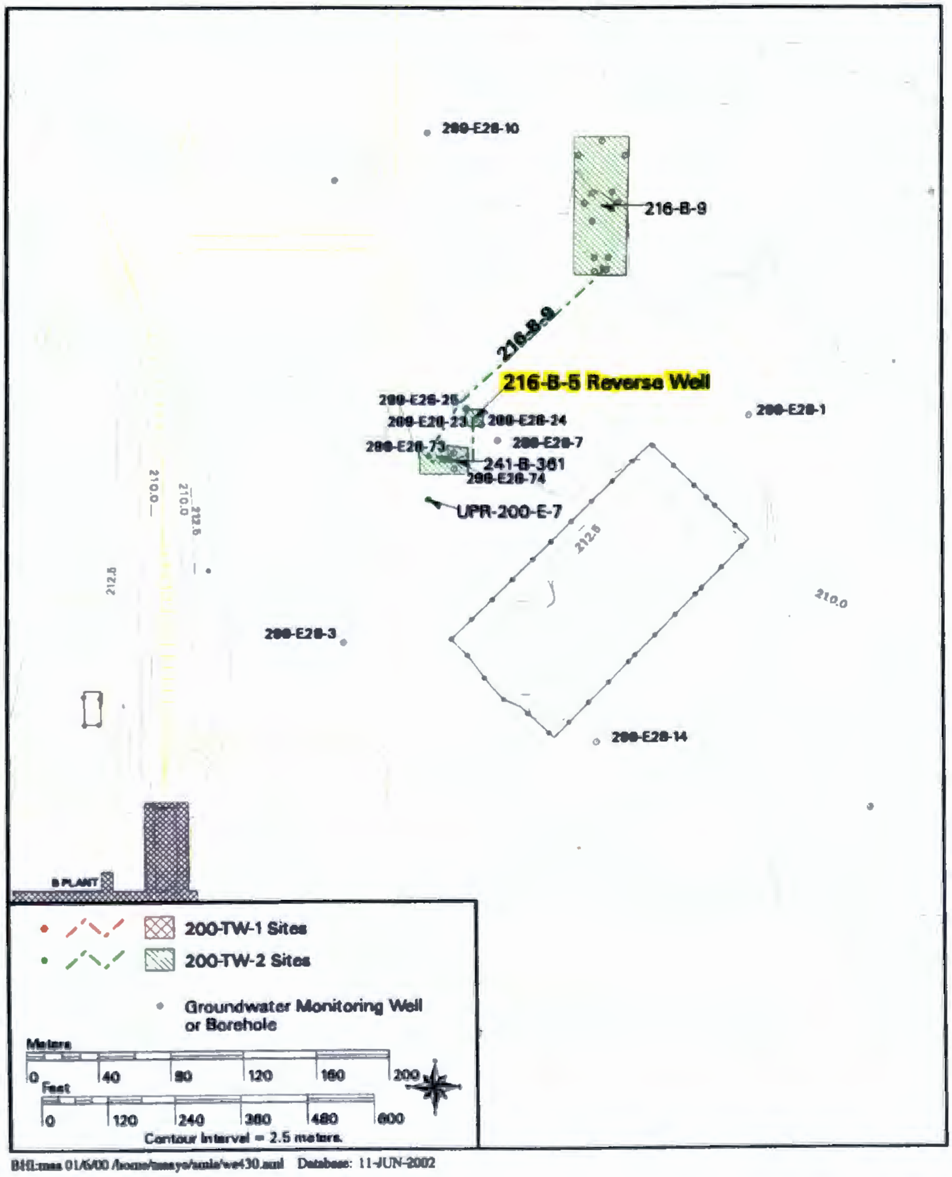


Table 2-1. Summary of Operable Unit Data Collection Activities.

	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 the 200-BP-1 RI report (DOE-RL 1993).

[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.

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

Method	Constituent or Property	216-T-26 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*
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[a]		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
UAEA	Uranium-235/236[a]		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
UAEA	Uranium-238[a]		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

Method	Constituent or Property	216-B-38 Trench														
		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*
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[a]		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
UAEA	Uranium-235/236[a]		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
UAEA	Uranium-238[a]		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

Method	Constituent or Property	216-B-7A Crib																
		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[a]		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
UAEA	Uranium-235/236[a]		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
UAEA	Uranium-238[a]		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

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												
		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*
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		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

Method	Constituent or Property	216-B-38 Trench														
		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*
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															

Method	Constituent or Property	216-B-7A Crib																
		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 section 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 section 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 the *200-BP-1 Remedial Investigation Report* (DOE-RL 1993b), *216-B-5 Reverse Well Characterization Study* (Smith 1980), 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 1999), the *B Plant Source Aggregate Area Management Study Report* (DOE-RL 1993a), and the *T Plant Source Aggregate Area Management Study Report* (DOE-RL 1992). Figure 3-1 is the generalized stratigraphic column for the OUs. Stratigraphic relationships in the vicinity of 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 Area Plateau. The 200 Area 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 Area 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 the North American Vertical Datum of 1988 [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 1988). 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, depth to basalt is approximately 79.0 m (258 ft) at the 216-B-7A Crib, 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 (1993b) 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 interpreted to be a weathered (WHC 1994, Bjornstad 1990) and eolian facies (Slate 1996) that consists of poorly sorted, locally derived, interbedded reworked loess, silt, sand, and basaltic gravel. The subunit consists of a lower 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 (Bjornstad 1990). Generally, it is well-sorted quartz-rich/basalt-poor silty sand to sandy silt (BHI 1996).

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 216-B-7A, 216-B-38, and 216-B-46. 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 (Wood et al. 2000). 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 Wood et al. (2000) as loose, unconsolidated sandy gravel to gravelly sand. These gravels contain 50% to 70% 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 has also 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 1993b). 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 area. 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 the purpose of contamination control, or both. The fill consists of silty-sandy gravel, silty sand to sandy silt, or both. The silt horizon consists of at least 40% 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 340 ft (103.7 m) thick. At the 216-B-5 Reverse Well, the vadose zone is 287 ft (87.5 m) 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 228 ft to 287 ft (69.5 to 87.5 m) at representative sites in the 200 East Area.

In the 200 West Area, the vadose zone thickness ranges from 132 ft to 337 ft (40.2 m to 102.7 m). Sediments in the vadose zone are the Ringold Formation, the Plio-Pleistocene unit, and the Hanford formation. The thickness of the vadose zone at 216-T-26 Crib is approximately 226 ft (68.9 m).

Moisture content in the 200 Area vadose zone typically ranges between 2% and 10% under ambient conditions (DOE-RL 1999), but has historically ranged widely from 10% 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 pre-operational conditions for some time in the vicinity of waste sites. Prior to 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 indicates that volumetric moisture content beneath representative sites ranges between 1.0% and 19.0%. Over most of the log interval, the moisture content was <4 %. Zones of higher moisture are associated with elevated levels of contamination within 40 ft (12.2 m) 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 (~1% to 4%) is noted within 20 ft (6.1 m) of the water table at each site. This reflects the decline of the water table surface across the 200 Area.

The area of highest moisture was detected beneath the 216-B-7A Crib within the Hanford formation/Plio-Pleistocene silt (?) at a depth of 218 ft (66.5). Soil samples from this zone were very wet as milliliters of water drained out of samples by gravity after collection. Monitoring of this zone over a 24-hr 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 maybe 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, grain size distribution by ASTM Method D422, 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 due to high radiological contamination or insufficient volume. Laboratory moisture content ranged between 1.4% and 22.5 % (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 A.

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 Area 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 446-ft (136-m) and 459-ft (140-m). Groundwater flows from west to east. March/April 2000 and March 2001 depth to water measurements in Hartman et .al (2002) 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 due to cessation of most discharges to the ground. The saturated thickness of the unconfined aquifer is 126 ft (38.4 m) beneath the 216-T-26 Crib and bound by the Ringold lower mud. Depth to water at 216-T-26 Crib is approximately 226 ft (69 m).

Depth to water beneath representative sites in the 200 East Area range between 228 ft and 287 ft (69.5-m and 87.5-m) and increases to the south. The elevation of the water table surface across the 200 East Area is bound completely by the 400- and 407-ft (122- and 124-m) contour intervals (Figure 3-9). Groundwater flow is to the northwest towards 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 Hartman et .al (2002) the surface of the water table is declining at a rate of 0.46 ft/yr (0.14 m/yr) in the 200 East Area. The saturated thickness of the unconfined aquifer is less than 3 ft (1 m) at the 216-B-46 Crib and 53 ft (16 m) 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

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 B 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 *Hanford Site Background: Part 1, Soil Background for Inorganics* (DOE-RL 1995a) and in *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE-RL 1996). *Natural Background Soil Metal Concentrations in Washington State* (Ecology 1994) was also 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 MTCA Method C soil cleanup levels in *Cleanup Levels and Risk Calculations under the MTCA Cleanup Regulations (CLARC)* (Ecology 2001), including soil concentrations considered protective of groundwater. Soil concentrations protective of groundwater were calculated based on WAC 173-340-747. Concentrations exceeding background concentrations, MTCA Method C soil clean up 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 Sections 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 waste 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 1993) 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 re-evaluated in this report to refine the list of contaminants. A summary of vadose contamination from the 200-BP-1 report is included in Section 3.2.1. Maximum detected concentrations of potential contaminants of concern from the 200-BP-1 OU waste sites (216-B-43, 216-B-44, 216-B-45, 216-B-46, 216-B-47, 216-B-48, 216-B-49, 216-B-50 and 216-B-57) are presented in the 200-BP-1 RI report, Tables 4-16 and 4-17 (DOE-RL 1993b). 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 OU 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.

3.2.1.1 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 1993b). Samples were collected to a maximum depth of 35 ft (10.7 m) in three boreholes. Because no samples were collected greater than 35 ft (10.7 m) 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 was also 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.

The following 18 constituents exceeded the screening in the soil column beneath the 216-B-46 Crib (Table 3-3) and include the following:

- antimony-125
- cesium-137
- cobalt-60
- plutonium-238
- plutonium-239
- plutonium-239/240
- radium-226
- strontium-90
- technetium-99
- tritium
- total uranium
- bismuth
- 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 18 ft (5.5 m). The majority of contaminants and the highest concentrations were detected from 18 to 49 ft (5.5 to 14.9 m) bgs. Figure 3-10 provides vertical profiles of the detected contaminants that show significant contamination from 18 to 49 ft (5.5 to 14.9 m) 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 18 ft (5.5 m) bgs. Cesium-137 and strontium-90 were the dominant radionuclides present, with maximum concentrations of 364,000 and 353,000 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 49 ft (14.9 m) bgs. With the exception of technetium-99, concentrations were less than 5 pCi/g at depths greater than 49 ft (14.9 m) bgs. Technetium-99 concentrations ranged from 65 to 160 pCi/g at depths greater than 49 ft (14.9 m) bgs. The distribution of these contaminants deep in the vadose zone is associated with very low contaminant distribution coefficients (K_ds) in contrast to cesium-137, plutonium 239/240, and strontium-90, which have higher K_ds and remain in vadose zone soils close to the point of release to the environment.

Bismuth and sodium were detected in significant concentrations relative to screening criteria. Bismuth was detected in one sample at a concentration of 31.3 mg/kg at a depth of 190.5 ft (58 m) bgs. Sodium was distributed throughout the vadose zone starting at a depth of about 18 ft (5.5 m) and had a maximum concentration of 4,360 mg/kg.

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 and 1,080 mg/kg, respectively. Nitrite and phosphate were distributed at depths less than 49 ft (14.9 m) bgs at maximum concentrations of 12.2 mg/kg and 86.7 mg/kg, respectively. Cyanide was detected from about 18 ft (5.5 m) bgs to a depth of 193 ft (58.8 m) with a maximum concentration of 12.0 mg/kg.

Cesium-137 was detected with the RLS from the surface to a depth of 90 ft (27.4 m) with significantly elevated levels from 16 to 57 ft (4.9 to 17.4 m) bgs. The RLS data indicate a maximum estimated concentration is 1,400,00 pCi/g at a depth of 25 ft (7.6 m). 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 72 ft (22 m) bgs. The data suggest that the deeper contamination may be attributed to the drag down of contamination during drilling. The RLS data from Borehole 299-E33-4 indicate that cesium-137 contamination extends laterally from the crib several meters to the west.

Based on the data generated for this 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 was revised. The new contaminant distribution model for the 216-B-46 Crib is shown in Figure 3-11.

3.2.1.2 Current Impacts to Groundwater at the 216-B-46 Crib. The effluent volume discharged to the 216-B-46 Crib is about 70 % of the soil column pore volume. 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 1955 to December 1955. Additional assessment of potential impact to groundwater is constrained at this site because soil data were only collected to a depth of 35 ft (10.7 m) 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 impact to groundwater at the waste site. The current 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) in the vicinity of the crib. The 216-B-46 Crib is a likely past and potential current and future contributor to the groundwater contamination. Future impacts to groundwater are evaluated in Section 4.0.

3.2.1.3 Summary of Vadose Contamination from the 200-BP-1 RI Report. Fifteen contaminants (cadmium, nickel, tributyl phosphate, polychlorinated biphenyls, antimony-125, cesium-137, cobalt-60, plutonium-238, plutonium-239, plutonium-239/240, radium-226, strontium-90, technetium-99, thorium-228, and total uranium) were identified in the 200-BP-1 RI Report. This list of contaminants is indicative of all contamination detected throughout the 200-BP-1 OU by sampling soils from the 216-B-43 through 216-B-50 Cribs, the 216-B-57 Crib, and the 216-B-61 Crib.

The 200-BP-1 RI indicates that contamination was detected to a depth of 236 ft (72 m) bgs; although, maximum concentrations were generally observed in the 15 to 50 ft (4.5 to 15.2 m) bgs zone. This zone of contamination begins at the base of the crib structures and extends into the underlying native soil. The observed contaminant distributions are consistent with the relative immobility of such radioactive constituents as cesium-137 and plutonium isotopes. Below 50 ft (15.2 m) bgs, contaminant levels generally decrease with depth. At depths greater than 100 ft (30.5 m) bgs, concentrations remain uniformly low. Soils from 0 to 15 ft (0 to 4.6 m) bgs were characterized by relatively low levels of contamination. Details of the 200-BP-1 RI are presented in DOE-RL (1993b).

3.2.1.4 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 227 ft (69.2 m) bgs in borehole C3102 and were analyzed for select radionuclides, inorganics (metals), general chemistry anions, semi-volatile compounds, and diesel range organic compounds. A majority of samples were also analyzed for carbon tetrachloride to assess the presence of carbon tetrachloride in the vadose zone for the 200-PW-1 OU remedial investigation.

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
- potassium-40
- plutonium-238
- plutonium-239/240
- 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 18 ft (5.5 m) bgs. The main zone of radiological contamination extends from 18 ft to 36.5 ft (5.5 to 11 m) bgs. The predominant radionuclides in this zone are contaminants with moderate to high k_ds, such as americium-241, cesium-137, europium-154, europium-155, plutonium-238, plutonium-239/240, and strontium-90. Cesium-137 concentrations decrease with depth through this zone. The maximum concentrations of the other contaminants occurred in the 34 to 36.5 ft (10.4 to 11 m) sample interval with only slightly elevated 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) and extends to the approximate top of the sand-dominated sequence of the Hanford formation. The maximum concentrations for cesium-137 and strontium-90 were 47,900 and 49,100 pCi/g, respectively. The maximum concentrations for plutonium-239/240 and tritium were 6,320 and 2,650 pCi/g, respectively.

Radiological contaminants with low k_ds, like cobalt-60, technetium-99, tritium, and uranium isotopes, were detected in soil samples to a depth of 94.5 ft (28.8 m), which is the approximate top of the Plio-Pleistocene Unit. Only technetium-99 and tritium were detected greater than 94.5 ft (28.8 m) deep and their concentrations were less than 4 pCi/g each in this zone. Significant reduction in the levels of contamination is associated with top of the sand-dominated sequence of the Hanford formation and the Plio-Pleistocene Unit.

Bismuth and sodium were detected in significant concentrations beneath the crib to a depth 36.5 ft (11 m) bgs. Maximum concentrations were 198 mg/kg and 1,510 mg/kg, respectively.

Ammonia, cyanide, fluoride, nitrate, nitrite, and sulfate were detected at depths greater than 18 ft (5.5 m) bgs. Phosphate was detected at depths greater than 10 ft (3.0 m) bgs. Maximum concentrations for ammonia (94.9 mg/kg), cyanide (7.9 mg/kg), and nitrite (47.7 mg/kg) were detected from depths of 67.3 ft to 94.5 ft (20.5 m to 28.8 m). Fluoride was detected from 18 to 94 ft (5.5 to 28.7 m) 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, respectively, at 94.5 ft (28.8 m) bgs.

Cesium-137 was detected with the RLS from near the surface to a depth of 128 ft (39 m) bgs. Log data indicate that most of the cesium-137 was detected from 18 to 91 ft (5.5 to 27.7 m) 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-2 7 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 was revised. The new contaminant distribution model for the 216-T-26 Crib is shown in Figure 3-16.

3.2.1.5 Current Impact to Groundwater at the 216-T-26 Crib. The effluent volume discharged to the 216-T-26 Crib was greater than the soil column pore volume. 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. Hartman et al. (2002) 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 other waste sites in the 200 West Area. Immobile contaminants, such as cesium, were not detected in the aquifer. The current status of groundwater near the crib is shown in Figures 3-17 and 3-18. Future impacts to groundwater are evaluated in Section 4.0.

3.2.2 Nature and Extent of Contamination at 200-TW-2 OU 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 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 Smith 1980). 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 Smith (1980) and RLS data collected in 2001. Analytical results are presented in Smith (1980).

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. Smith (1980) 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 concentration ranging between 0.11 pCi/g and 1,800 pCi/g. These concentrations were associated with the perforated interval in the reverse well from 243 to 284 ft (74 to 86.6 m) 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 284 ft (86.6 m). The maximum concentration of 1,800 pCi/g was at the water table.

Cesium-137 was also detected across the saturated thickness (87 ft [26.5]) of the aquifer. Within the aquifer, 11,400 pCi/g to 51,300 pCi/g were detected from depths of 282 to 306 ft (86 to 93.3 m) bgs. Concentrations ranged from 124 to 1,800 pCi/g between 306 ft (93.3 m) bgs and the top of the basalt at a depth of 330 ft (100 m) bgs. The decrease in contamination is associated with the termination of the perforated zone in the reverse well at a depth of 302 ft (92 m) 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 pCi/g 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 286 ft (87 m) 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 pCi/g 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 284 ft (86.6 m) 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 286 ft (87 m), 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. The maximum activity in the vadose zone, based on the current depth to water of 286 ft (87 m), 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 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 286 ft (87 m), is 170 pCi/g.

3.2.2.4 RLS Logging at 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 was only detected sporadically at the minimum detection level of the logging tool. In Well 299-E28-23, cesium-137 was detected starting at about 250 ft (76.2 m) and extending to the water table (logging was discontinued prior to the saturated zone due to 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%) from 282 ft (86 m) (approximate depth of 1980 water table) to the end of the log run at 287 ft (87.5 m) bgs. In this zone, the activity exceeds 1,000 pCi/g. In Well 299-E28-24, cesium-137 was detected from 270 to 287 ft (82.3 to 87.5 m) bgs, with a maximum concentration of 3,000 pCi/g at 272 ft bgs (83 m). In Well 299-E28-25, cesium-137 was detected from 252.2 to 287.5 ft (76.9 to 87.7 m) bgs with a maximum concentration of 398 pCi/g at 254.5 ft (77.6 m) bgs. The cesium-137 distribution below 200 ft (61 m) 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.

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 current 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 221.5 ft (67.5 m) in borehole C3103 and were analyzed for radionuclides, inorganics (metals), general chemistry anions, herbicides, volatile and semi-volatile organics, and diesel range organic compounds.

The following 21 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
- 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 2.5 ft (0.76 m) bgs. Low levels of cesium-137 and strontium-90 were found from 2.5 ft to 18.5 ft bgs. A portion of this zone is likely 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 18.5 to 37.5 ft (5.6 to 11.4 m) 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). 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 37.5 to 221.5 ft (11.4 to 67.5 m) 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 50.5 ft [15.4 m] bgs). In the upper 50.5 ft (15.4 m) of the soil column, contamination correlates to increases in silt and moisture contents. At depths greater than 50.5 ft (15.4 m) 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 crib (Table 3-4). Bismuth, iron, and sodium were only analyzed for and detected associated with the bottom of the crib at depths from 22.5 to 25 ft (6.9 to 7.6 m) 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 crib (Table 3-4). Nitrate and phosphate were distributed throughout the soil column from 2.5 ft to 221.5 ft (0.76 to 67.5 m) at maximum concentrations of 493 and 105 mg/kg, respectively. Fluoride was detected from depths of 18.5 ft to 221.5 ft (5.6 m to 67.5 m) bgs with a maximum concentration of 205 mg/kg. Ammonium was detected in one sample (21.3 mg/kg) above the background concentration near the surface.

Cesium-137 was detected continuously with the RLS from the surface to a depth of 56 ft (17.1 m) bgs with the highest zone of contamination from 18 to 36 ft (5.5 to 11 m) bgs. The maximum activity in this zone is approximately 300,000 pCi/g at a depth of 23 ft (7 m). Concentrations decreased with depth from 45 ft (13.7 m) 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 100 ft (30 m) and a lateral extent greater than 70 ft (21.3 m). 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 crib with the RLS system are shown in Figures 3-24 and 3-25.

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 was revised. The new contaminant distribution model for the 216-B-7A Crib is shown in Figure 3-26.

3.2.2.7 Current Impact to Groundwater at 216-B-7A Crib. The effluent volume discharged to the 216-B-7A Crib is 75 times greater than the 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. Hartman et al. (2002) indicates that mobile contaminants (nitrate, uranium, technetium-99, and iodine-129) exceed groundwater protection 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 other waste sites in the 200 East Area.

The current status of groundwater near the crib is shown in Figures 3-12 and 3-13. Future impacts to groundwater are evaluated in Section 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 265.5 ft (80.9 m) in borehole C3104 and were analyzed for radionuclides, inorganics (metals), general chemistry anions, and herbicides.

The following nineteen 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
- radium-228
- strontium-90
- technetium-99
- tritium
- total uranium
- uranium 233/234
- uranium-238
- ammonia
- fluoride
- nitrate
- nitrite
- phosphate
- 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 3.5 ft and 200 ft (1.1 m and 61 m) bgs. Cesium-137 was detected at low levels from 3.5 ft to 12.5 ft (1.1 m to 3.8 m) bgs with a maximum activity of 1.82 pCi/g.

The major zone of radiological contamination extends from 14.5 to 40 ft (4.4 to 12 m) 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 40 ft to 200 ft (12 m to 61 m) 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 54.5 ft (16.6 m) 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 14.5 to 20.5 ft (4.4 to 6.25 m) bgs (i.e., the bottom of the trench) at a maximum concentration of 848 mg/kg.

Ammonia, fluoride, nitrate, nitrite, and phosphate exceeded the screening at the trench. Nitrate and nitrite were distributed deep in the vadose zone to a maximum depth of 200 ft (61 m) bgs. Ammonium, fluoride, and phosphate were not detected deeper than 54.5 ft (16.6 m) bgs.

Maximum concentrations were 65.2 mg/kg for ammonia, 33.4 mg/kg for fluoride, and 3,180 mg/kg for nitrate.

The distribution of cesium-137 was also assessed with the RLS. Logs from one borehole and five direct push holes installed along the axis of the trench indicate that the vertical extent of cesium-137 contamination is about 60 ft (18.3 m). However, most of the contamination is located at approximately 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 system 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 was revised. The new contaminant distribution model for the 216-B-38 Trench is shown in Figure 3-29.

3.2.2.9 Current Impact to Groundwater at 216-B-38 Crib. The effluent volume discharged to the 216-B-38 Crib was less than a third of the associated soil column pore volume (DOE-RL 1997). This information suggests that the volume of effluent released was not sufficient to reach the aquifer during operations of the waste site in 1954. Hartman et al. (2002) 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 current status of the groundwater near the crib is shown in Figures 3-12 and 3-13. Future impacts to groundwater are evaluated in section 4.0.

3.2.3 Nature and Extent of Contamination at 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 (1993b). 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, semi-volatile and volatile organics, pesticides, and polychlorinated biphenyls. Soil samples were collected from near the surface to a depth of 235.5 ft (71 m) bgs in borehole 299-E33-304 and to 50 ft bgs in boreholes 299-E33-305 and 299-E33-306.

The following ten 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 26-ft (7.9-m) 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 235.5 ft (71.7 m) bgs beneath the crib. The major zone of radiological contamination extends from 15 to 33 ft (4.6 to 10.1 m) 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 pCi/g), strontium-90 (67 pCi/g), plutonium-239 (0.01 pCi/g), technetium-99 (60 pCi/g), and tritium (16 pCi/g) were detected in this zone. Very low levels (<2 pCi/g) of contamination were detected from 0 to 15 ft (0 to 4.6 m) bgs and at depths greater than 33 ft (10.1 m) bgs with the exception of cesium-137. The maximum vertical extent of contamination at levels greater than 1 pCi/g is 50.5 ft (15.4 m) (i.e., cesium-137 at 68.4 pCi/g). Technetium-99 and radium-226 were the only radionuclides present at depths greater than 84.5 ft (25.6 m) 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 84 ft (25.6 m) with the maximum concentration of 2,120 mg/kg at a depth of 17 ft (5.2 m) bgs. Nitrite and phosphate were detected at depths less than 17 ft (5.2 m) bgs. Maximum concentrations were 8.3 and 2.7 mg/kg, respectively.

Based on the data generated for this 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 in the vicinity of 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 216-B-57. The data collected during the 200-BP-1 RI indicate little contamination is present below 84.5 ft (25.8 m) bgs (DOE-RL 1993b).

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

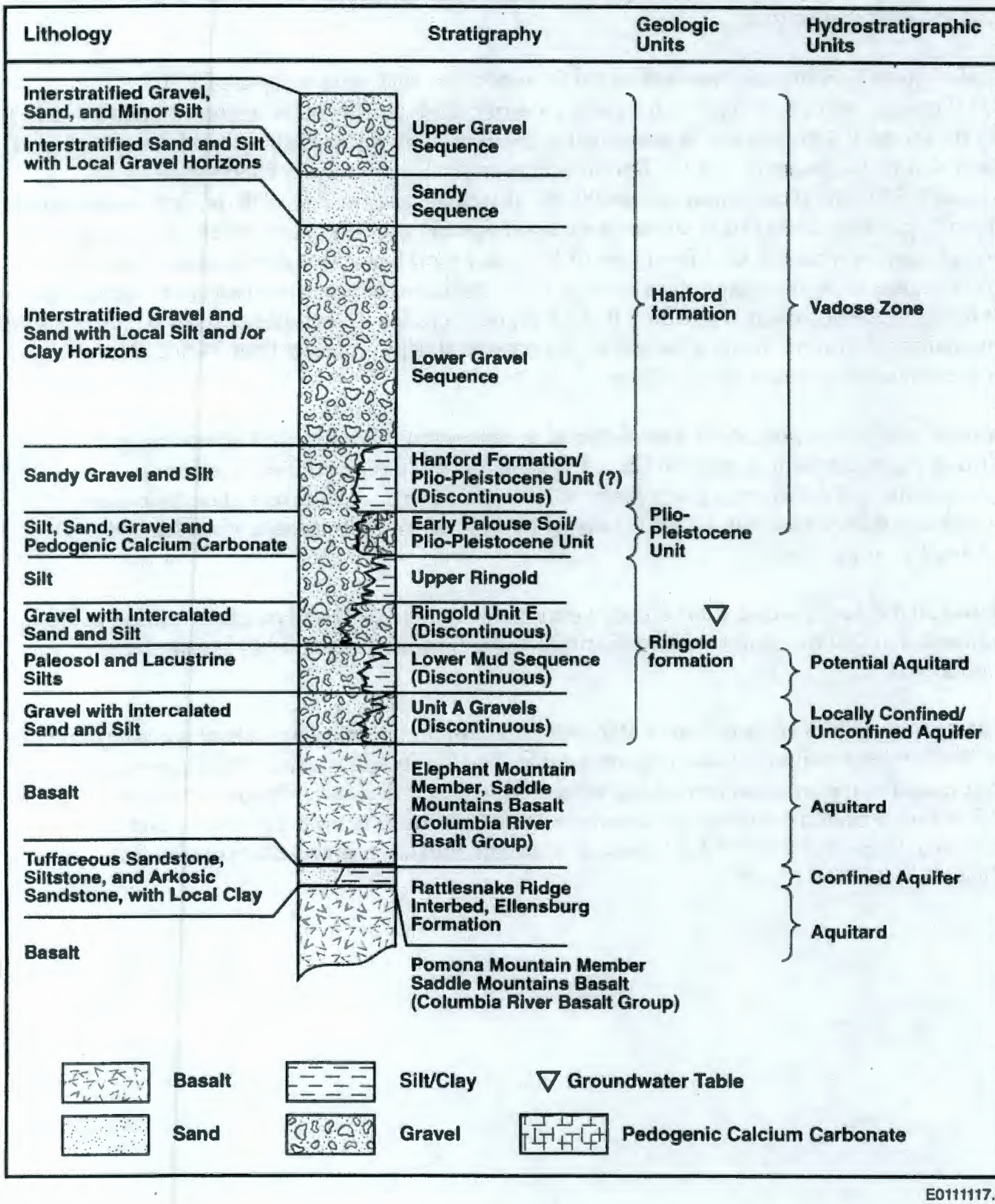


Figure 3-2. Cross-Section Location Map for 200-TW-1 Representative Site in 200 West Area.

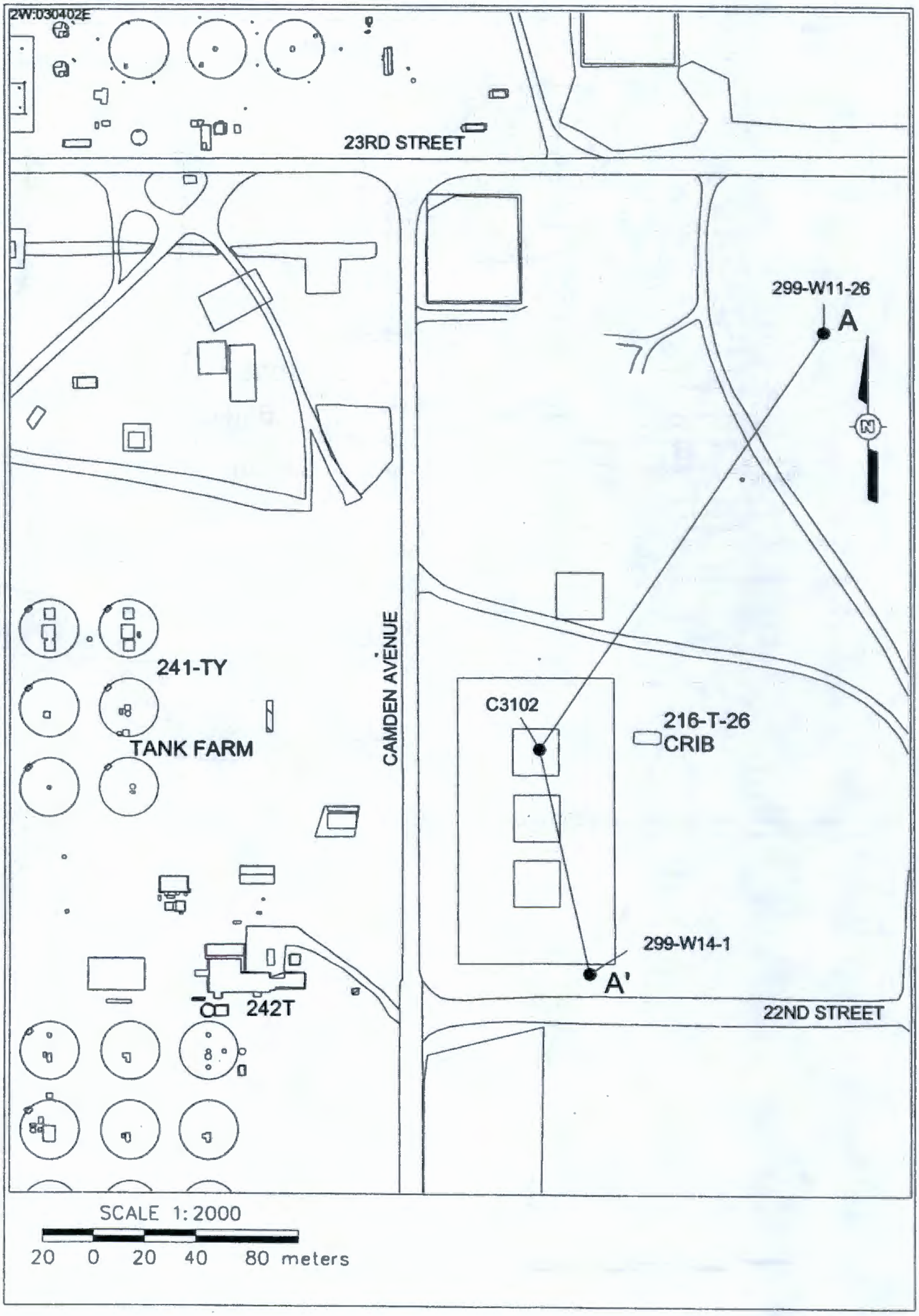


Figure 3-3. Cross-Section Location Map for 200-TW-1, 200-TW-2, and 200-PW-5 Representative Sites in 200 East Area.

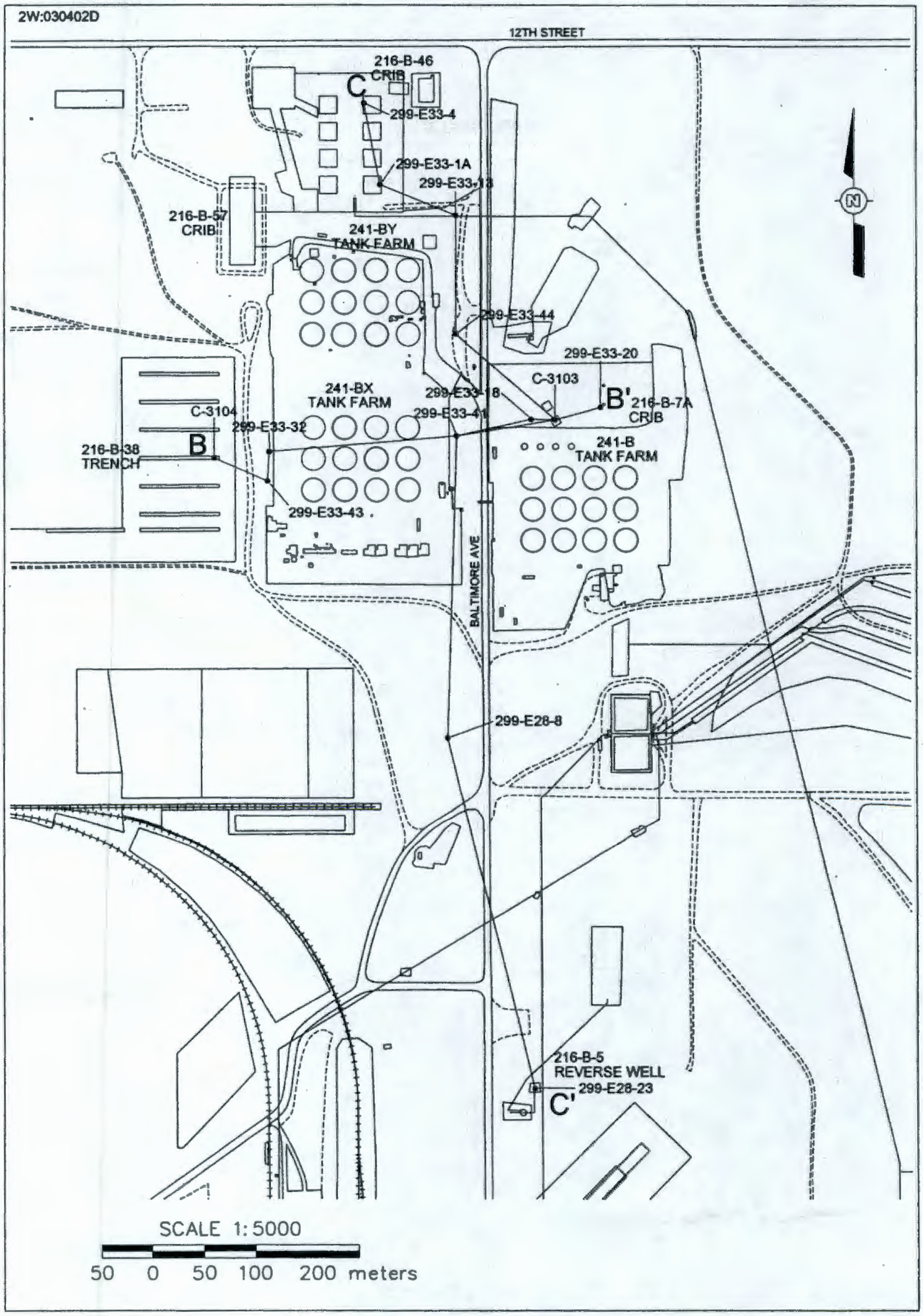


Figure 3-4. North-South Geologic Cross Section through 216-T-26 Crib.

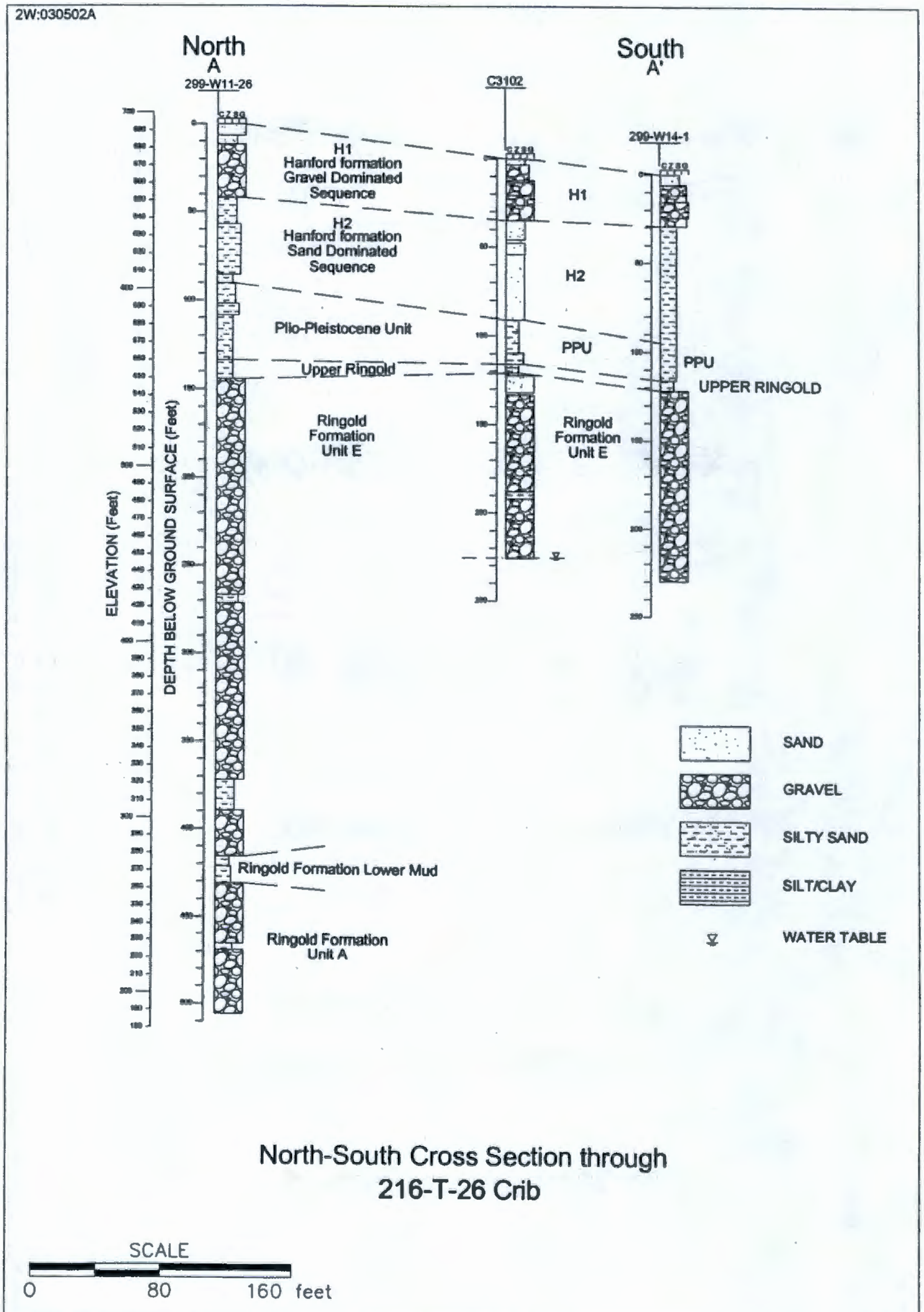


Figure 3-5. North-South Geologic Cross Section from 216-B-46 Crib to 216-B-5 Reverse Well.

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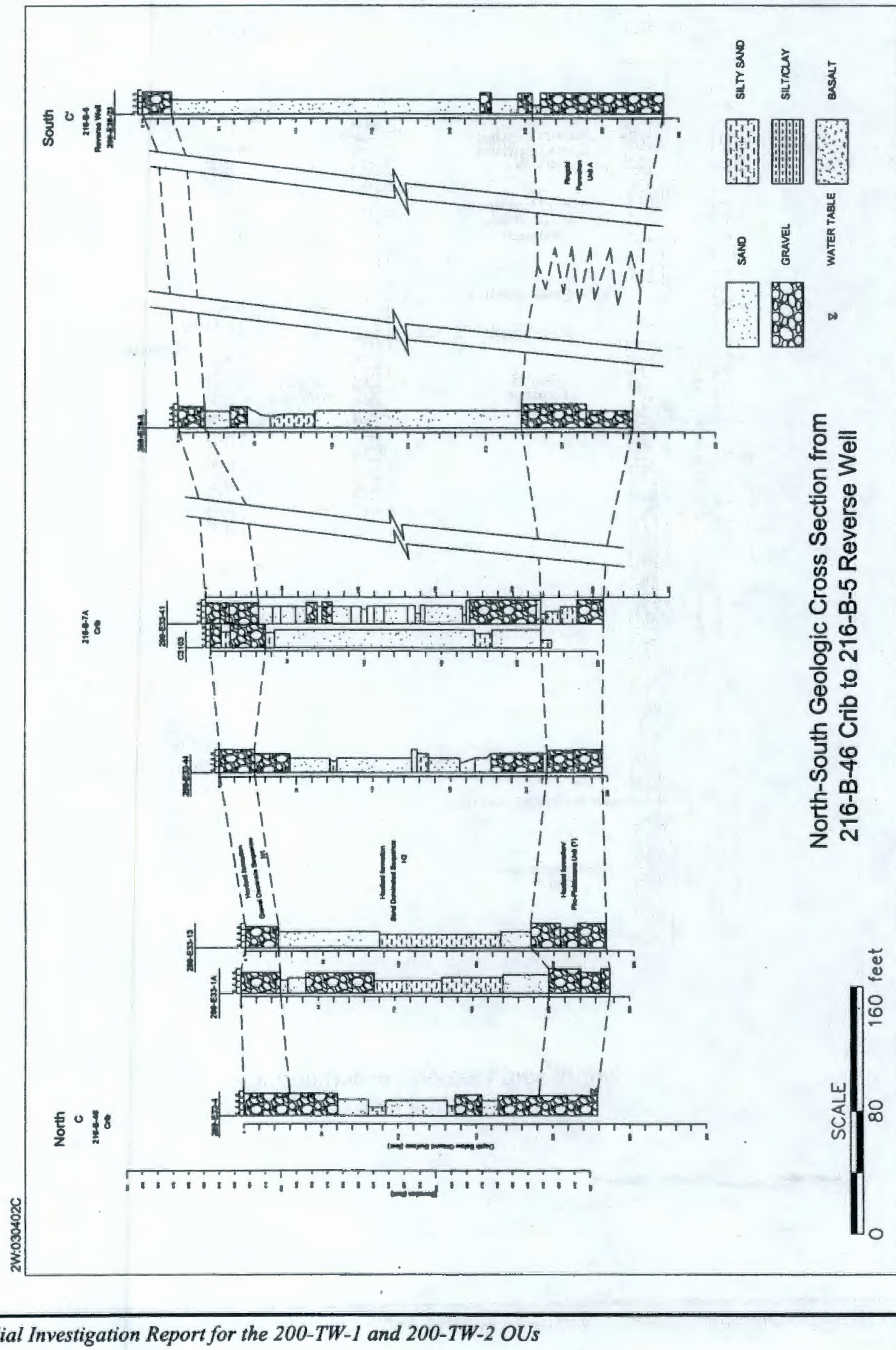


Figure 3-6. West-East Geologic Cross Section Through 216-B-38 Trench to 216-B-7A Crib.

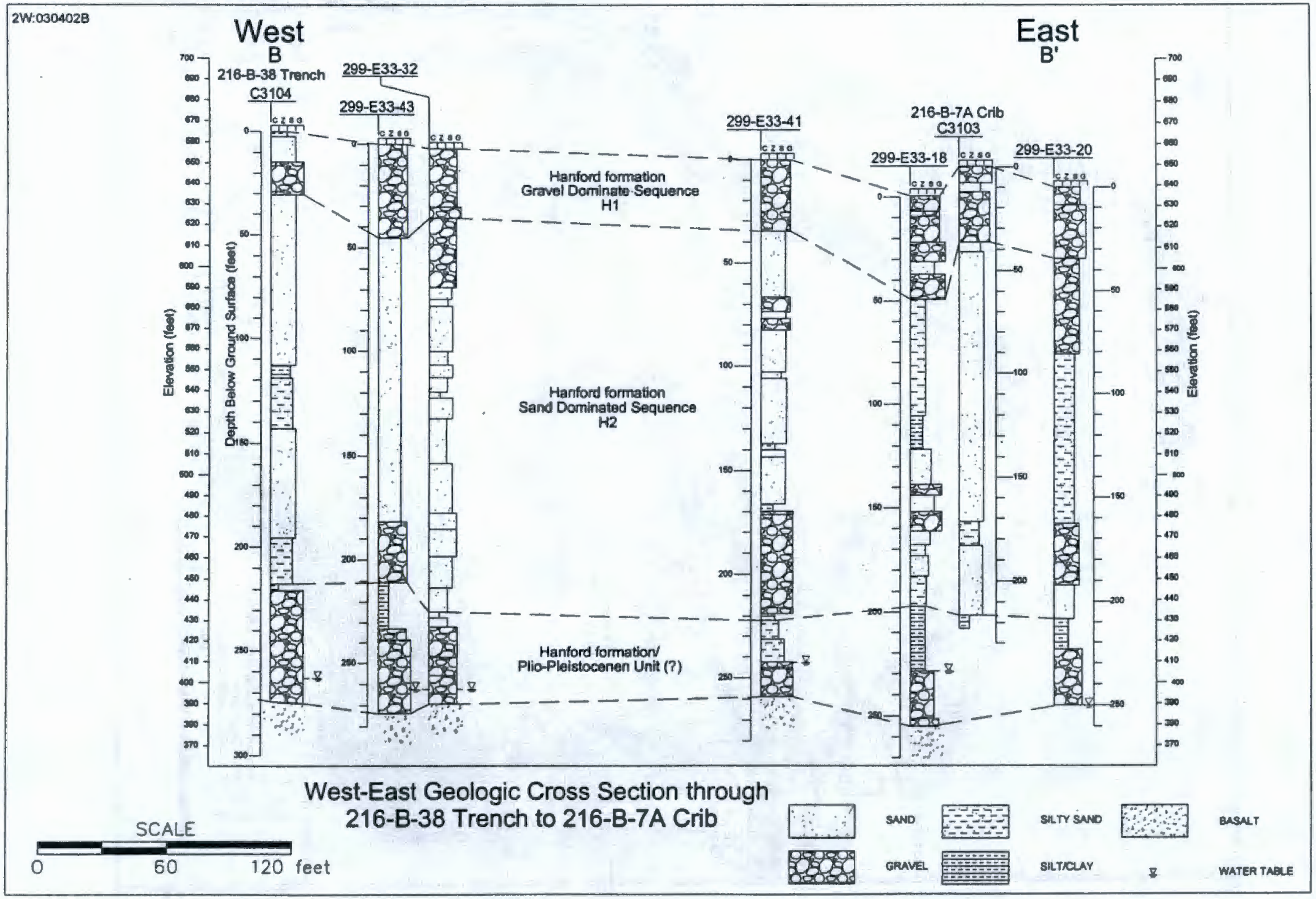


Figure 3-7. Topographic Map of the Hanford Site.

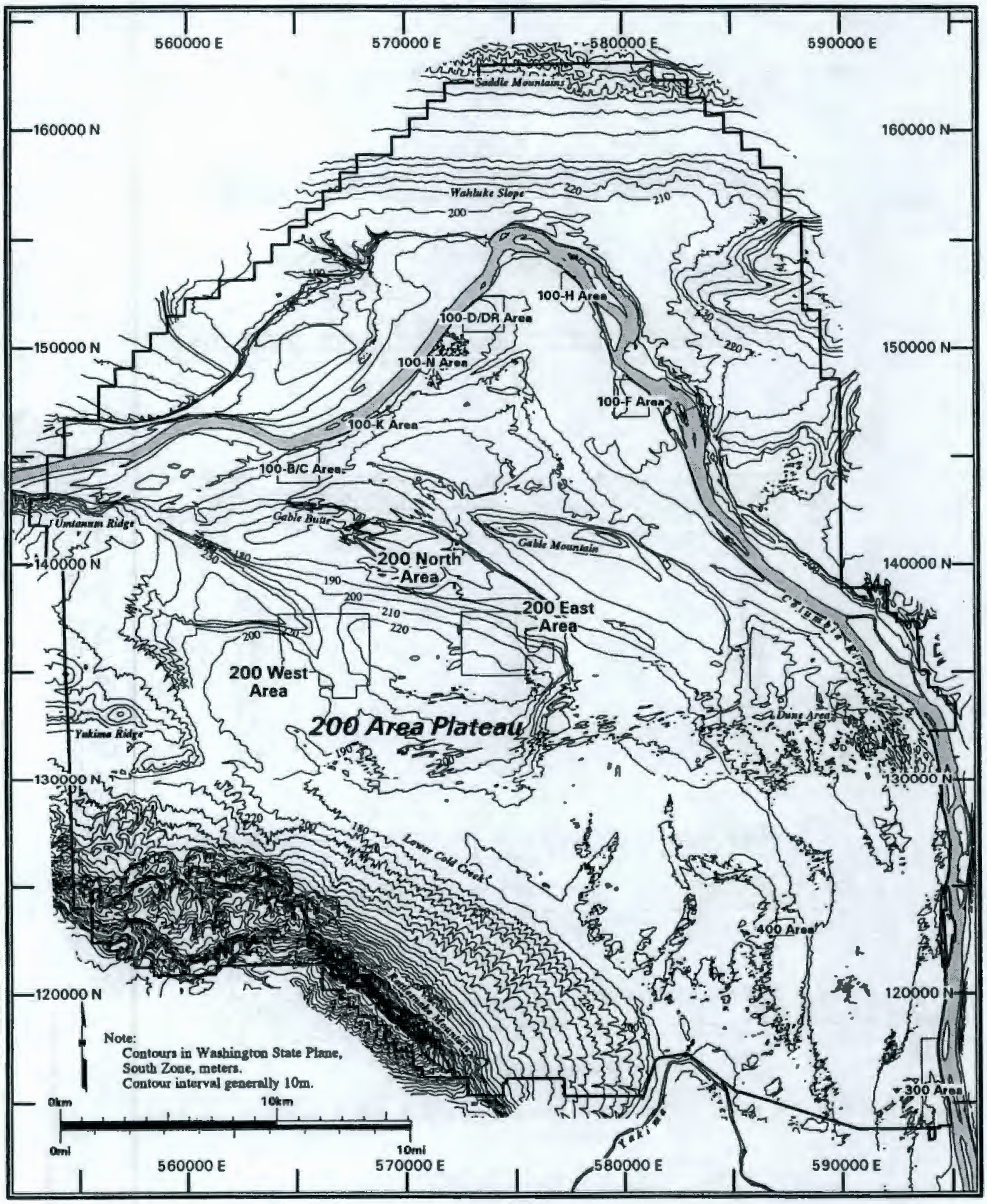
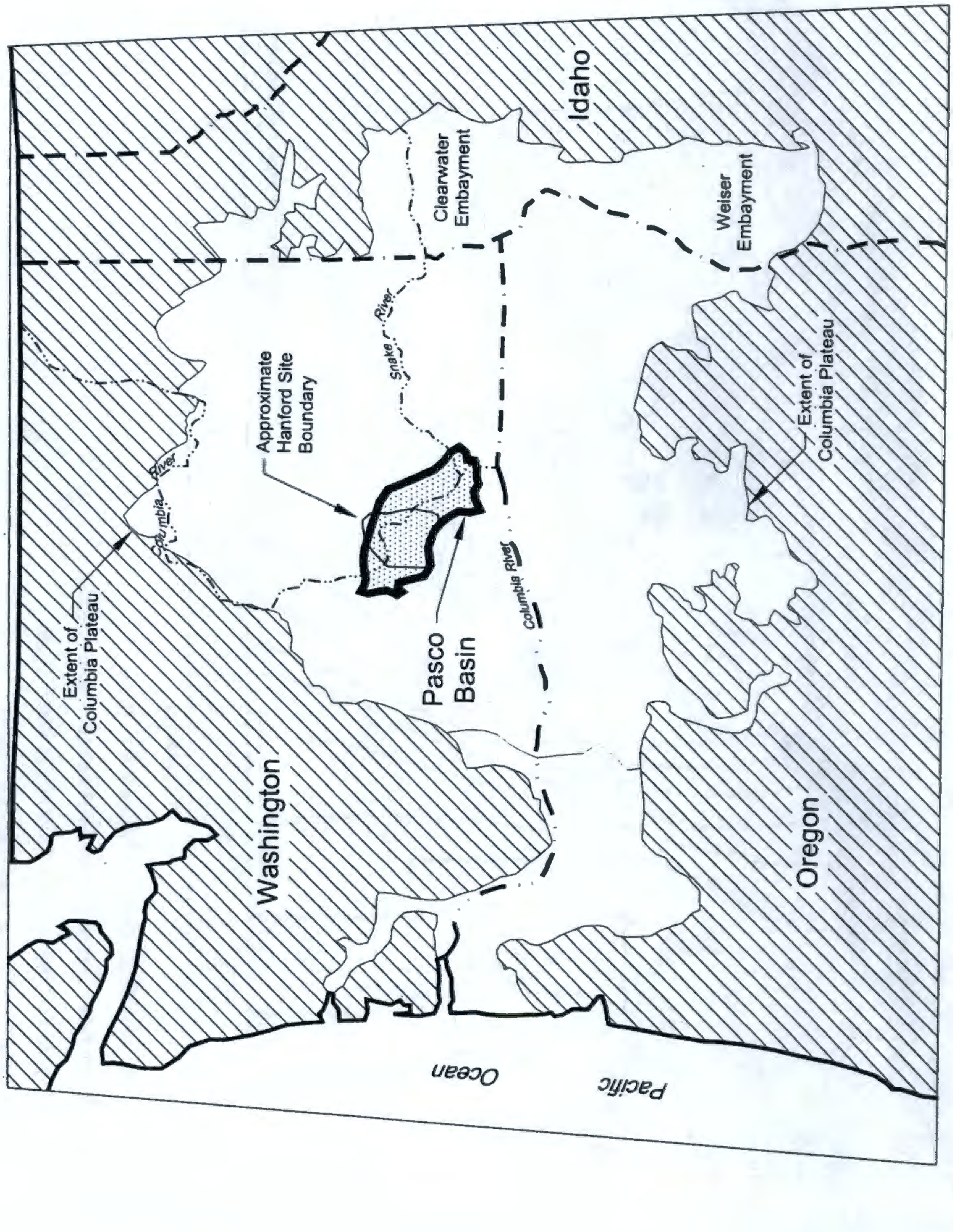


Figure 3-8. Pasco Basin Location Map.



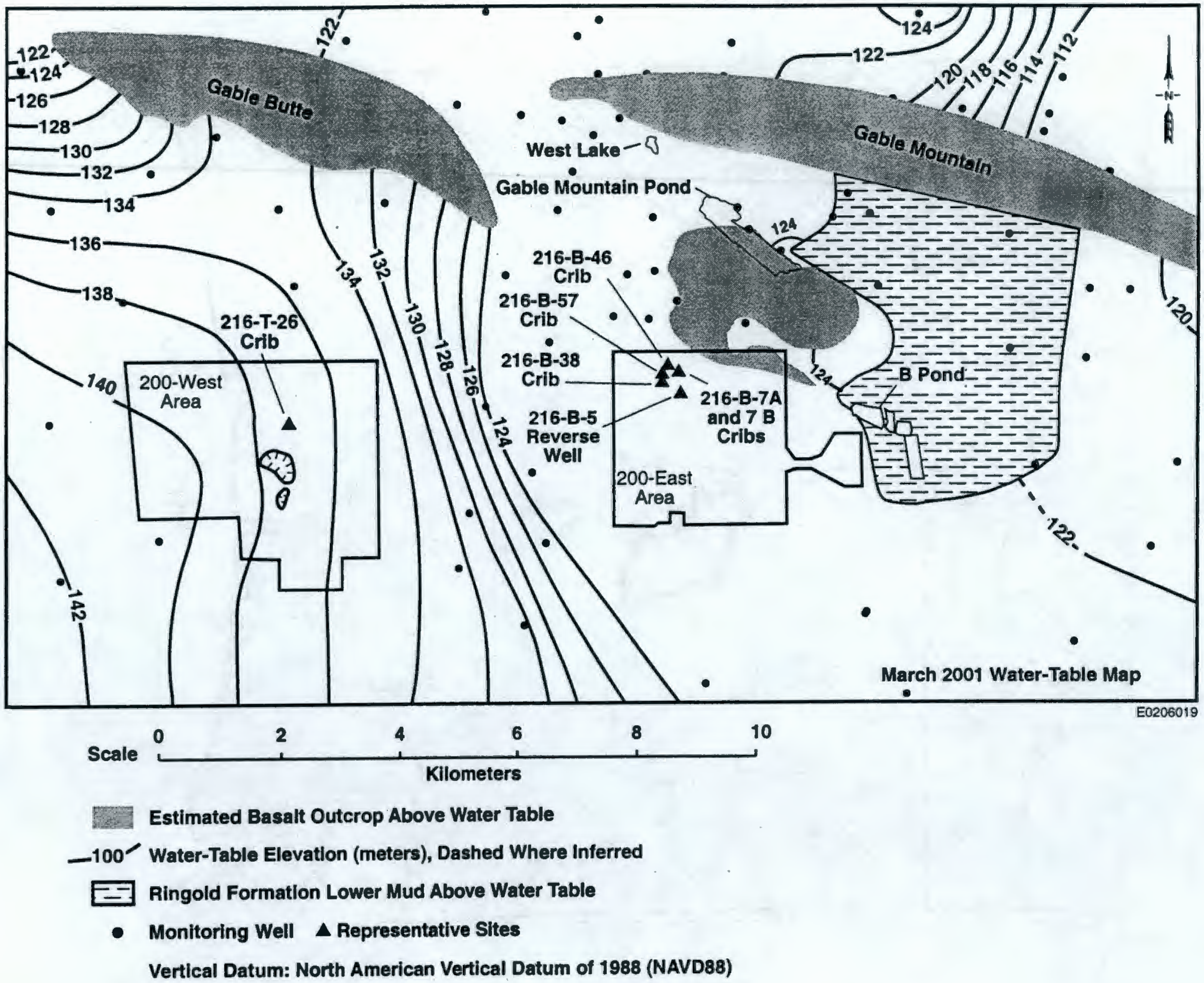
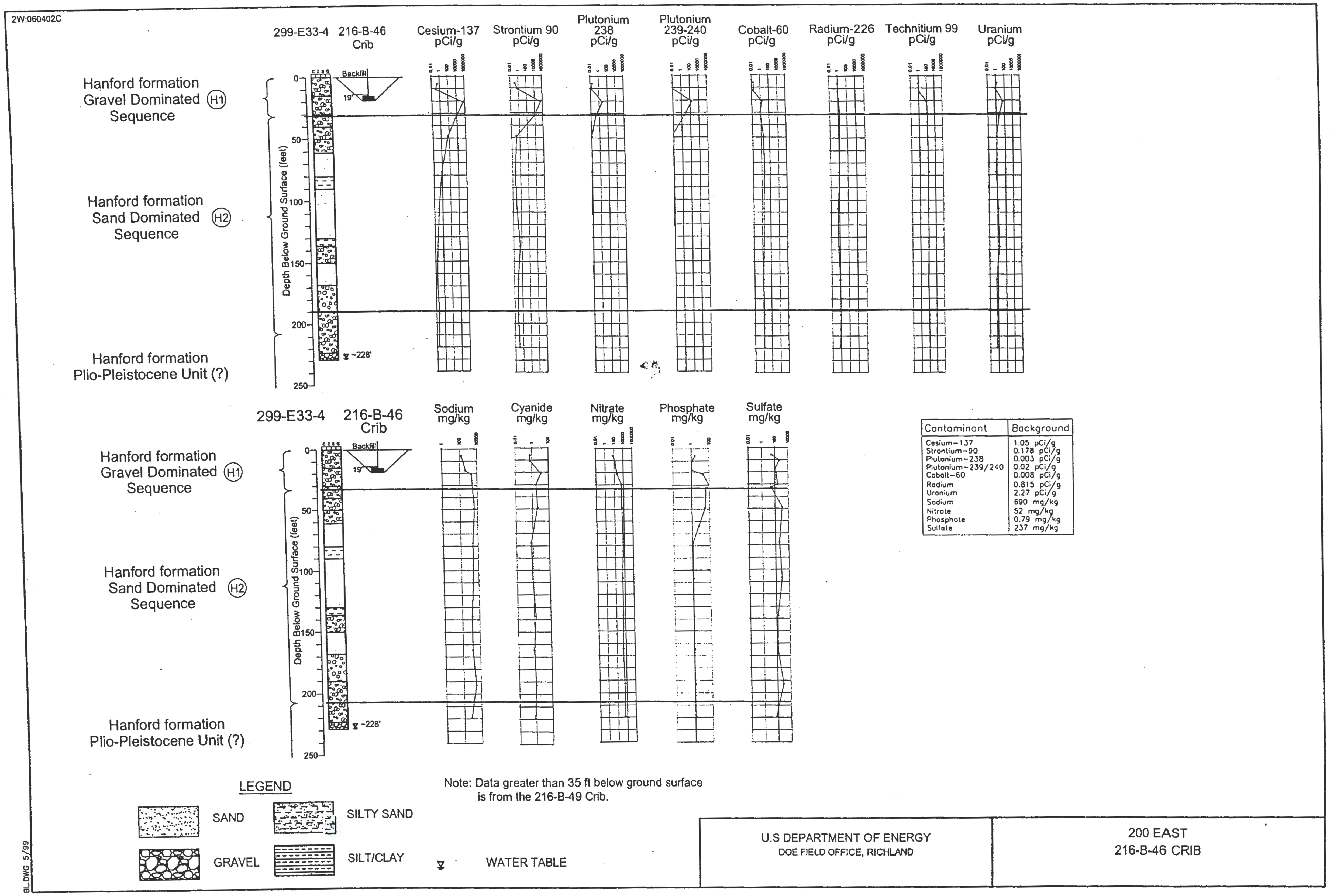


Figure 3-9. 200 Area Water Table Map.

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



Contaminant	Background
Cesium-137	1.05 pCi/g
Strontium-90	0.178 pCi/g
Plutonium-238	0.003 pCi/g
Plutonium-239/240	0.02 pCi/g
Cobalt-60	0.008 pCi/g
Radium	0.815 pCi/g
Uranium	2.27 pCi/g
Sodium	690 mg/kg
Nitrate	52 mg/kg
Phosphate	0.79 mg/kg
Sulfate	237 mg/kg

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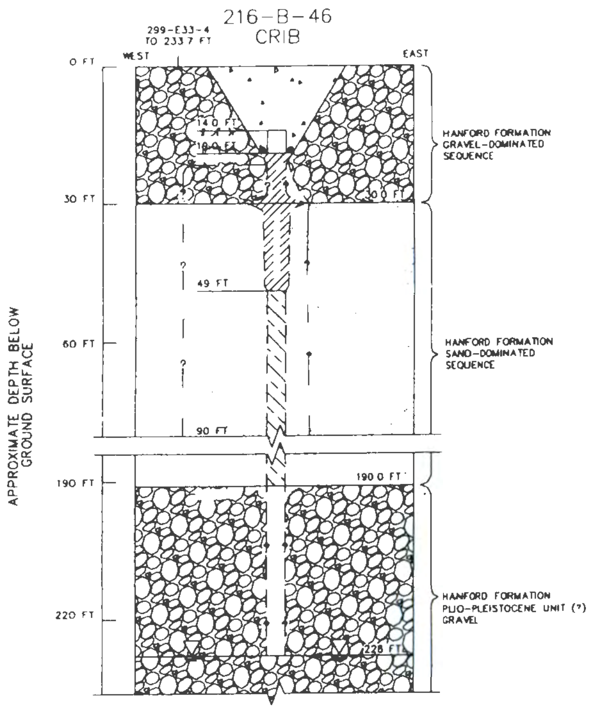


SOIL CONTAMINATION

0-18 FT
- NITRATE 60.3-135 mg/kg
- PHOSPHATE 1.3-3.0 mg/kg
- STRONTIUM-90 0.6-2.9 pCi/g
- SULFATE 268-477 mg/kg
- RADIUM-226 < 1.0 pCi/g

18-49 FT
- ANTIMONY-125 22.7-50.4 pCi/g
- CESIUM-137 50.1-364,000 pCi/g
- COBALT-60 0.685 pCi/g
- CYANIDE 3.2-7.1 mg/kg
- PHOSPHATE 14-42 mg/kg
- NITRATE 316-4840 mg/kg
- NITRITE 2.8-12.2 mg/kg
- PLUTONIUM-238 0.115-6.94 pCi/g
- PLUTONIUM-239 < 1.0 pCi/g
- PLUTONIUM-239/240 3.53-227 pCi/g
- RADIUM-226 0.872-2.44 pCi/g
- SODIUM 1590-4390 mg/kg
- STRONTIUM-90 2.6-353000 pCi/g
- SULFATE 264-1080 mg/kg
- TECHNETIUM-99 90-120 pCi/g
- TRITIUM 21-53 pCi/g
- TOTAL URANIUM 4.1-35.3 mg/kg

49-190 FT
- COBALT-60 1.24-4.03 pCi/g
- CYANIDE 1.5 mg/kg
- NITRATE 2220-5470 mg/kg
- RADIUM-226 < 1.01 pCi/g
- SODIUM 1370-2410 mg/kg
- STRONTIUM-90 < 1.0 pCi/g
- SULFATE 362-822 mg/kg
- TECHNETIUM-99 65-160 pCi/g
- TOTAL URANIUM 2.4 mg/kg

>190 FT
- BISMUTH 31.3 mg/kg
- COBALT-90 1.45-1.65 pCi/g
- CYANIDE 1.2 mg/kg
- NITRATE 3760-3710 mg/kg
- SODIUM 2750 mg/kg
- SULFATE 722 mg/kg
- TECHNETIUM-99 100-140 pCi/g

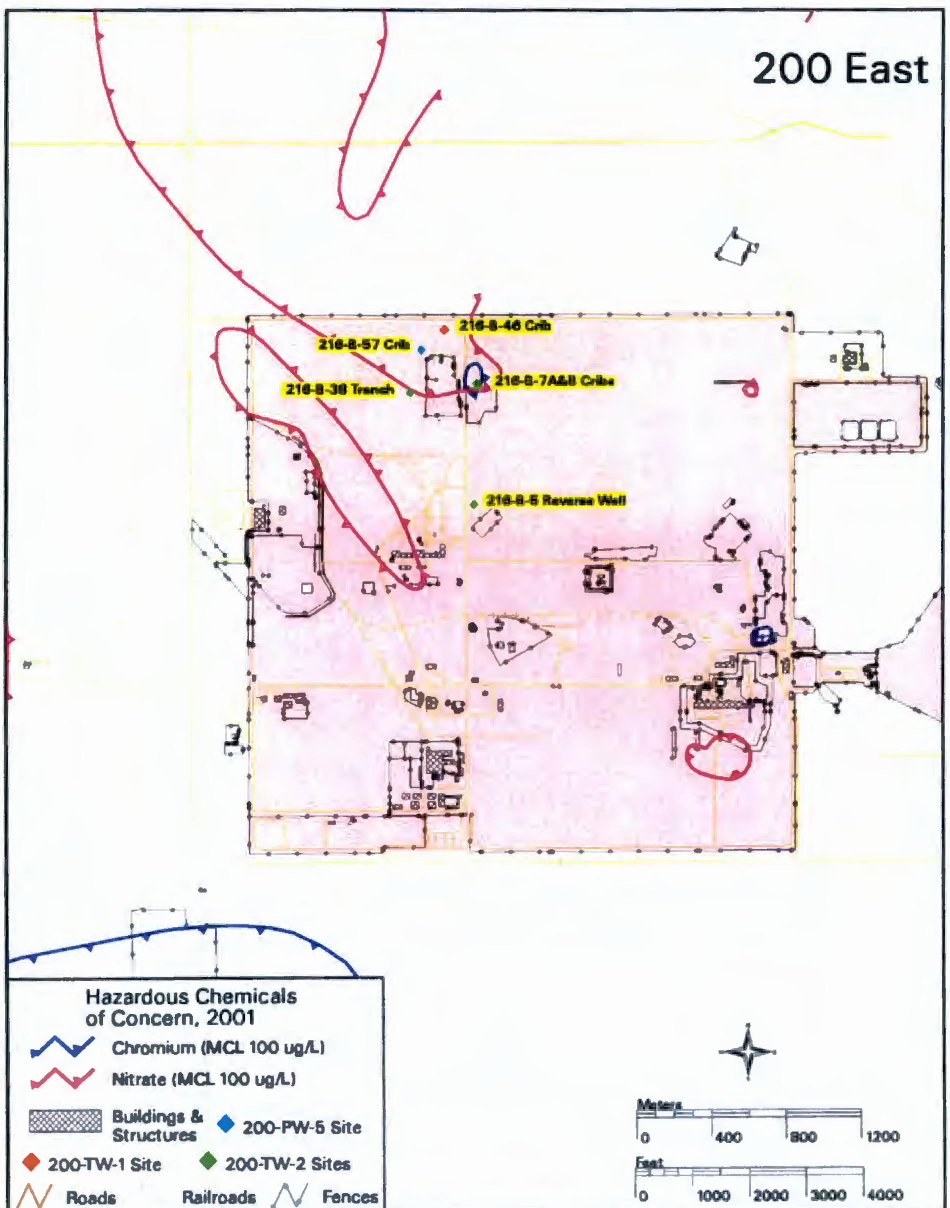
RLS DATA CESIUM-137

? UNCERTAINTY

U.S DEPARTMENT OF ENERGY DOE FIELD OFFICE, RICHLAND HANFORD ENVIRONMENTAL RESTORATION PROGRAM	216-B-46 CRIB CONTAMINANT DISTRIBUTION MODEL

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

Figure 3-12. Nonradiological Groundwater Plumes in the Vicinity of the 200 East Area.



BHI:rmaa 1/12/00 /home/maaye/amls/rads2east.aml 15-JUL-2002

Figure 3-13. Radiological Groundwater Plumes in the Vicinity of the 200 East Area.

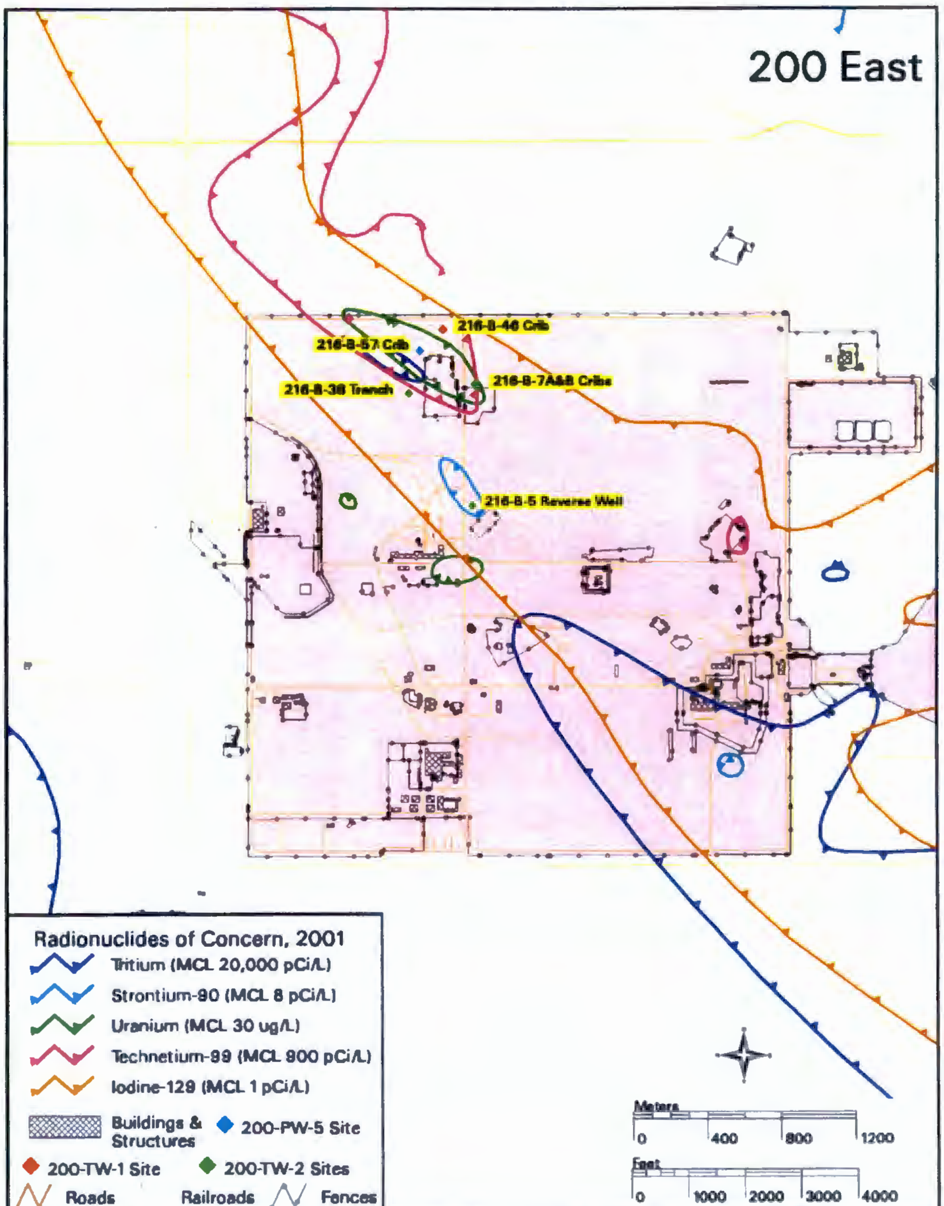


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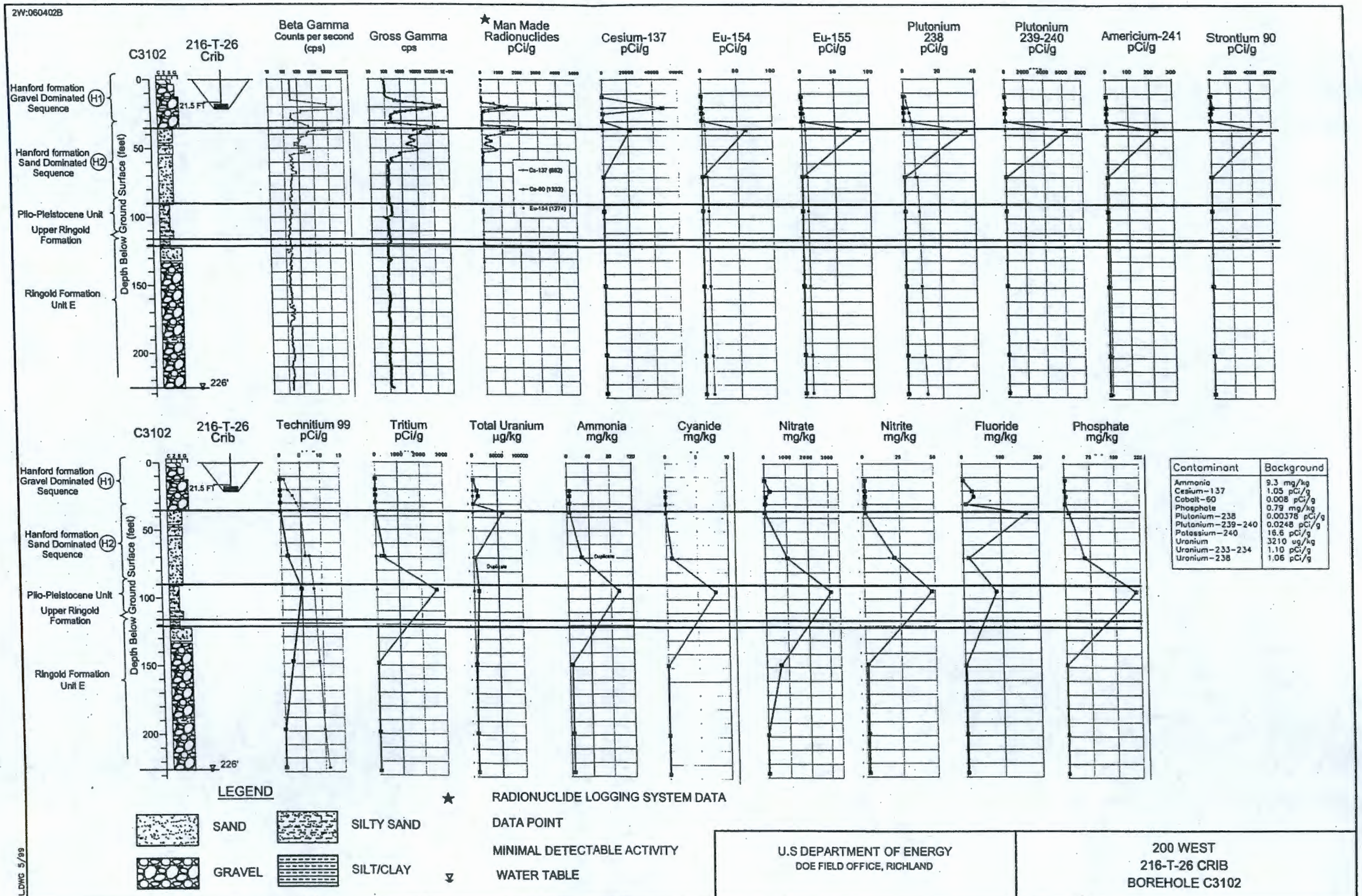
Figure 3-14. Vertical Profile of the Contamination at the 216-T-26 Crib with Correlation to Stratigraphy and Geophysical Log Data.



G:\200W\TW1-TW2\060402b.dwg, 08/08/2002 10:55:43 AM

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

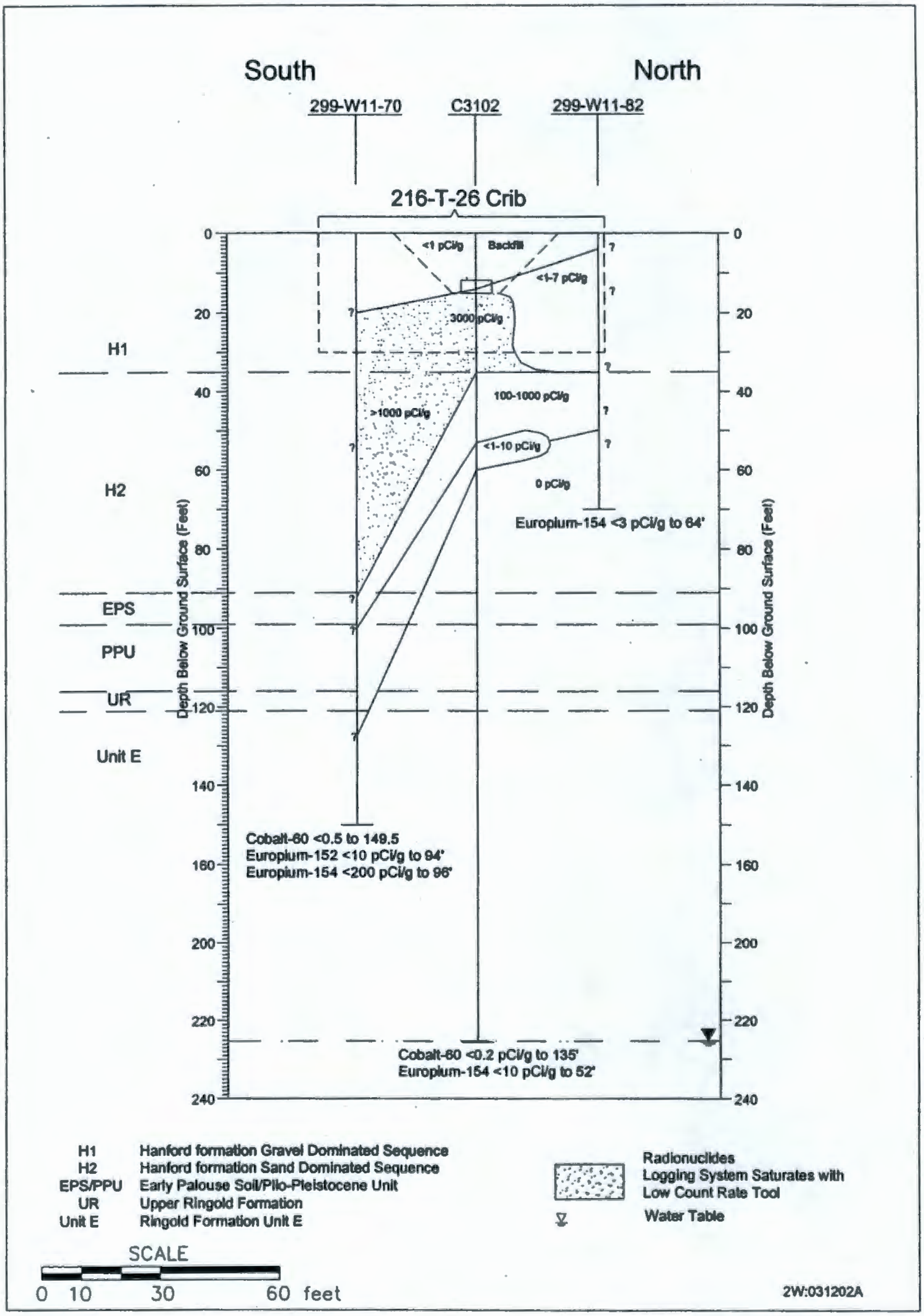


Figure 3-16. 216-T-26 Crib Contaminant Distribution Model.

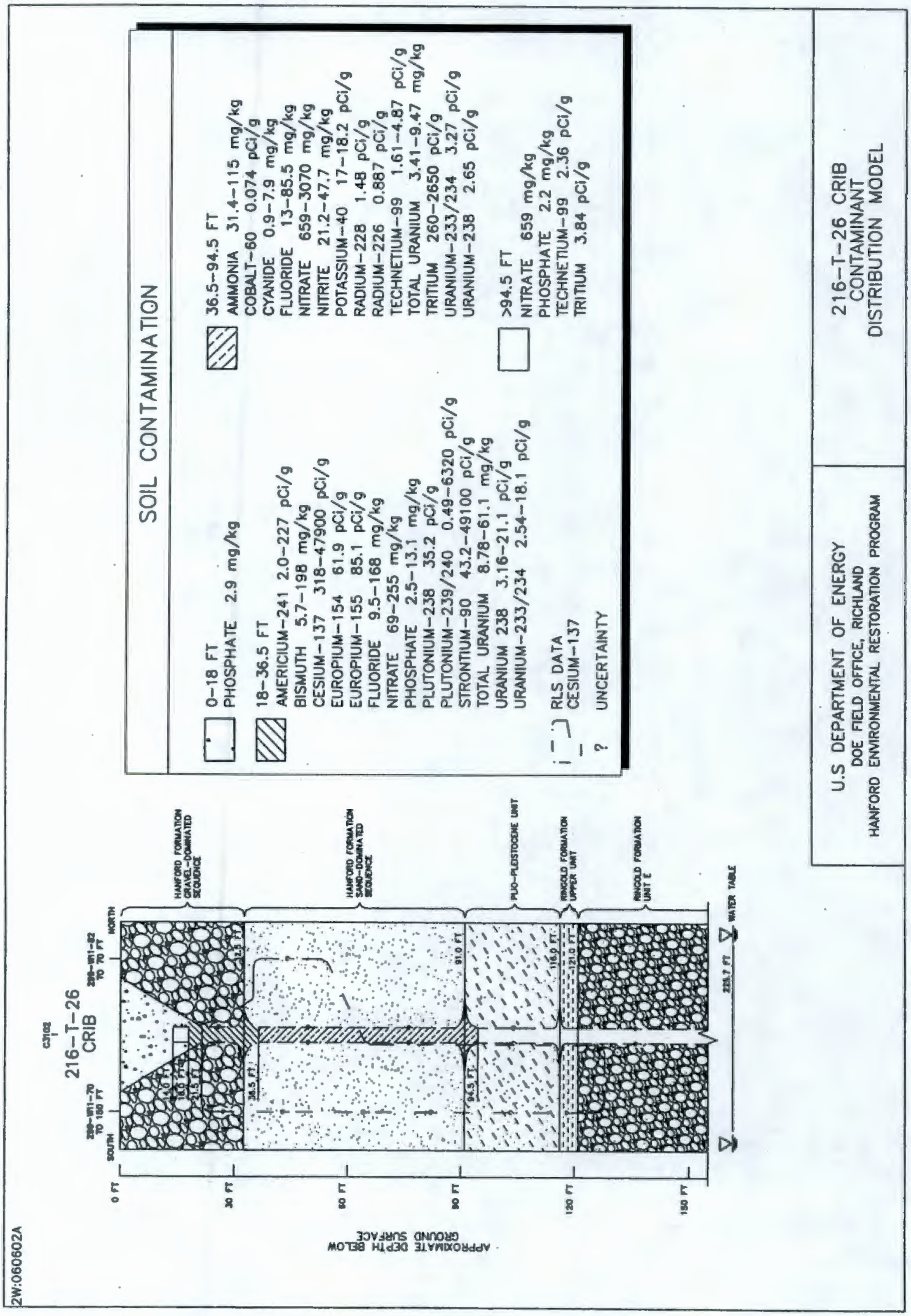


Figure 3-17. Nonradiological Groundwater Plumes in the Vicinity of the 200 West Area.

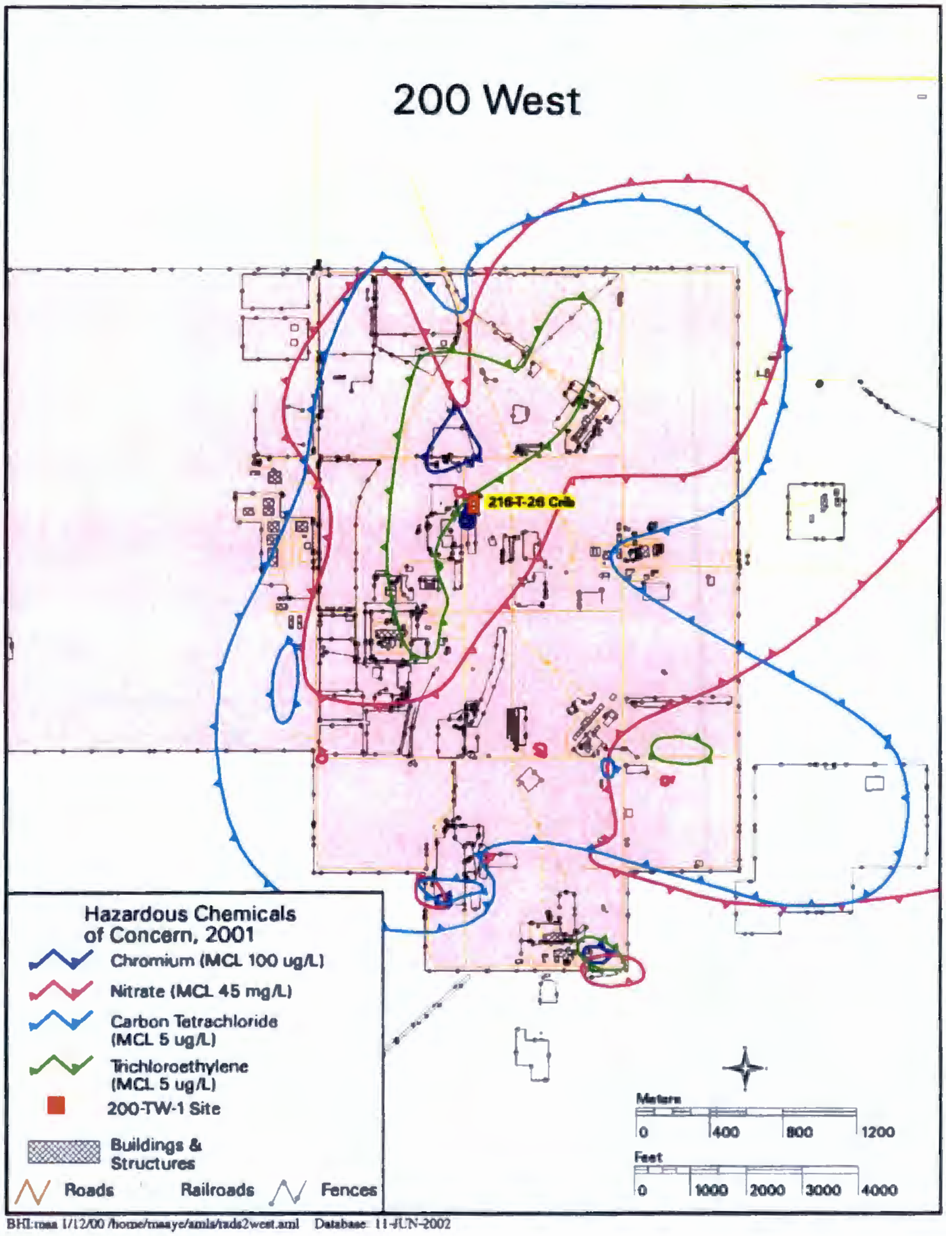
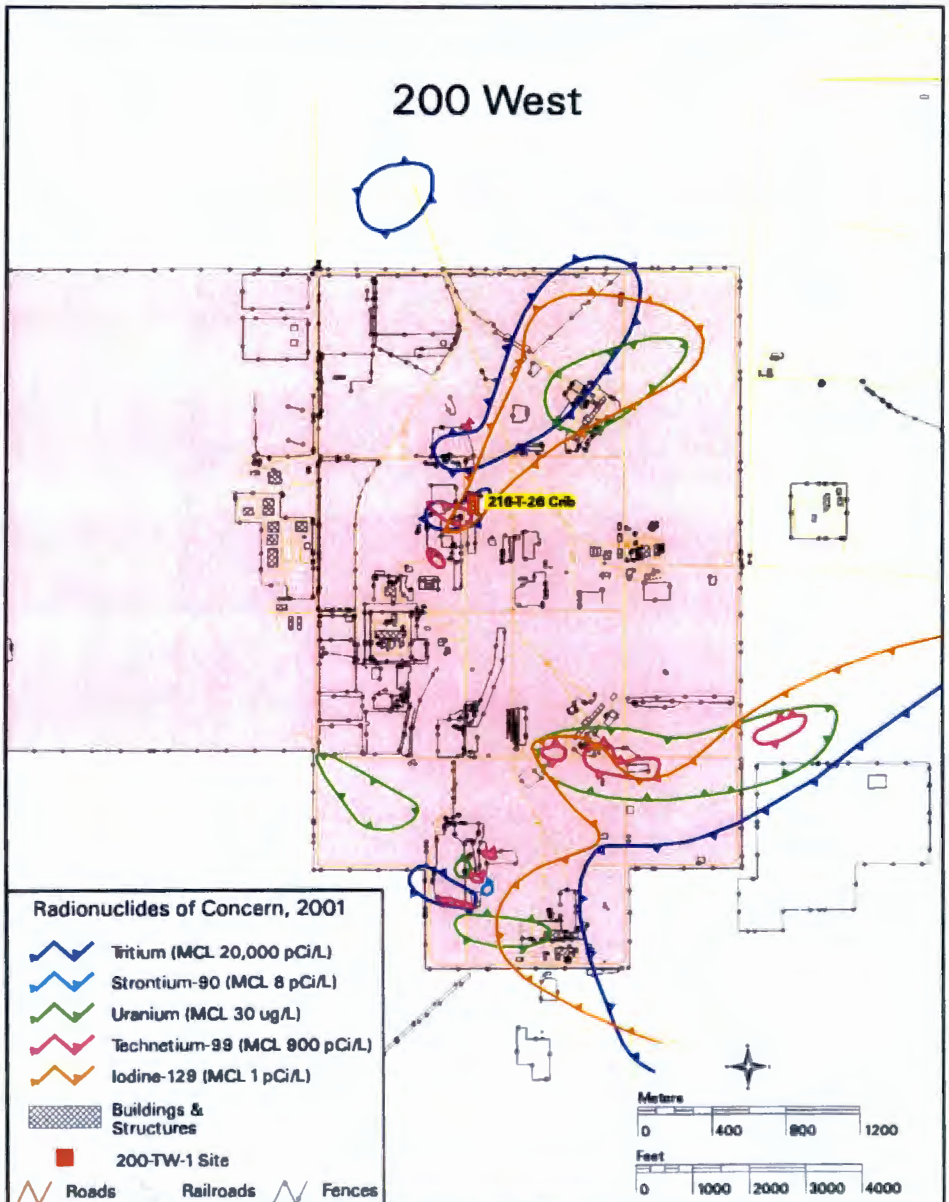


Figure 3-18. Radiological Groundwater Plumes in the Vicinity of the 200 West Area.



BHI:maa 1/12/00 /home/maaye/amls/rads2west.aml Database: 15-JUL-2002

Figure 3-19. Distribution of Cesium-137 at the 216-B-5 Reverse Well – Modified from Smith (1980) with RLS Data.

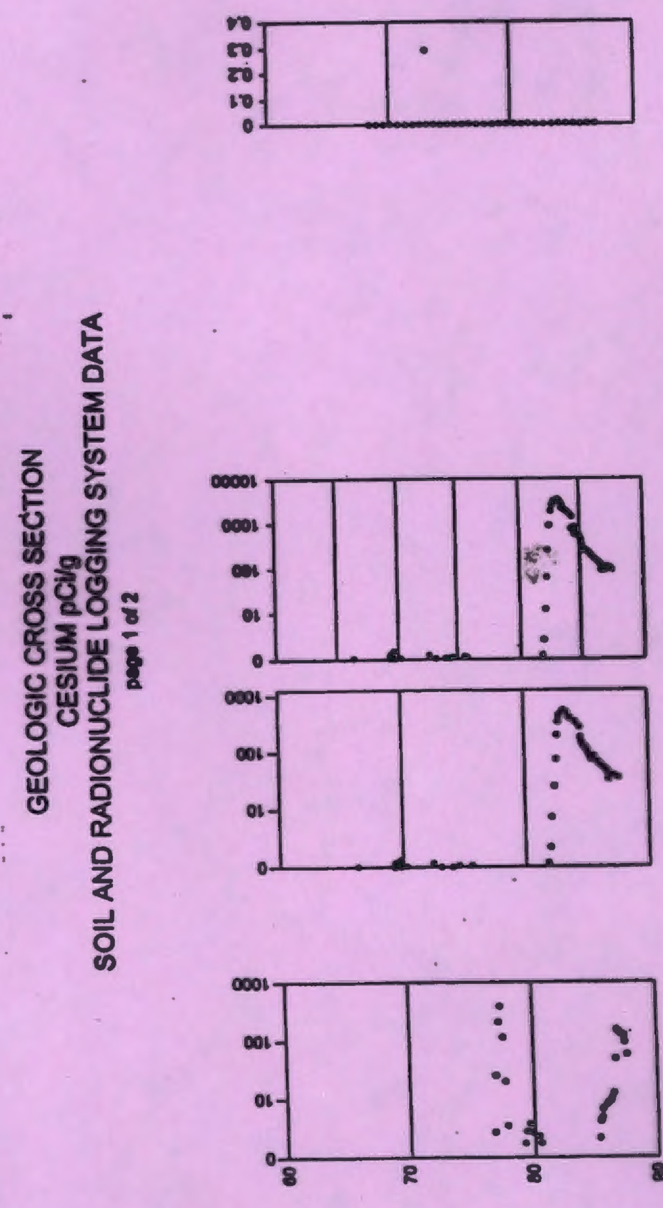


Figure 3-19. Distribution of Cesium-137 at the 216-B-5 Reverse Well – Modified from Smith (1980) with RLS Data.

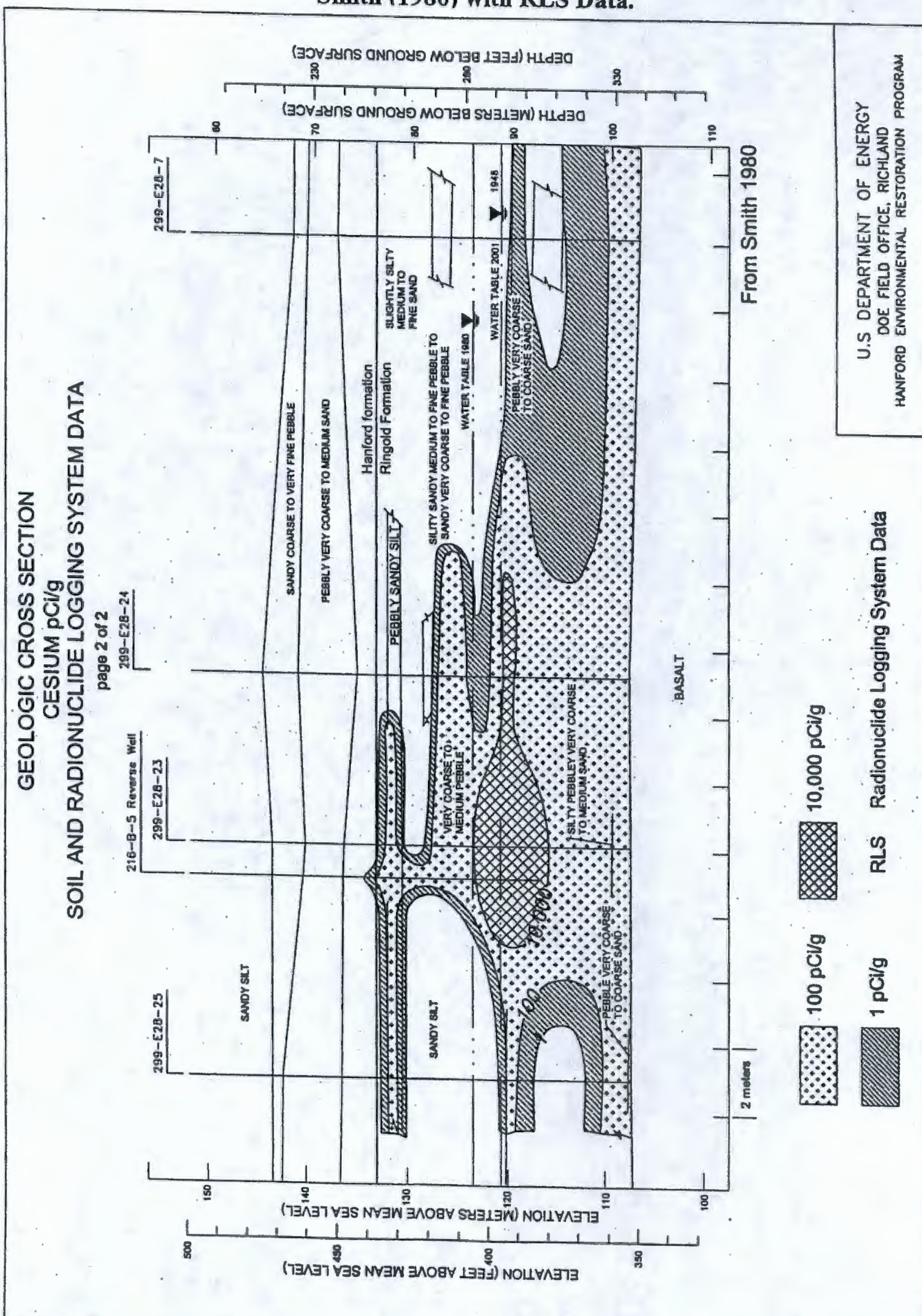


Figure 3-20. Distribution of Plutonium-239/240 at the 216-B-5 Reverse Well – Modified from Smith (1980).

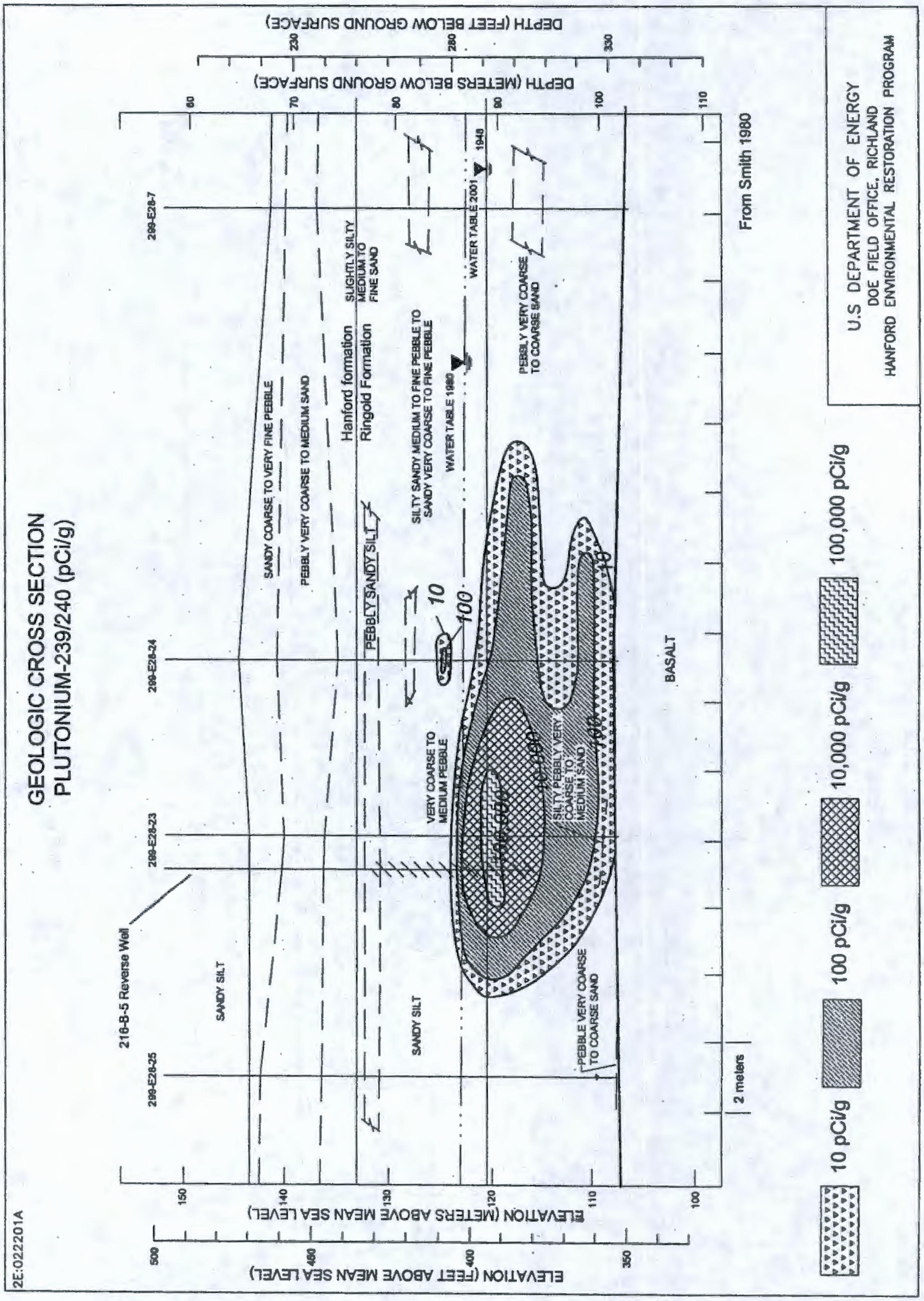


Figure 3-21. Distribution of Strontium-90 at the 216-B-5 Reverse Well – Modified from Smith (1980).

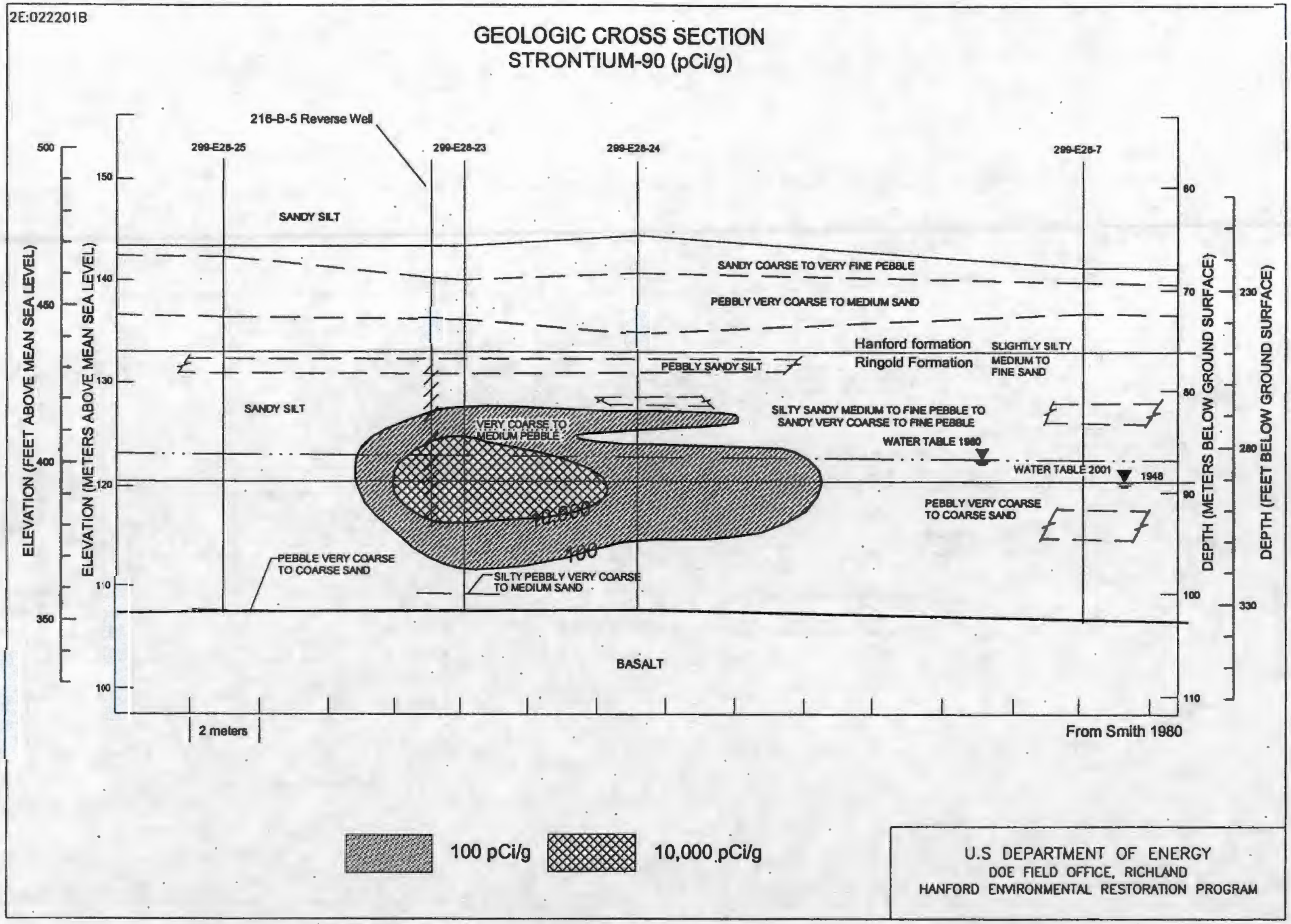
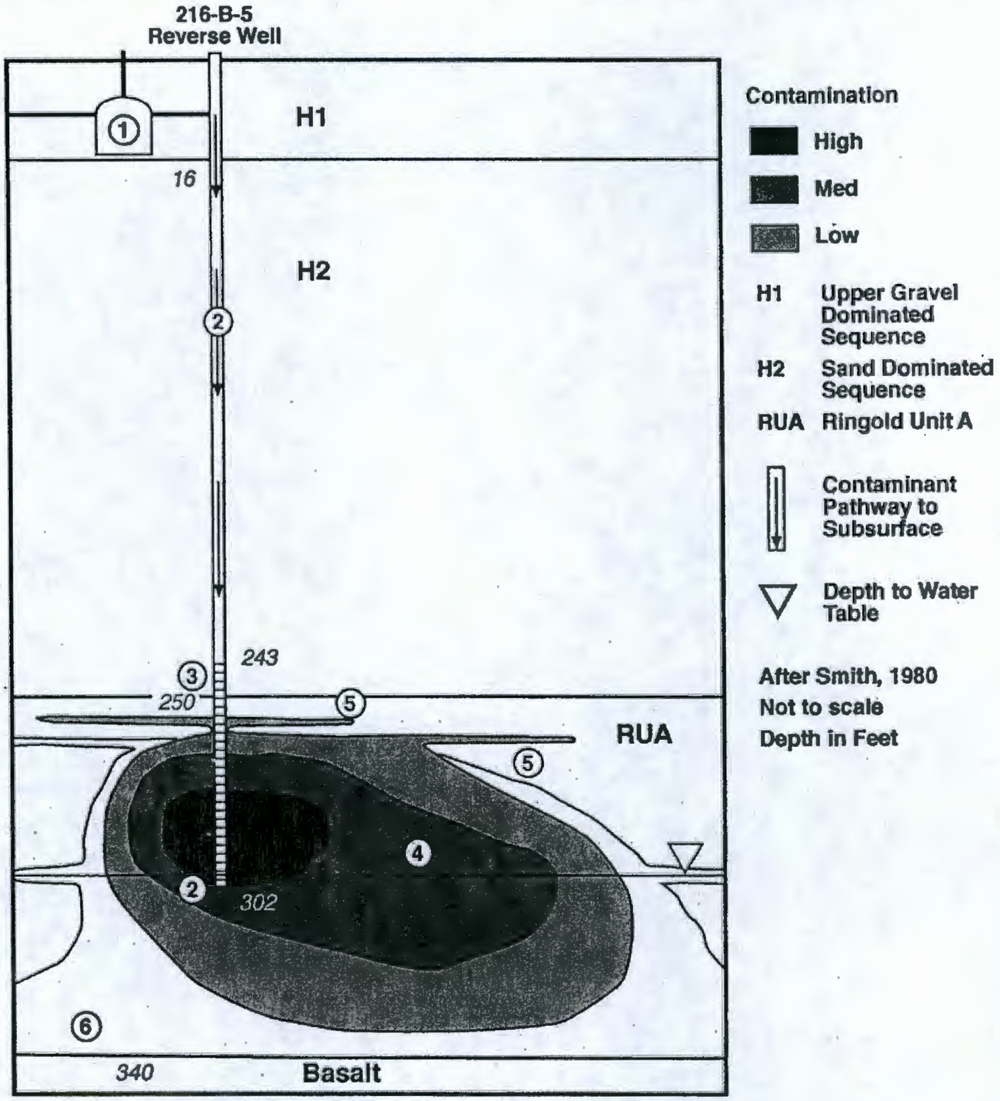


Figure 3-22. 216-B-5 Reverse Well Contaminant Distribution Model.



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.

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

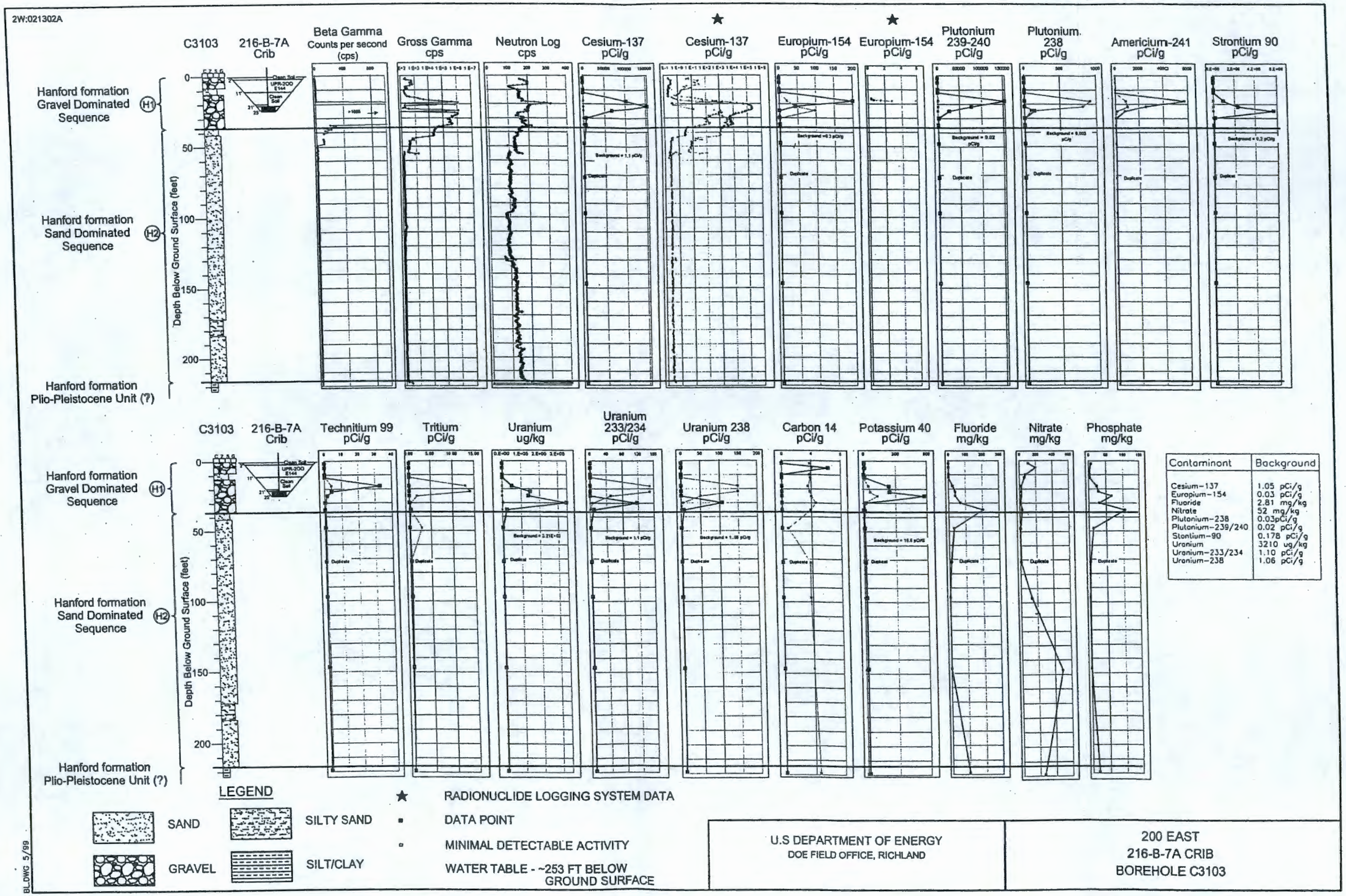


Figure 3-24. North-South Cross-Section of Vertical and Lateral Extent of Cesium-137 at 216-B-7A Crib – RLS Data.

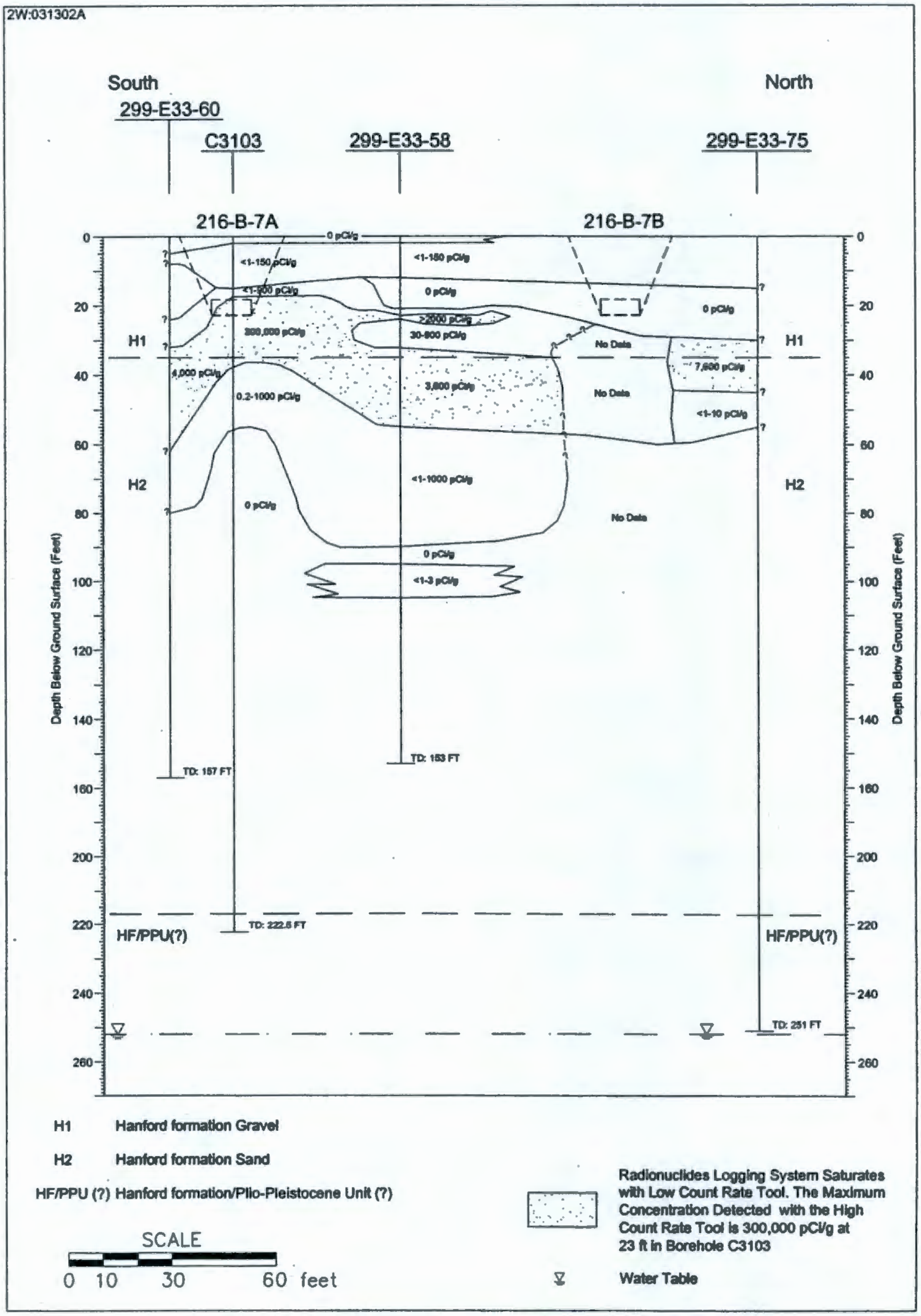
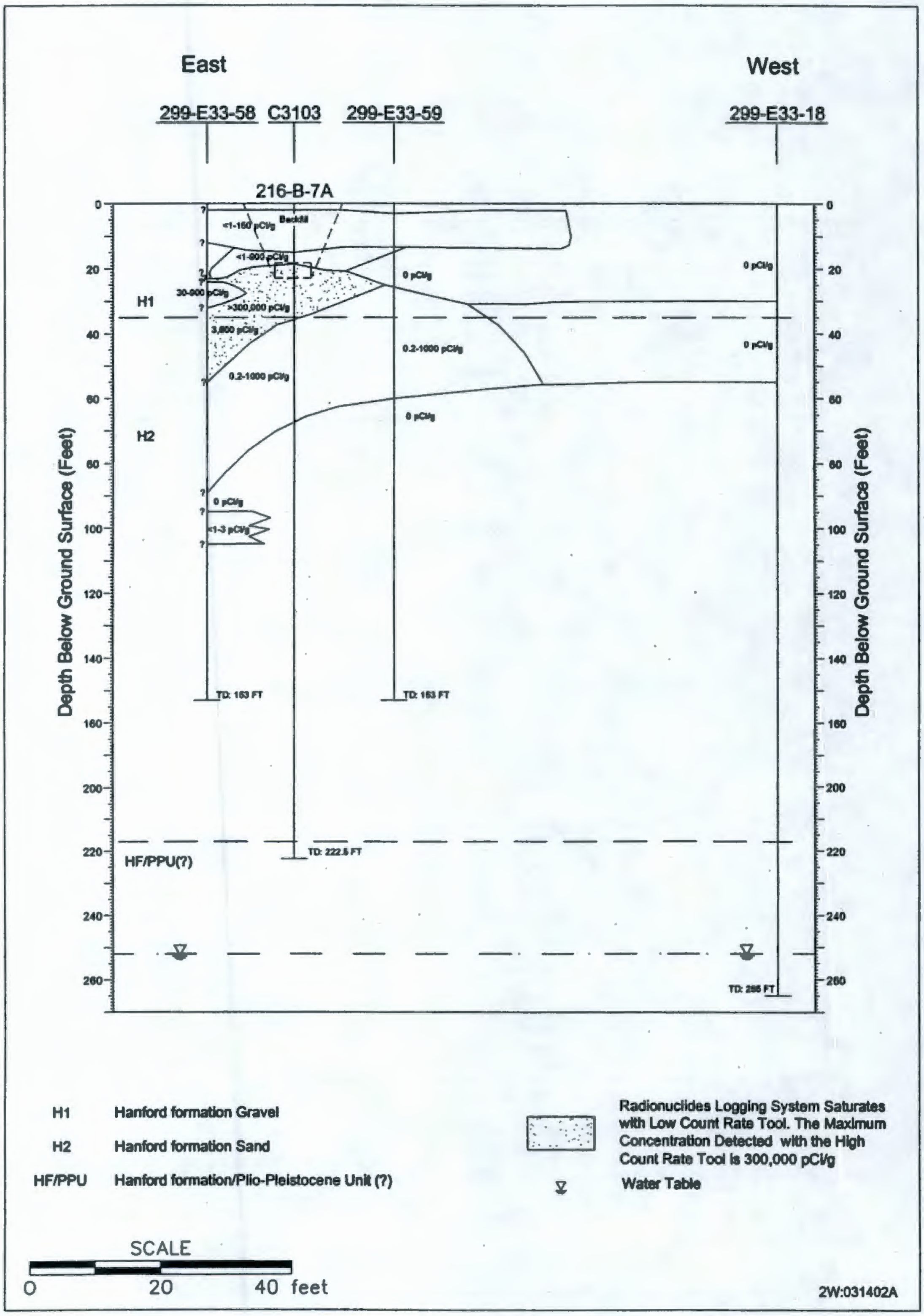


Figure 3-25. East-West Cross-Section of Vertical and Lateral Extent of Cesium-137 at 216-B-7A Crib – RLS Data.



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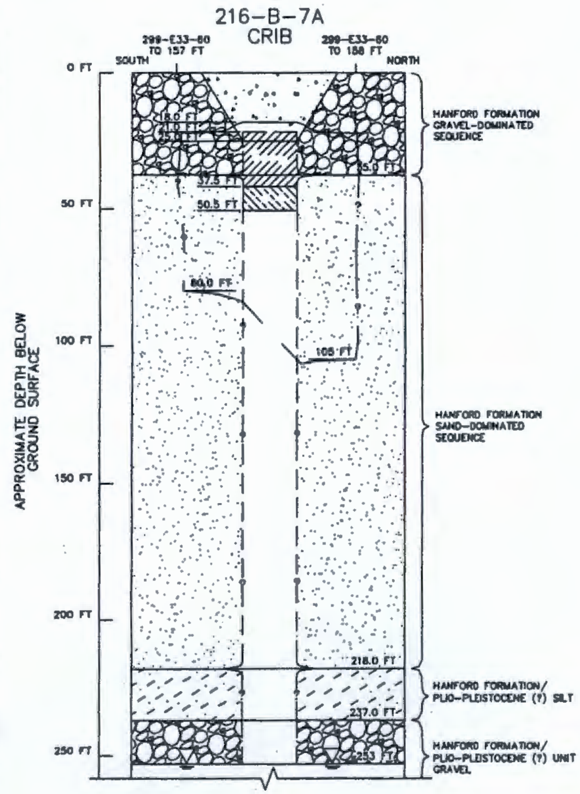


SOIL CONTAMINATION

0-18 FT
AMMONIA 25.9 mg/kg
CARBON-14 6.3 pCi/g
CESIUM-137 1.52-42.5 pCi/g
NITRATE 65-110 mg/kg
PHOSPHATE 3.0-7.3 mg/kg
STRONTIUM-90 2.66-13.5 pCi/g

18-37.5 FT
AMERICIUM-241 21.8-5690 pCi/g
BISMUTH 3300 mg/kg
CESIUM-137 5910-153000 pCi/g
EUROPIUM-154 200 pCi/g
IRON 34900 mg/kg
MANGANESE 1650 mg/kg
NITRATE 93.8-126 mg/kg
PLUTONIUM-238 140 pCi/g
PHOSPHATE 22.4-105 mg/kg
PLUTONIUM-239/240 1360-153000 pCi/g
POTASIUM-40 236-572 pCi/g
SODIUM 1310 mg/kg
STRONTIUM-90 128000-5710000 pCi/g
TECHNETIUM-99 1.56-32.9 pCi/g
TRITIUM 0.328 pCi/g
TOTAL URANIUM 24.2-147.0 mg/kg
URANIUM 238 7.5-108 pCi/g
URANIUM-233/234 8.1-117 pCi/g

37.5-50.5 FT
AMERICIUM-24 0.07 pCi/g
AMMONIA 28.8 mg/kg
CESIUM-137 ≤ 5.06 pCi/g
PHOSPHATE 12.7 mg/kg
PLUTONIUM-239/240 < 2 pCi/g
STRONTIUM-90 39.5-98.3 pCi/g

>50.5 FT
AMMONIA 11.6-101 mg/kg
NITRATE 133-493 mg/kg
PHOSPHATE 2.3-17.8 mg/kg
TRITIUM 0.22-0.29 pCi/g

RLS DATA
CESIUM-137

? UNCERTAINTY

U.S DEPARTMENT OF ENERGY DOE FIELD OFFICE, RICHLAND HANFORD ENVIRONMENTAL RESTORATION PROGRAM	216-B-7A CRIB CONTAMINANT DISTRIBUTION MODEL

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

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

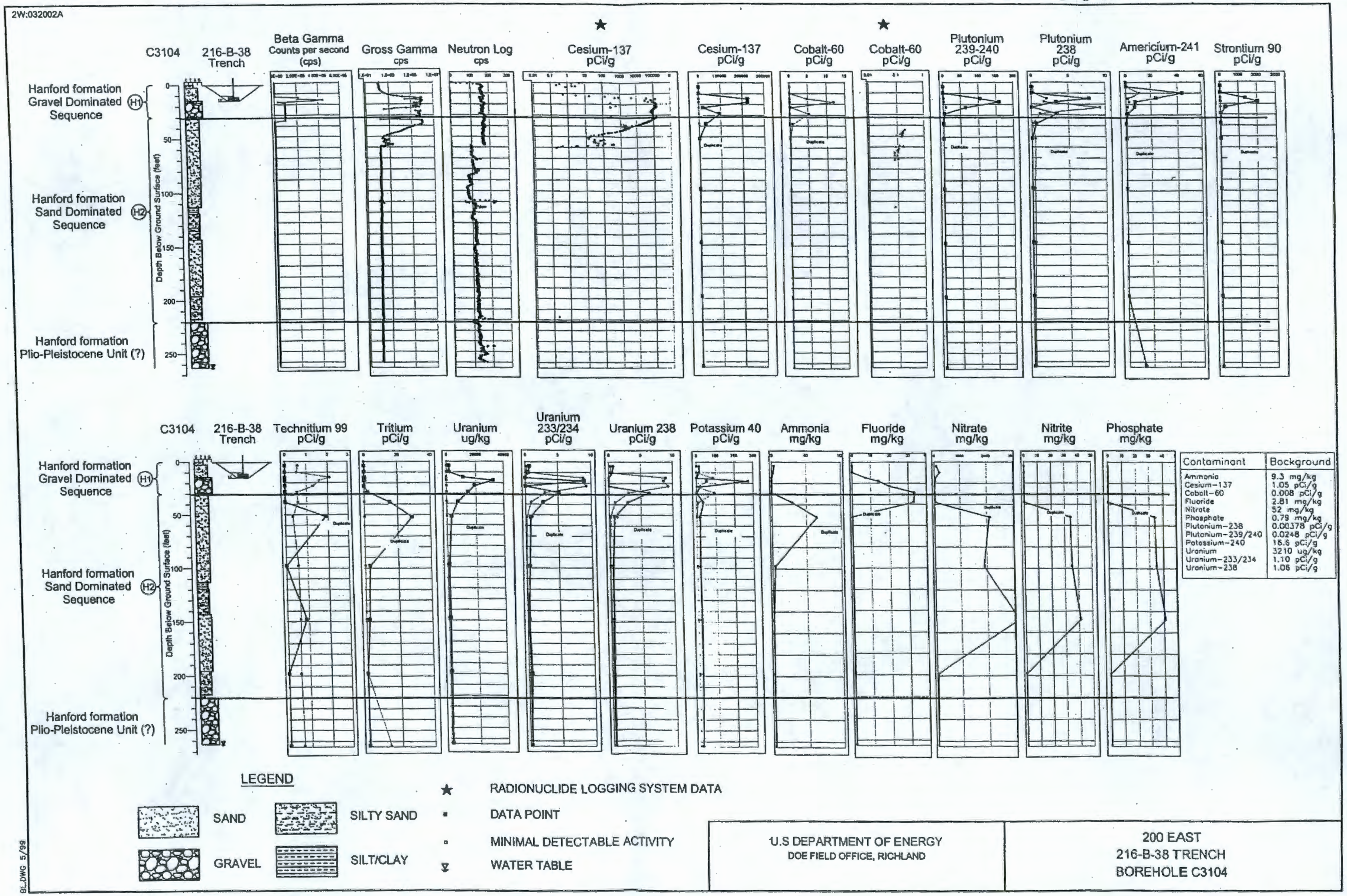
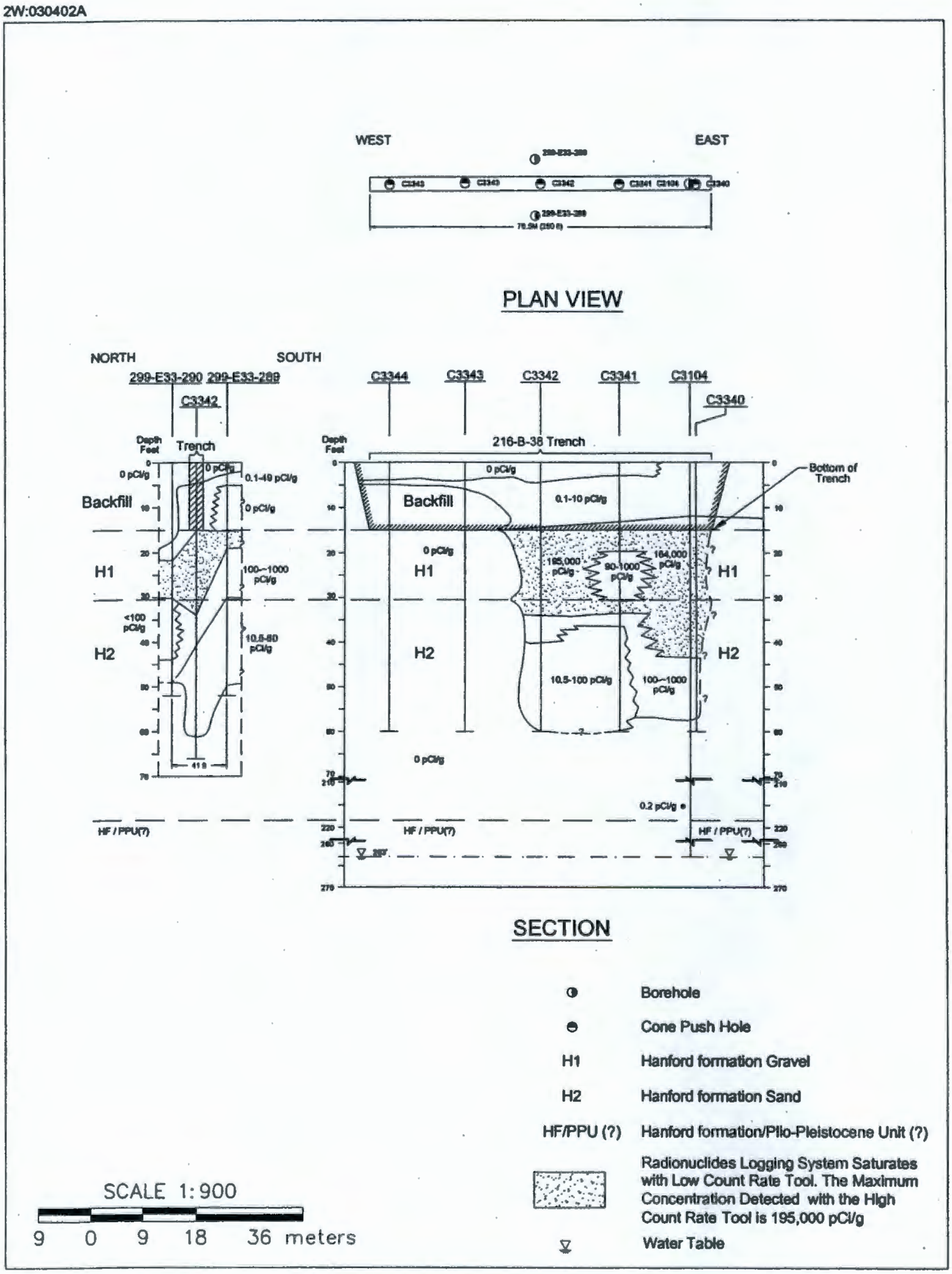


Figure 3-28. Vertical and Lateral Extent of Cesium-137 at 216-B-38 Trench – RLS Data.



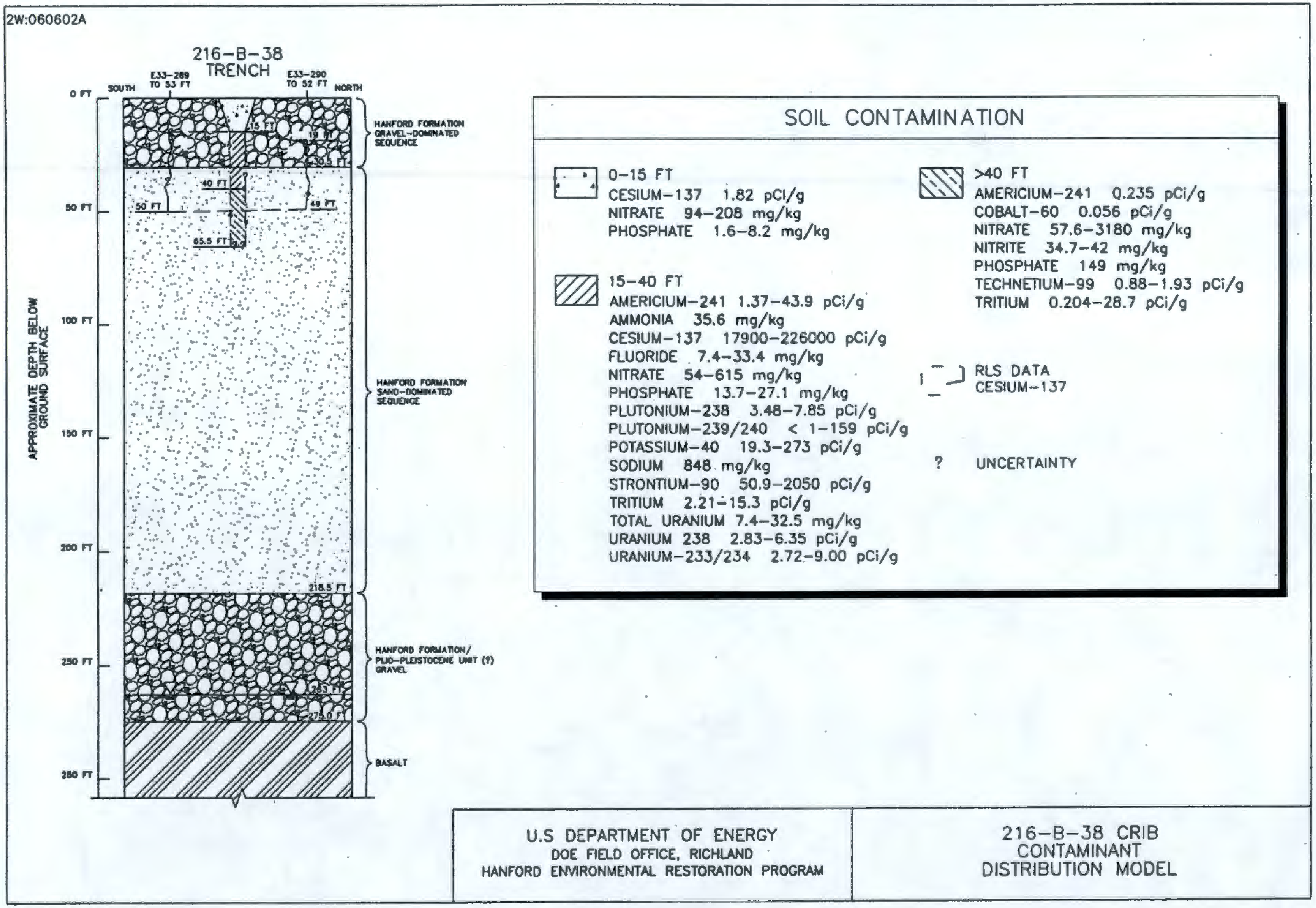
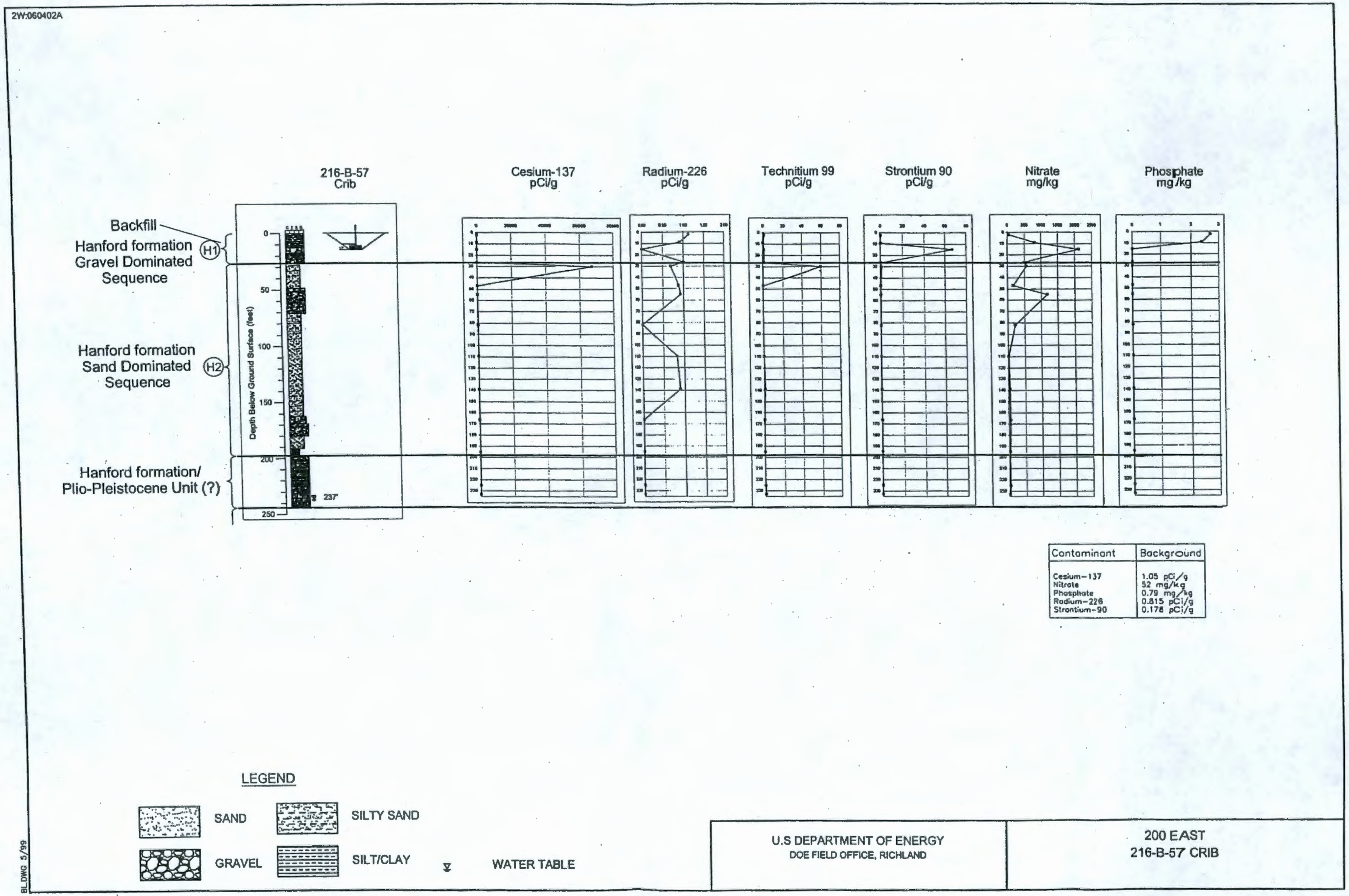


Figure 3-29. 216-B-38 Trench Contaminant Distribution Model.

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



Contaminant	Background
Cesium-137	1.05 pCi/g
Nitrate	52 mg/kg
Phosphate	0.79 mg/kg
Radium-226	0.815 pCi/g
Strontium-90	0.178 pCi/g

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

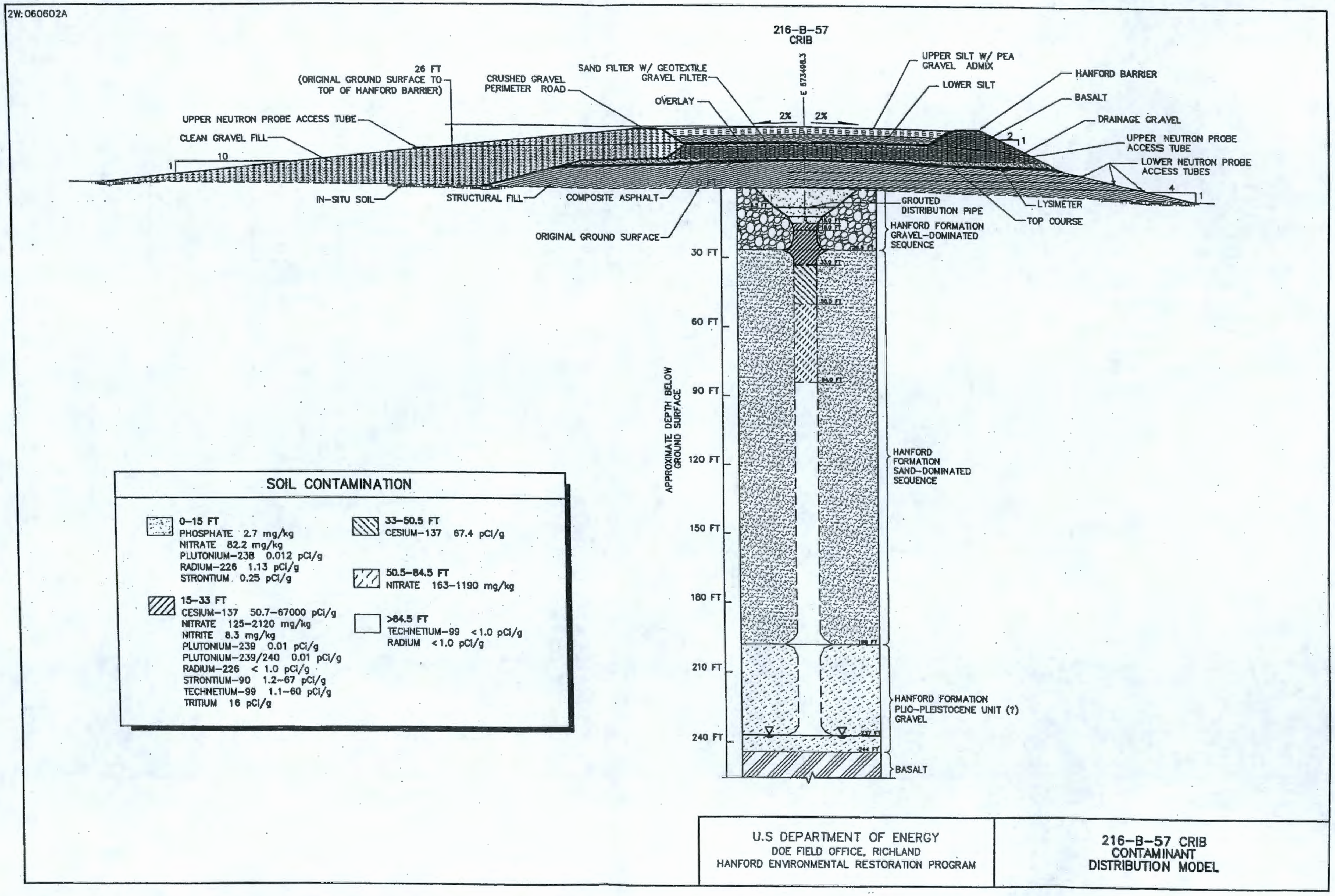


Table 3-1. Physical Property Testing Data.

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[a]	1.98	8.13	--
97.5	1.4	1.69	2.37	B12CB8
261	4.6[a]	1.91	8.80	--
216-B-7A Crib				
2.5	4.9	2.01	2.01	B12BR7
22.5	10[a]	2.06	2.06	--
25	18[a]	1.88	1.88	--
97.5	2.7	1.61	1.61	B12BR8
220	22.5	1.56	1.56	B12BR9

[a] 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	MTCA Method C	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	--	NC	227	NA	43.9	5,690	NA
Antimony-125	--	NC	NA	50.4	NA	NA	NA
Carbon-14	--	NC	ND	NA	ND	6.3	NA
Cesium-137	1.05	NC	47,900	364,000	226,000	153,000	67,000
Cobalt-60	0.00842	NC	0.074	4.03	0.056	ND	ND
Europium-152	--	NC	ND	ND	ND	ND	NA
Europium-154	0.0334	NC	61.9	ND	ND	200	NA
Europium-155	0.0539	NC	85.1	ND	ND	ND	NA
Neptunium-237	--	NC	ND	NA	ND	ND	NA
Nickel-63	--	NC	ND	NA	ND	ND	NA
Plutonium-238	0.00378	NC	35.2	6.94	7.85	140	0.012
Plutonium-239	--	NC	NA	0.93	NA	NA	0.01
Plutonium-239/240	0.0248	NC	6,320	227	159	153,000	0.00325
Potassium-40	16.6	NC	18.2	16.5	273	572	16.6
Radium-226	0.815	NC	0.887	2.44	0.594	0.682	1.13
Radium-228	1.32[c]	NC	1.48	NA	0.974	1.07	NA
Total radioactive strontium	0.178	NC	49,100	353,000	2,050	5,710,000	67
Technetium-99	--	NC	4.87	160	1.9	32.9	60
Tritium	--	NC	2,650	53	28.7	0.328	16
Thorium-228	--	NC	1.07	1.17	1.26	1.28	0.875
Thorium-230	--	NC	0.74	NA	0.665	0.936	NA

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

Analyte	Hanford Site Background Concentrations	MTCA Method C	216-T-26 Crib	216-B-46 Crib	216-B-38 Trench	216-B-7A Crib	216-B-57 Crib
Thorium-232	1.32	NC	0.87	NA	0.621	0.86	NA
Total uranium (µg/g)	3.21	NC	61.1	44.1	32.5	346	2.53
Uranium-233/234	1.1	NC	18.1	NA	9	117	NA
Uranium-235/236	0.109	NC	0.256	NA	ND	0.586	NA
Uranium-238	1.06	NC	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
Bismuth	--	NC	198	31.3	ND	3,300	ND
Cadmium	0.81[a]	3,500	0.67	1.5	0.1	0.07	1.6
Calcium	17,200	NC	9,590	10,400	9,610	11,900	9,450
Chromium (III)	18.5	NC	93.6	29.5	14.5	142	11.3
Hexavalent chromium	--	10,500	4.2	NA	0.49	17.8	NA
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	11.5	8	349	12.7
Magnesium	7,060	NC	5,460	5,150	4,580	6,460	4,710
Manganese	512	49,000	318	334	317	1,650	457
Mercury	0.33	1,050	0.18	0.24	0.089	0.42	ND
Molybdenum	--	17,500	ND	NA	ND	ND	NA
Nickel	19.1	70,000	51.4	25.6	22	66.6	11
Potassium	2,150	NC	1,720	1,860	1,140	1,900	1,290
Silver	0.73	1750	0.5	0.3	ND	3.1	2.3

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

Analyte	Hanford Site Background Concentrations	MTCA Method C	216-T-26 Crib	216-B-46 Crib	216-B-38 Trench	216-B-7A Crib	216-B-57 Crib
Sodium	690	NC	1,510	4,360	848	1,310	382
Thallium	--	245	NA	0.6	NA	NA	ND
Vanadium	85.1	24,500	65.7	56.1	63.9	88.4	24.2
Zinc	67.8	105,000	45	41.7	54.9	127	36.8
General Inorganics (mg/kg)							
Ammonia	9.23	Unlimited	94.9	NA	65.2	21.3	NA
Chloride	100	25,000[b]	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 and nitrate/nitrite as N	52	350,000	3,070	5,470	3,180	493	2,120
Nitrite and nitrate/nitrite as N	--	350,000	47.7	12.2	41.2	ND	8.3
Phosphate	0.79	NC	213	86.7	149	105	2.7
Sulfate	237	25,000[b]	250	1,080	248	185	139
Total Organic Carbon	--	NC	281	2,410	2,760	3,850	6,750
Semi-Volatile Organics (µg/kg)							
Tributyl phosphate	--	NC	90.99	19.3	NA	ND	NA
Diesel fuel	--	2,000	ND	NA	NA	ND	NA

[a] State wide background concentration (Ecology 1994).
[b] MTCA Method B soil values for groundwater protection.
[c] 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. (2 Pages)

Contaminant of Concern	Screening Levels			216-B-46 Crib				216-T-26 Crib			
	Background (pCi/g)	MTCA C Soil Cleanup Level	Protective of Groundwater	Max (pCi/g)	Exceeds Background[a]	Exceeds MTCA Method C	Exceeds Groundwater Protection	Max (pCi/g)	Exceeds Background[a]	Exceeds MTCA Method C	Exceeds Groundwater Protection
Radionuclides (pCi/g)											
Antimony-125	ND	--	--	50.4	Yes	--	--	NA	NA	NA	NA
Americium-241 -	ND	--	--	NA	NA	NA	NA	227	Yes	--	--
Cesium-137	1.05	--	--	364,000	Yes	--	--	47,900	Yes	--	--
Cobalt-60	0.008	--	--	4.03	Yes	--	--	0.074	Yes	--	--
Europium-154	ND	--	--	NA	NA	NA	NA	61.9	Yes	--	--
Europium-155	ND	--	--	NA	NA	NA	NA	85.1	Yes	--	--
Plutonium-238	0.00378	--	--	6.94	Yes	--	--	35.2	Yes	--	--
Plutonium-239	ND	--	--	0.93	Yes	--	--	NA	NA	NA	NA-
Plutonium-239/240	0.0248	--	--	227	Yes	--	--	6,320	Yes	--	--
Potassium-40	16.6	--	--	16.5	No	--	--	18.2	Yes	--	--
Radium-226	0.815	--	--	2.44	Yes	--	--	0.88	Yes	--	--
Radium-228[b]	1.32[2]	--	--	NA	NA	NA	NA	1.48	Yes	--	--
Total Radioactive Strontium	0.178	--	--	353,000	Yes	--	--	49,100	Yes	--	--
Technetium-99	ND	--	--	160	Yes	--	--	4.87	Yes	--	--
Tritium	ND	--	--	53	Yes	--	--	2,650	Yes	--	--
Total uranium pCi/g/mg/kg	2.27 pCi/g/ 3.2 mg/kg	--	--	35.3 pCi/g	Yes	--	--	61.1 mg/kg	Yes	--	--
Uranium-233/234	1.10	--	--	NA	NA	NA	NA	18.1	Yes	--	--
Uranium-235	0.109	NA	NA	NA	NA	NA	NA	0.256	Yes	--	--
Uranium-238	1.06	--	--	NA	NA	NA	NA	21.1	Yes	--	--

Table 3-3. 200-TW-1 Operable Unit Initial Screening. (2 Pages)

Contaminant of Concern	Screening Levels			216-B-46 Crib				216-T-26 Crib			
	Background (pCi/g)	MTCA C Soil Cleanup Level	Protective of Groundwater	Max (pCi/g)	Exceeds Background[a]	Exceeds MTCA Method C	Exceeds Groundwater Protection	Max (pCi/g)	Exceeds Background[a]	Exceeds MTCA Method C	Exceeds Groundwater Protection
Inorganic Metals (mg/kg)											
Bismuth	ND	--	--	31.3	Yes	--	--	198	Yes	--	--
Sodium	690	--	--	4,360	Yes	--	--	1,510	Yes	--	--
General Inorganics (mg/kg)											
Ammonia	9.23	NA	NA	NA	NA	NA	NA	94.9	Yes	--	--
Cyanide	ND	70,000	0.80	12	Yes	No	Yes	7.9	Yes	No	Yes
Fluoride	2.81	NA	NA	6.71	Yes	No	No	168	Yes	Yes	Yes
Nitrate	52	350,000	40	5,470	Yes	No	Yes	3,070	Yes	No	Yes
Nitrite	ND	350,000	4	12.2	Yes	No	Yes	47.7	Yes	No	Yes
Phosphate	0.79	--	--	86.7	Yes	--	--	213	Yes	--	--
Sulfate	237	--	1,000	1,080	Yes	--	Yes	250	Yes	No	No

[a] Exceeds background concentration/background has not been defined. Therefore, contaminant is carried forward after initial background screening process.
[b] Contaminant is in secular equilibrium with thorium-232 which as a background concentration of 1.32 pCi/g.
-- = A standard has not been defined or calculated. Therefore, contaminant is carried forward to risk evaluation
NA = not applicable
ND = No data were collected/available.

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

Contaminants of Concern	Screening Levels			216-B-5 Reverse Well				216-B-7A Crib				216-B-38 Trench			
	Background (pCi/g)	MTCA C Soil Cleanup Level	Soil Protective of Groundwater	Max pCi/g	Exceeds Background[a]	Exceeds MTCA Method C	Exceeds Soil for Groundwater Protection	Max (pCi/g)	Exceeds Background[a]	Exceeds MTCA Method C	Exceeds Soil for Groundwater Protection	Max (pCi/g)	Exceeds Background[a]	Exceeds MTCA Method C	Exceeds Soil for Groundwater Protection
Radionuclides (pCi/g)															
Americium-241	ND	--	--	1,330	Yes	--	--	5,690	Yes	--	--	43.9	Yes	--	--
Carbon-14	ND	--	--	NA	NA	NA	NA	6.3	Yes	--	--	NA	U	NA	NA
Cesium-137	1.05	--	--	51,300	Yes	--	--	153,000	Yes	--	--	226,000	Yes	--	--
Cobalt-60	0.00842	--	--	NA	NA	NA	NA	NA	U	NA	NA	0.056	Yes	--	--
Europium-154	ND	--	--	NA	NA	NA	NA	200	Yes	--	--	NA	U	NA	NA
Plutonium-238	0.00378	--	--	NA	NA	NA	NA	140	Yes	--	--	7.85	Yes	--	--
Plutonium-239/240	0.0248	--	--	70,200	Yes	--	--	153,000	Yes	--	--	159	Yes	--	--
Potassium-40	16.6	--	--	NA	ND	NA	NA	572	Yes	--	--	273	Yes	--	--
Radium-228	1.32[b]	--	--	NA	ND	NA	NA	1.07	No	--	--	0.974	No	--	--
Total Radioactive Strontium	0.178	--	--	60,300	Yes	--	--	5,710,000	Yes	--	--	2,050	Yes	--	--
Technetium-99	ND	--	--	NA	NA	NA	NA	32.9	Yes	--	--	1.9	Yes	--	--
Tritium	ND	--	--	NA	NA	NA	NA	0.328	Yes	--	--	28.7	Yes	--	--
Total uranium (mg/kg)	3,200	--	--	NA	NA	NA	NA	346	Yes	--	--	32.5	Yes	--	--
Uranium-233/234	1.10	--	--	NA	NA	NA	NA	117	Yes	--	--	9.0	Yes	--	--
Uranium-235	0.109	--	--	NA	NA	NA	NA	0.586	Yes	--	--	NA	U	NA	NA
Uranium-238	1.06	--	--	NA	NA	NA	NA	108	Yes	--	--	6.35	Yes	--	--
Inorganic Metals (mg/kg)															
Bismuth	ND	--	--	NA	NA	NA	NA	3,300	Yes	--	--	NA	U	NA	NA
Iron	32,600	1,050,000	5,340	NA	NA	NA	NA	34,900	Yes	--	--	19,800	No	No	No
Sodium	690	--	--	NA	NA	NA	NA	1,310	Yes	--	--	848	Yes	--	--
General Inorganics (mg/kg)															
Ammonia	9.23	--	--	NA	NA	NA	NA	21.3	Yes	--	--	65.2	Yes	--	--
Fluoride	2.81	--	16	NA	NA	NA	NA	205	Yes	--	Yes	33.4	Yes	--	Yes
Nitrate	52	350,000	40	NA	NA	NA	NA	493	Yes	No	Yes	3,180	Yes	No	Yes
Nitrite	ND	350,000	4	NA	NA	NA	NA	NA	U	NA	NA	41.2	Yes	No	Yes
Phosphate	0.79	--	--	NA	NA	NA	NA	105	Yes	--	--	149	Yes	--	--

[a] Exceeds background concentration/background has not been defined. Therefore, contaminant is carried forward after initial background screening process.
[b] Contaminant is in secular equilibrium with thorium-232 which as a background concentration of 1.32 pCi/g.
-- = A standard has not been defined or calculated. Therefore, contaminant is carried forward to risk evaluation
NA = not applicable
ND = No data was collected/available.
U = Non-detected

Table 3-5. 200-PW-5 Operable Unit Initial Screening

Contaminants of Concern	216-B-57 Crib						
	Background (pCi/g)	MTCA C Soil Cleanup Level	Protective of Groundwater	Max (pCi/g)	Exceeds Background[a]	Exceeds MTCA Method C	Exceeds Groundwater Protection
Radionuclides (pCi/g)							
Cesium-137	1.05	--	--	67,000	Yes	--	--
Plutonium-238	0.00378	--	--	0.012	Yes	--	--
Plutonium-239	ND	--	--	0.01	Yes	--	--
Radium-226	0.815	--	--	1.13	Yes	--	--
Total Radioactive Strontium	0.178	--	--	67	Yes	--	--
Technetium-99	ND	--	--	60	Yes	--	--
Tritium	ND	--	--	16	Yes	--	--
General Chemistry (mg/kg)							
Nitrate	52	350,000	40	2,120	Yes	No	Yes
Nitrite	2.81	350,000	4	8.3	Yes	No	Yes
Phosphate	0.79	--	--	12	Yes	--	--

[a] Exceeds background concentration/background has not been defined. Therefore, contaminant is carried forward after initial background screening process.
-- = A standard has not been defined or calculated. Therefore, contaminant is carried forward to risk evaluation in Section 4.0.
ND = No data was collected/available.

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 may also assist in determining the remediation strategy and establishing criteria for cleanup.

4.2 MODELING METHODOLOGY

The models constructed to simulate the 200-TW-1 and 200-TW-2 representative waste sites are two-dimensional vertical cross-section representations of the actual physical systems. 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 its vertical hydraulic conductivity is on the same order of magnitude as the other geologic units present in the vadose zone. Therefore, for the purpose of this analysis, assuming contaminant transport occurs primarily vertically provides a conservative 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 then 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 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 was then 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 years into the future. Figures showing the comparison of the model input contaminant distributions and the measured data are presented in Appendix C.

The scaling of the modeled concentration results also provides a basis for estimating the inventory of contaminants discharged at the facilities. The mobile contaminants transport and distribution is not 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 Section 3.0. Figures 3-2 through 3-6 show the vertical cross-sections developed to describe the geology in the vicinity of 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. In general, soil hydraulic properties describe the amount of water 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 is often expressed in terms of the saturation, which is the amount of water contained by the soil relative to the amount the soil could contain:

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

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), and
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 is frequently applied to express the saturation in terms of the soil capillary pressure and three fitted variables:

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

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

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, and
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), and
S_w and m are defined as before.

The characterization effort conducted at the 200-TW-1 and 200-TW-2 representative waste sites produced detailed descriptions of the local geology. Khaleel and Freeman (1995) collected and summarized much of the unsaturated hydraulic data collected at the Hanford site, and developed statistical distributions for six general soil types. The characterization effort conducted at the 200-TW-1 and 200-TW-2 representative waste sites identified more than the six soil types described by Khaleel and Freeman (1995), 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 Khaleel and Freeman (1995), unless an appropriate soil type match was not available. In those cases, properties were determined from the closest soil type available and 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 representative waste 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 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 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 coefficients for the contaminants were derived from the "Best Estimate" lists in *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, (Kincaid et al. 1998) for Zone G Category for the 200-TW-1 representative sites and for Zone E Category for the 200-TW-2 representative sites. The modeling included a simulation period representing the time from waste disposal to the RI/FS data collection effort. 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 (MCLs). 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-year 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 years. 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 years from the present (year 2000). The concentrations of the mobile contaminants attenuate below the MCLs within 200 years, except cyanide, which attenuates below its MCL in about 250 years. 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 at concentrations below 10 mg/kg from 164 ft to 197 ft (50 to 60 m) bgs, compared to 660 mg/kg at a depth of 148 ft (45 m) and 3,070 mg/kg at a depth of about 98 ft (30 m) 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 years. The concentrations of the uranium-233/234 and uranium-238 isotopes remain above the MCLs after 1000 years, but the concentrations are decreasing at the end of the simulation period. The plutonium-239 concentration exceeds the MCL in about 800 years, 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, are expected to reach the groundwater with concentrations exceeding their MCLs. The list of mobile contaminants at 216-B-46 Crib includes cobalt-60 and radium-226, which usually experience some sorption during transport in the environment. The maximum predicted concentrations of cyanide and nitrite (0.8 and 1.4 mg/L, respectively) are close to the MCLs for those contaminants (0.2 and 1.0 mg/L, respectively). The other less mobile contaminants (plutonium-239 and uranium-238) also reach the groundwater at concentrations above their respective MCLs. None of the other contaminants of concern (cesium-137 and plutonium-239) reach the groundwater with concentrations exceeding their MCLs during the 1,000-year simulation period. 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. They are not expected to be present anywhere in the vadose zone in appreciable quantity in 1,000 years. Americium-241 is expected to remain in the environment, but not 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-year 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 years. 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) and technetium-99 (generally greater than 100 pCi/g) were measured consistently and continually from about 26 ft (8 m) 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, carbon-14, fluoride, nitrate, strontium-90, and uranium-233/234/238 are predicted to reach the groundwater with concentrations exceeding their MCLs. The maximum predicted concentration of technetium-99 (770 pCi/L) is close to, but 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-year 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 years. Americium-241, potassium-40, and plutonium-239/240 are expected to remain in the environment, but not 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, 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-year 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 years 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) were measured consistently from just below ground surface to a depth of 98 ft (30 m) bgs. The two deepest soil samples collected (151 and 223 ft [46 and 68 m] 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 18 and 27.5 ft (5.5 and 8.4 m) 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 about 29.5 to 33 ft (9 to 10 m) bgs. The model results predict the peak strontium-90 groundwater concentration occurring about 270 years into the future, but then decaying below the drinking water standard in about 480 years. The stronium-90 soil concentration data showed almost all of the strontium-90 contained within the top 59 ft (18 m) 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 predicted to reach the groundwater, but not at concentrations above their respective MCLs. None of the other contaminants are predicted to reach the groundwater at measurable concentrations during the 1,000-year 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 years. Americium-241 and potassium-40 are expected to remain in the environment, but not 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-year 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) were measured between 49 and 151 ft (15 and 46 m) bgs, with the concentration decreasing to 58 and 1.5 mg/kg in the two deepest samples (197 and 266 ft [60 and 81 m] 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 caused by the representative waste site approach, and the purpose of 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. The B-BX-BY Field Investigation Report 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. The B-BX-BY Field Investigation Report modeling indicated that the uranium isotopes would not reach the water table during the 1,000-year 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, which reduced infiltration to 0.1 mm/yr for 5000 years and to 3.5 mm/yr, thereafter.

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. 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) may also 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 59 ft (18 m) 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 98 ft (30 m), 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. (Kincaid et al. 1998). 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.

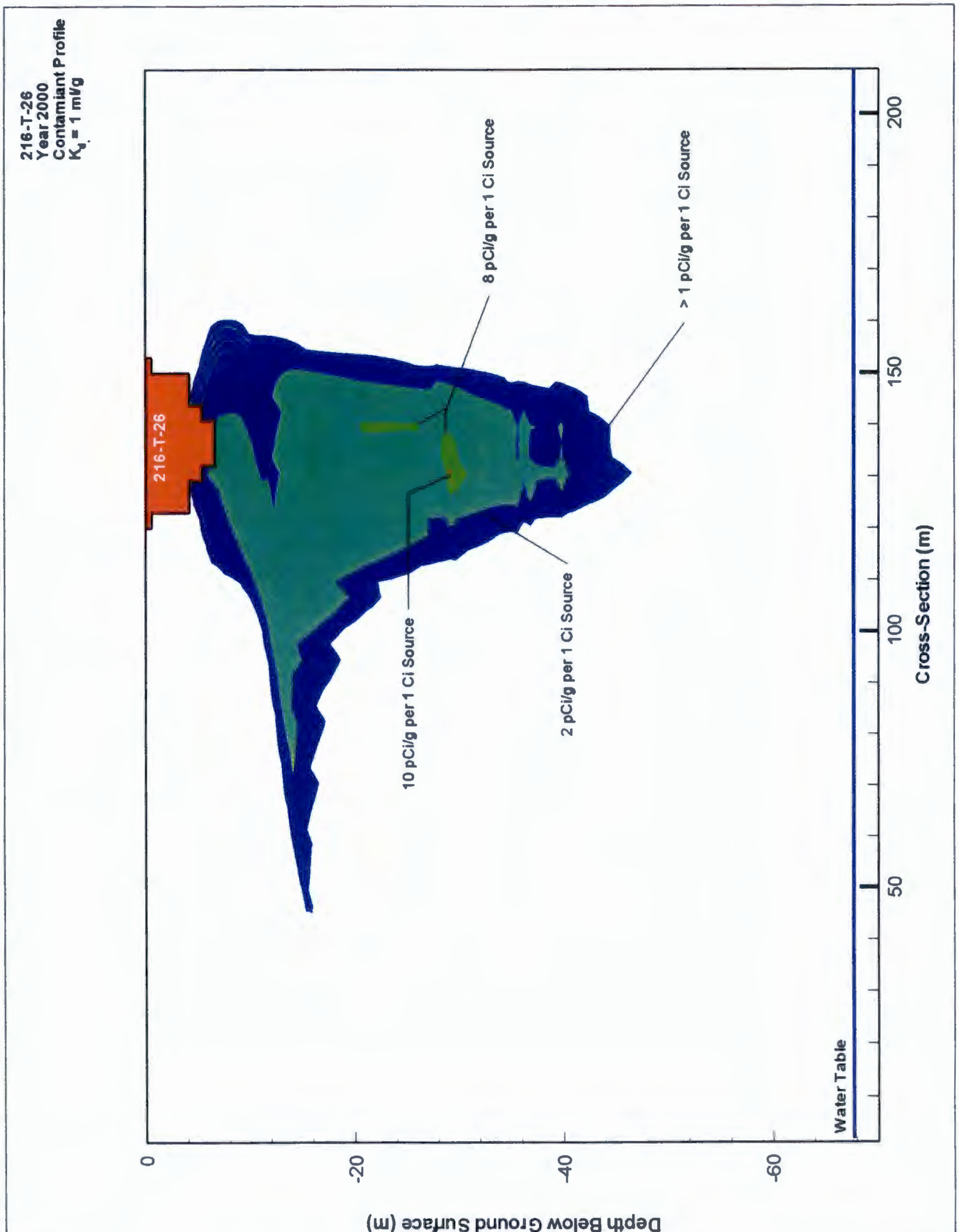


Figure 4-2. Contaminant Breakthrough Curves in Groundwater for H-3, Tc-99, and Sr-90 at the 216-T-26 Crib.

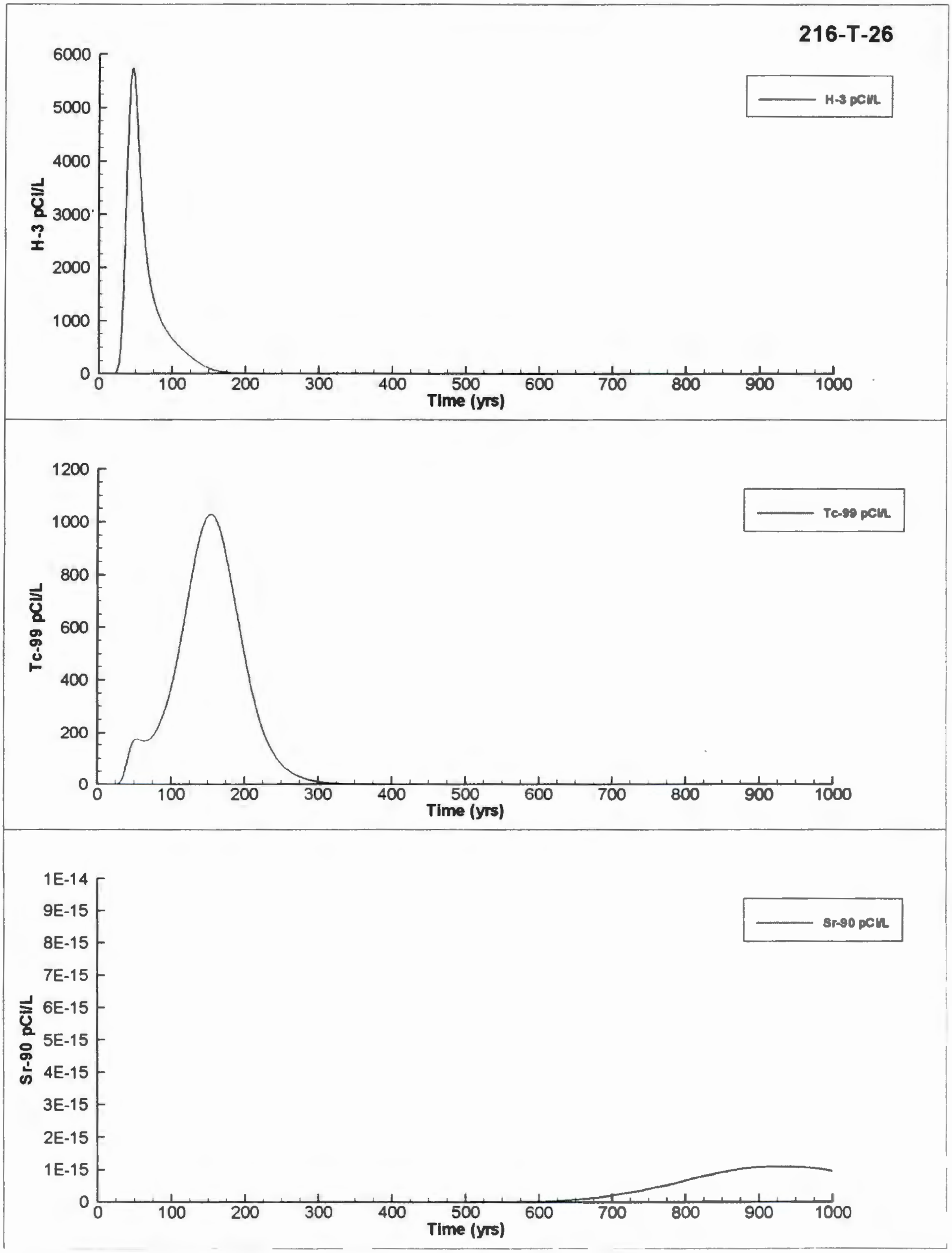


Figure 4-3. Contaminant Breakthrough Curves in Groundwater for U-233/234, U-235, and U-238 at the 216-T-26 Crib

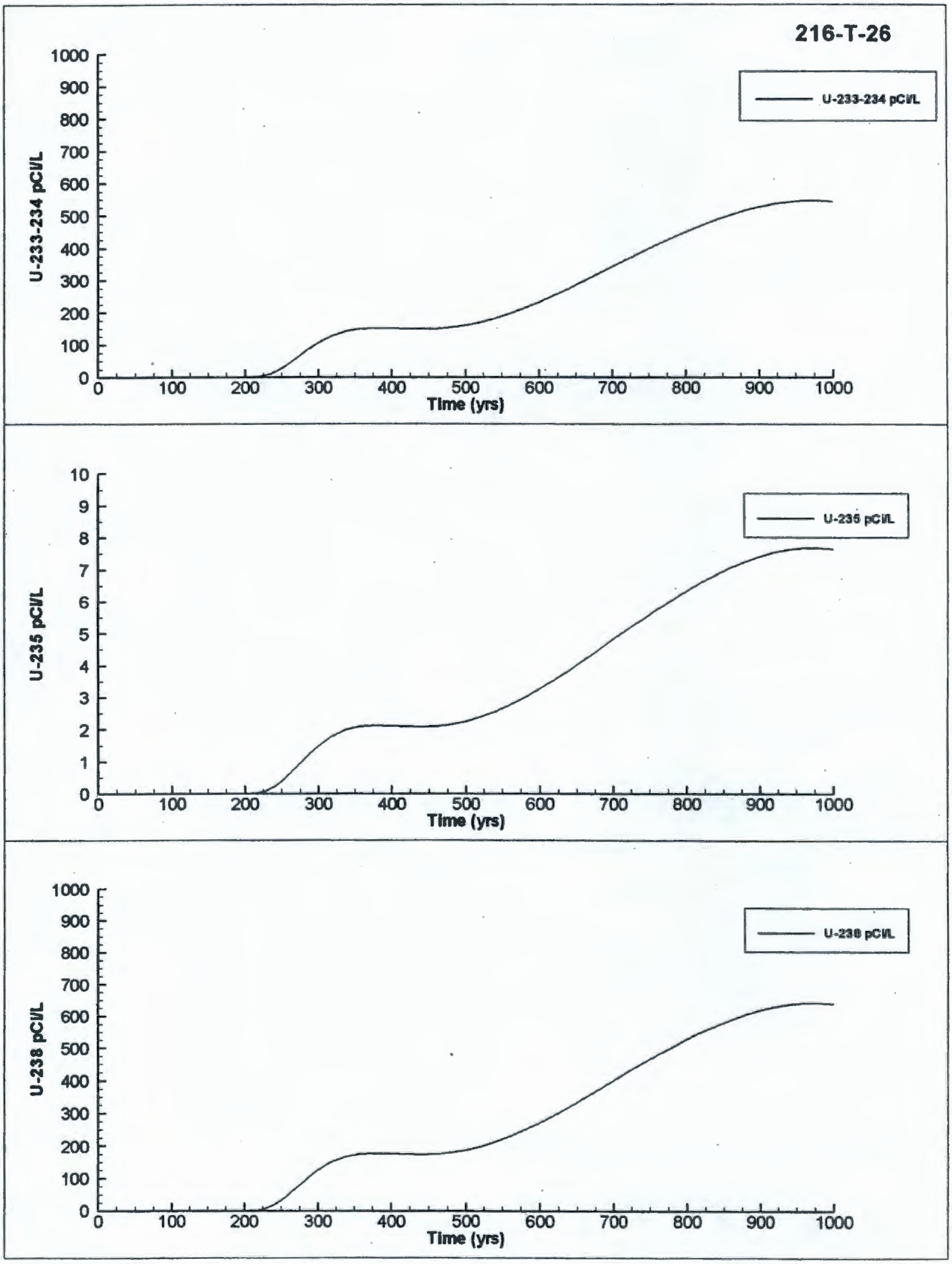


Figure 4-4. Contaminant Breakthrough Curves in Groundwater for Nitrate, Nitrite, and Cyanide at the 216-T-26 Crib.

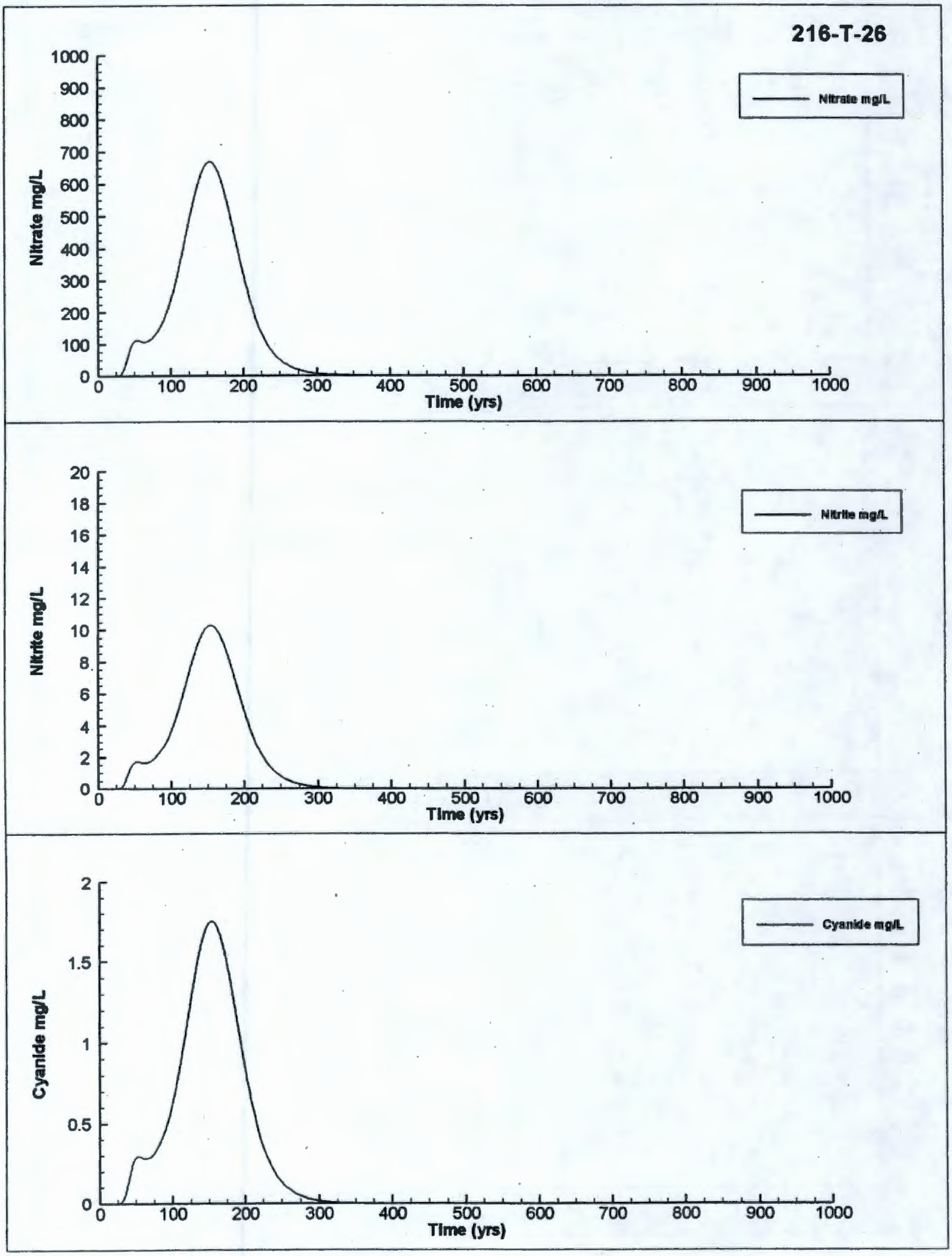


Figure 4-5. Contaminant Breakthrough Curves in Groundwater for Nitrate, Nitrite, and Sulfate at the 216-B-46 Crib.

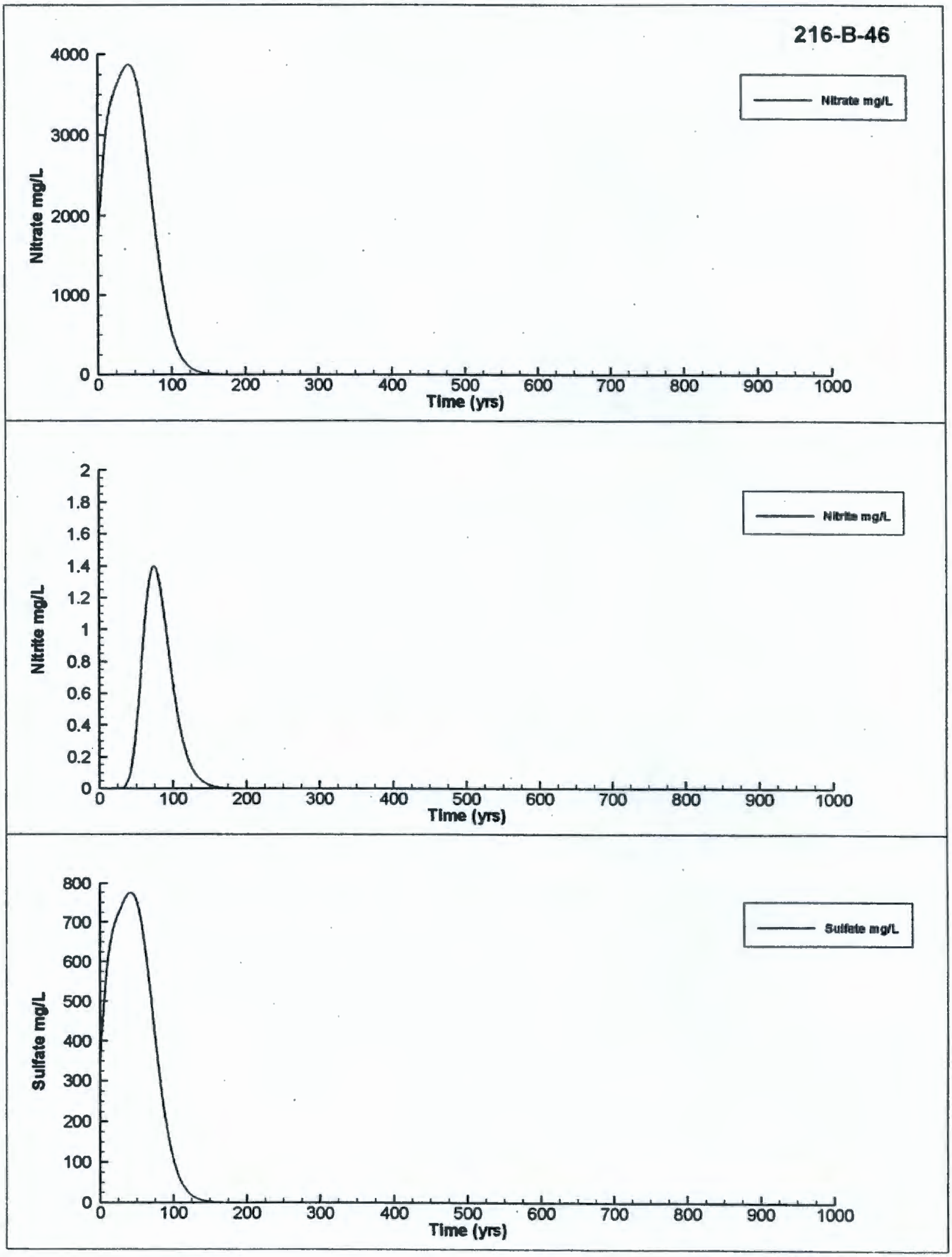


Figure 4-6. Contaminant Breakthrough Curves in Groundwater for Cyanide, H-3, and Tc-99 at the 216-B-46 Crib.

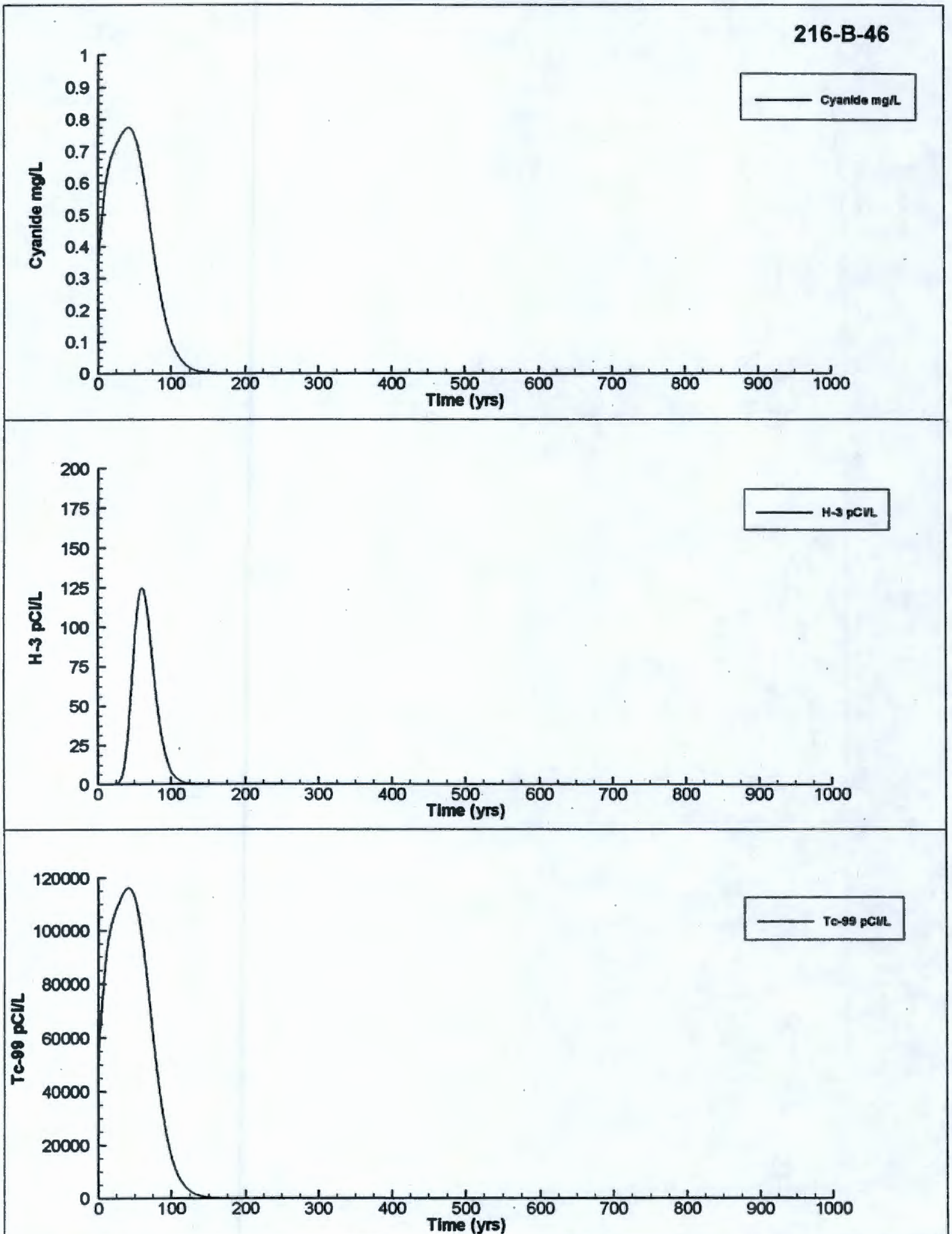


Figure 4-7. Contaminant Breakthrough Curves in Groundwater for Pu-238, Pu-239/240, and Ra-226 at the 216-B-46 Crib.

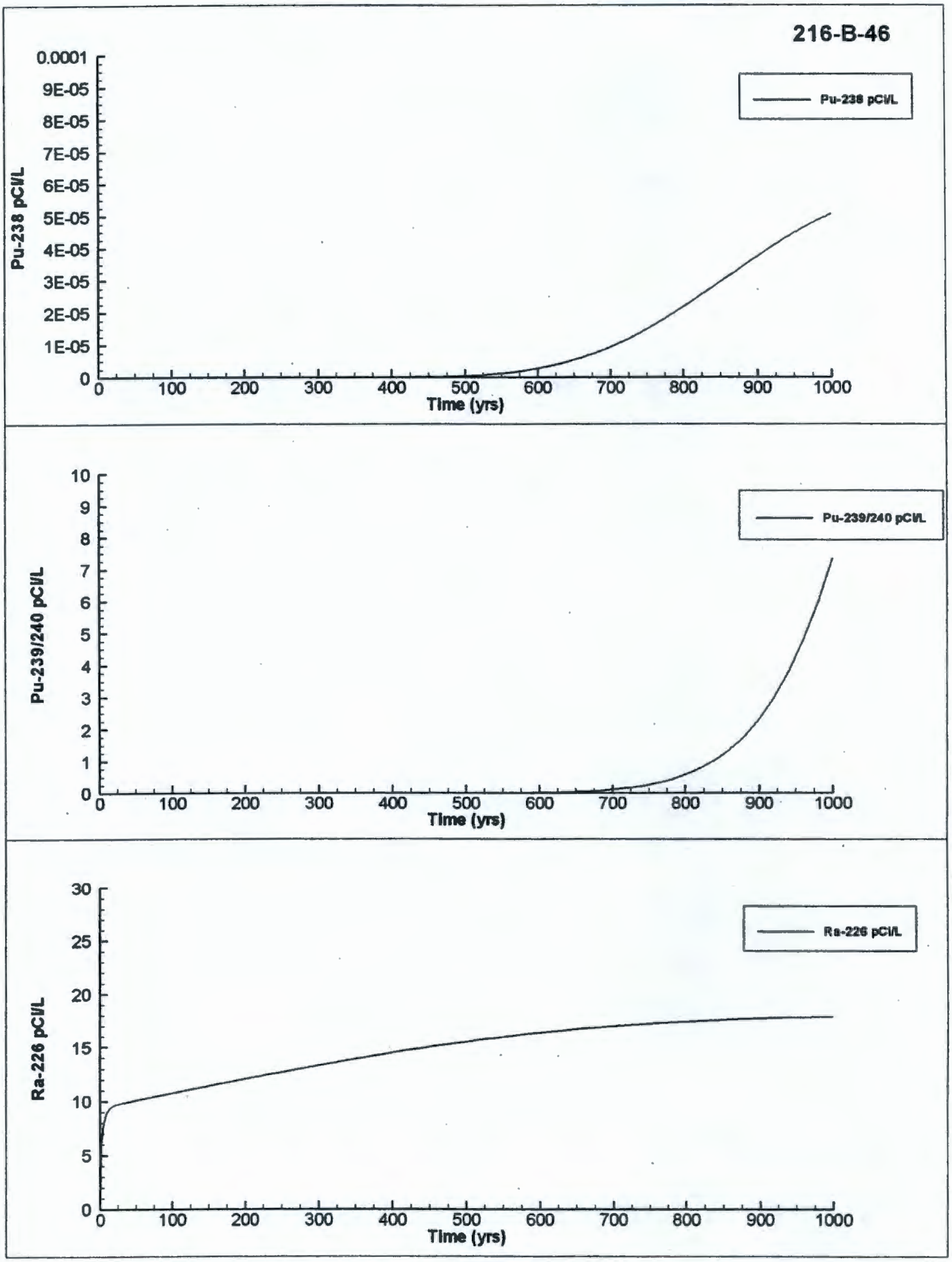


Figure 4-8. Contaminant Breakthrough Curves in Groundwater for Co-60, Sr-90, and Cs-137 at the 216-B-46 Crib.

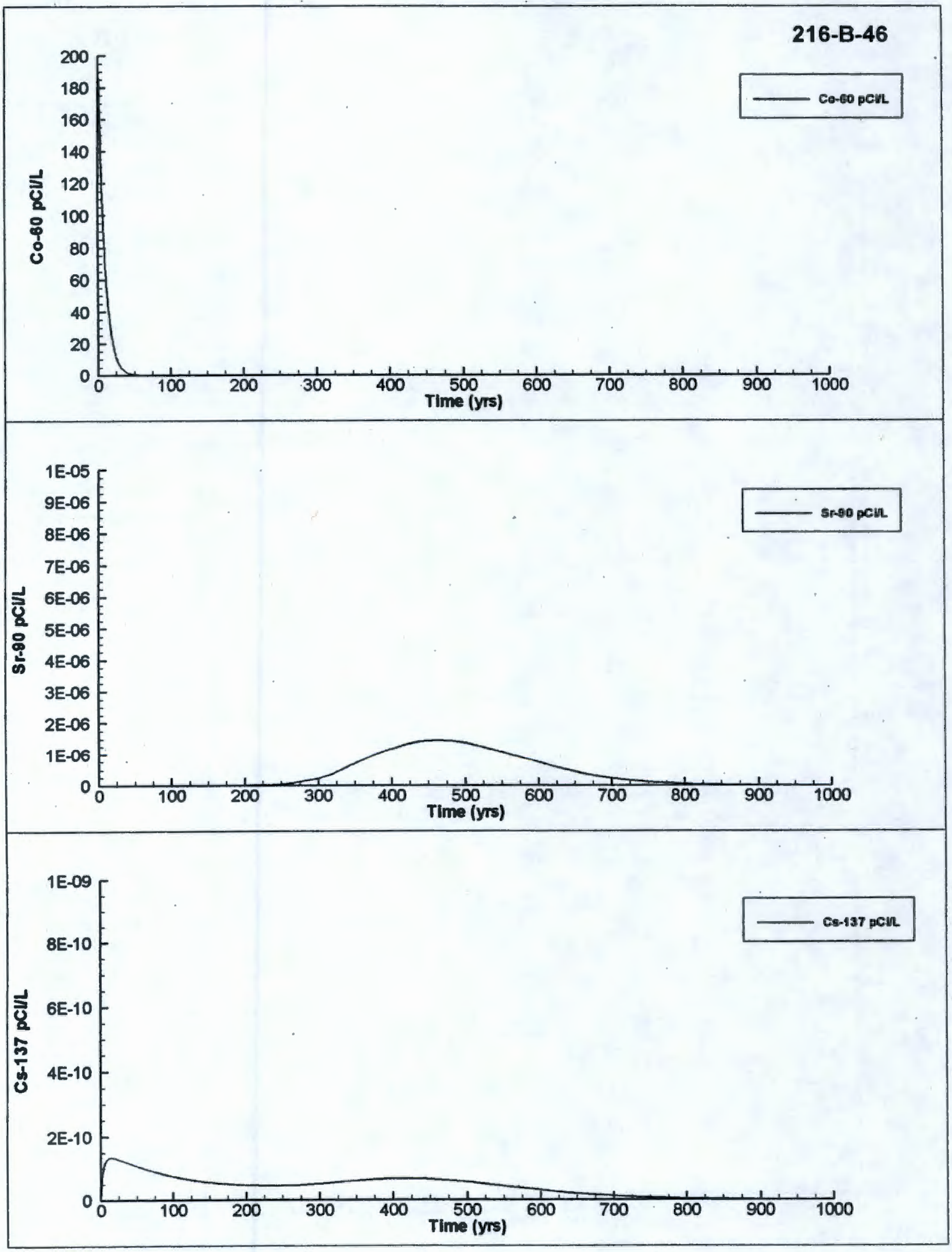


Figure 4-9. Contaminant Breakthrough Curves in Groundwater for H-3, Tc-99, and K-40 at the 216-B-7A Crib.

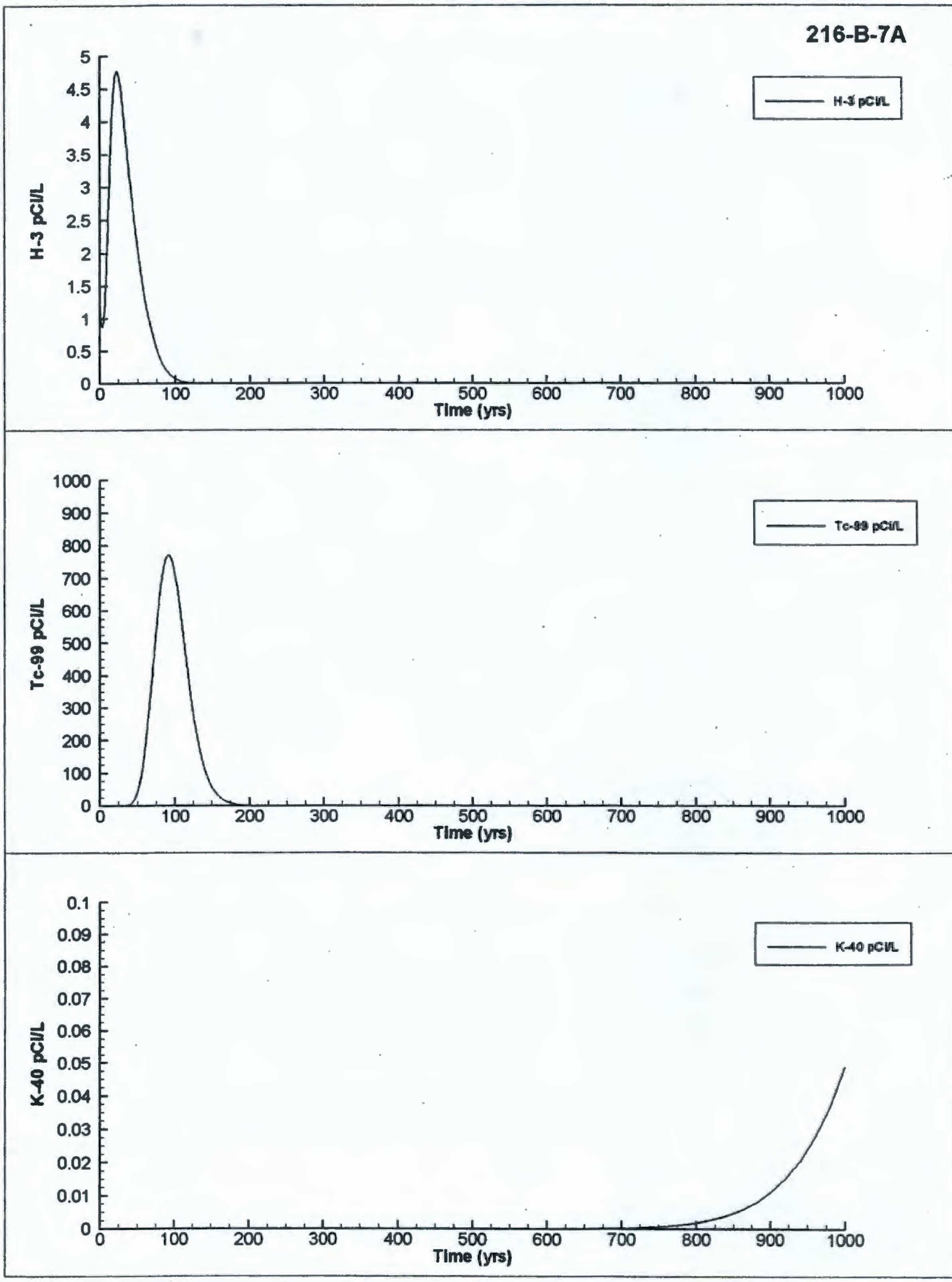


Figure 4-10. Contaminant Breakthrough Curves in Groundwater for Nitrate, Fluoride, and C-14 at the 216-B-7A Crib.

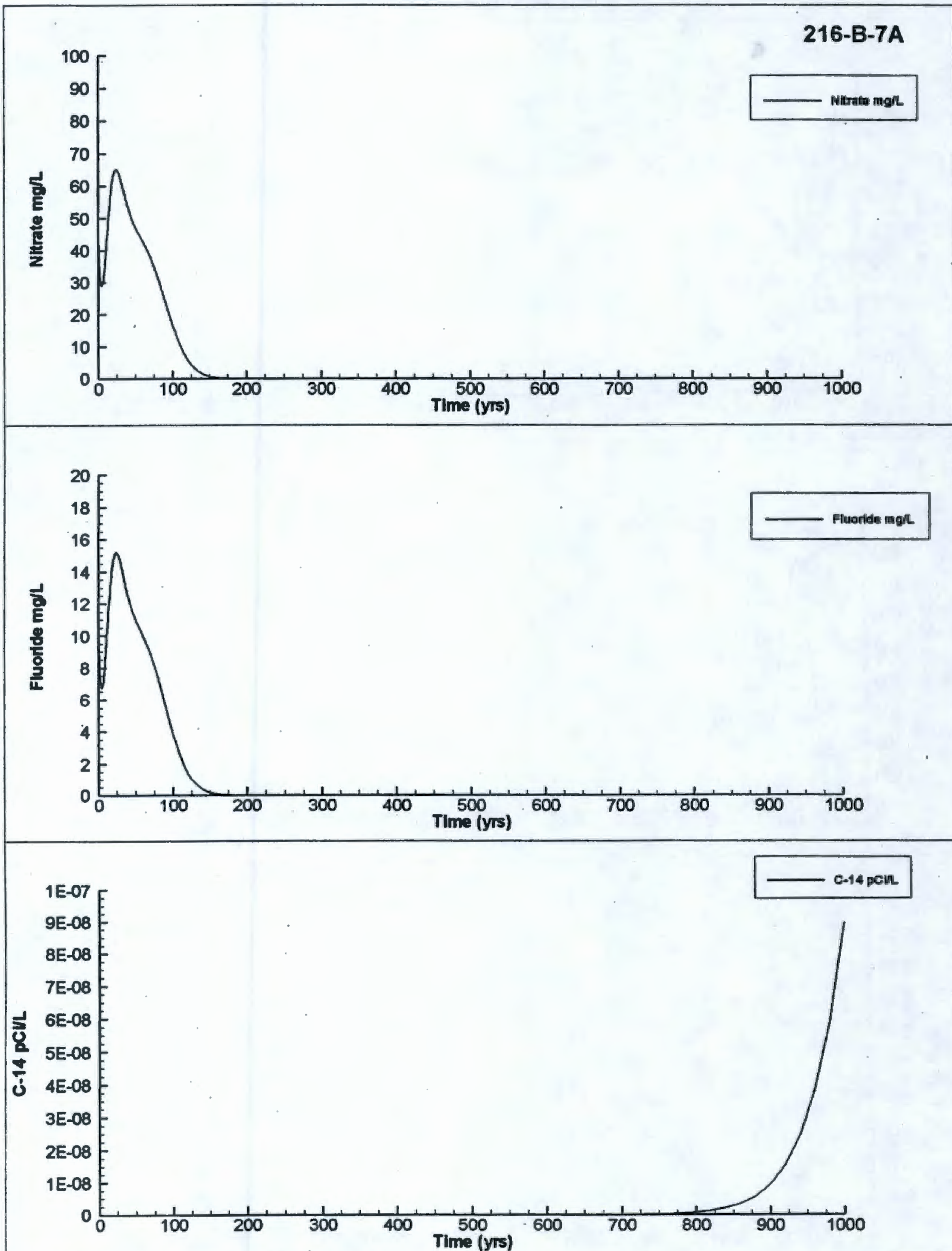


Figure 4-11. Contaminant Breakthrough Curves in Groundwater for U-233/234, U-235, and U-238 at the 216-B-7A Crib.

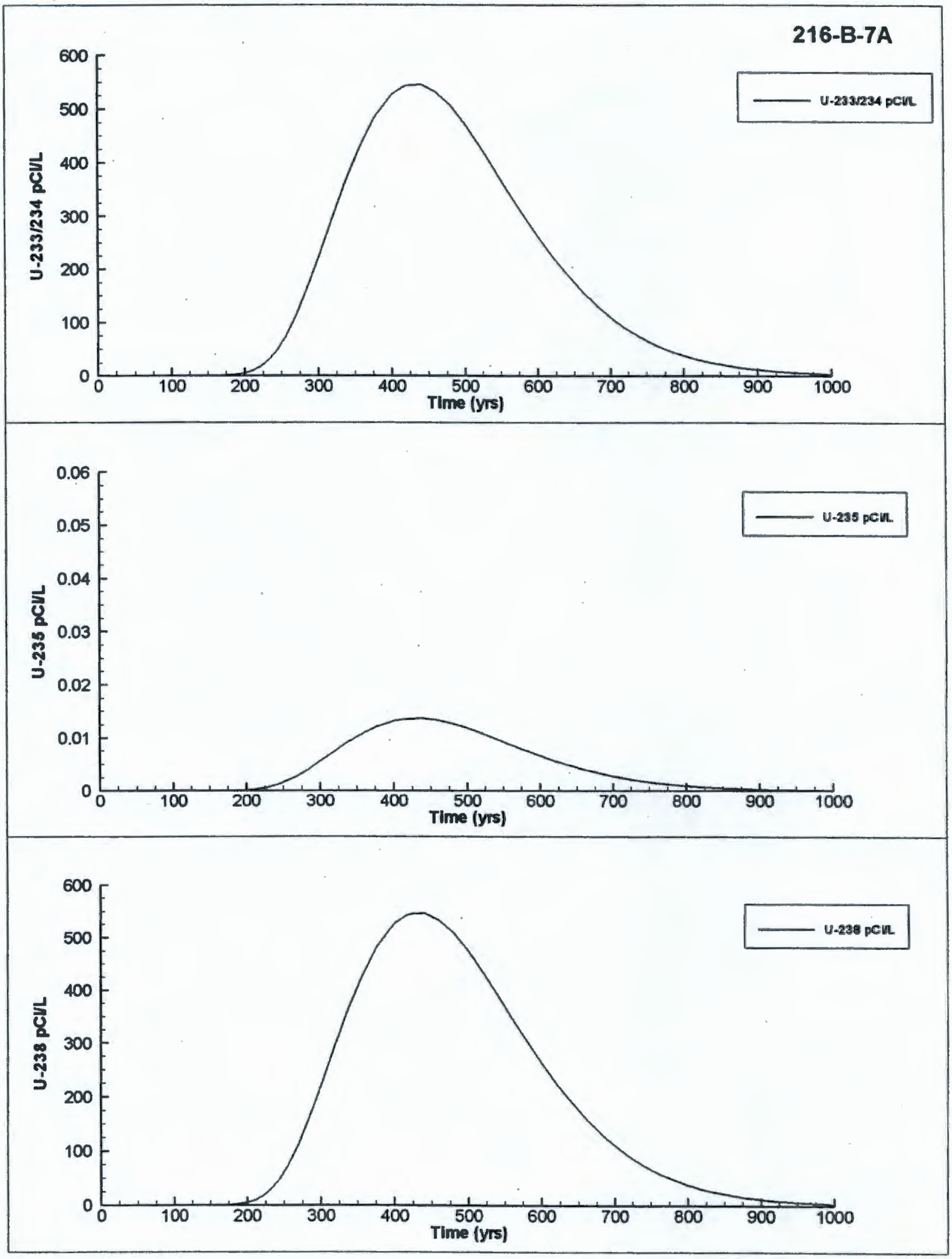


Figure 4-12. Contaminant Breakthrough Curves in Groundwater for Pu-238, Pu-239/240, and Sr-90 at the 216-B-7A Crib.

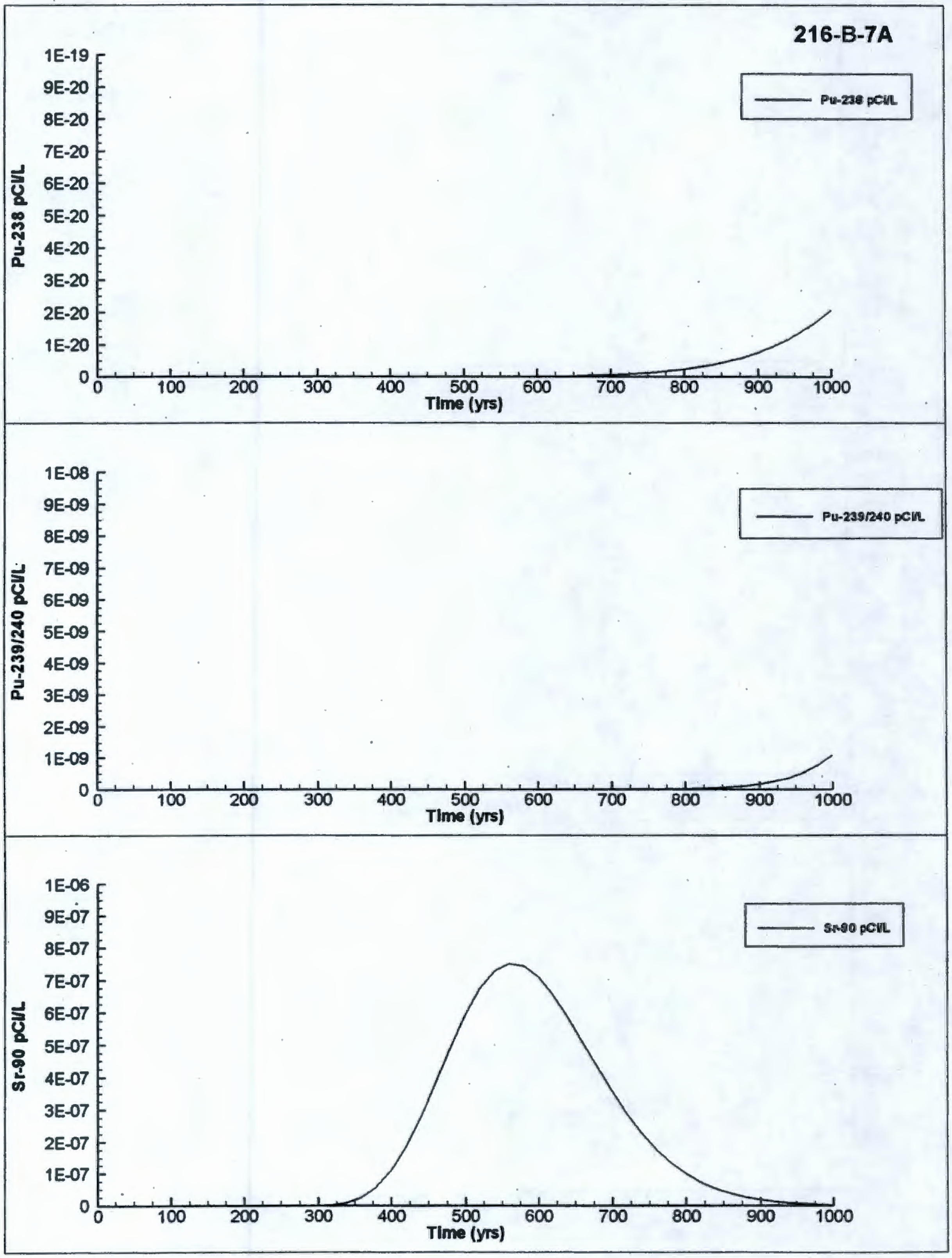


Figure 4-13. Contaminant Breakthrough Curves in Groundwater for H-3, Tc-99, and K-40 at the 216-B-38 Trench.

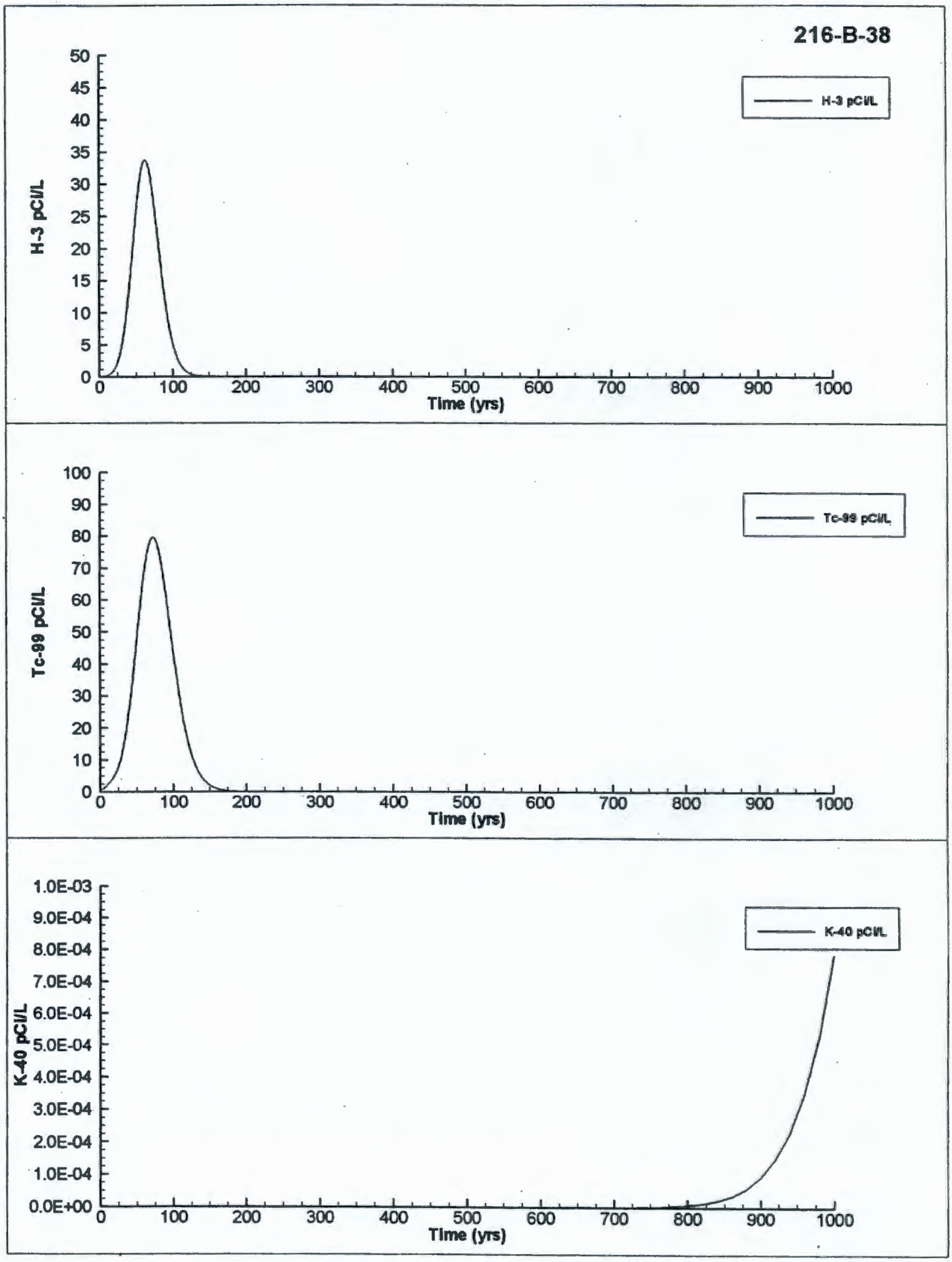


Figure 4-14. Contaminant Breakthrough Curves in Groundwater for Nitrate, Nitrite, and Fluoride at the 216-B-38 Trench.

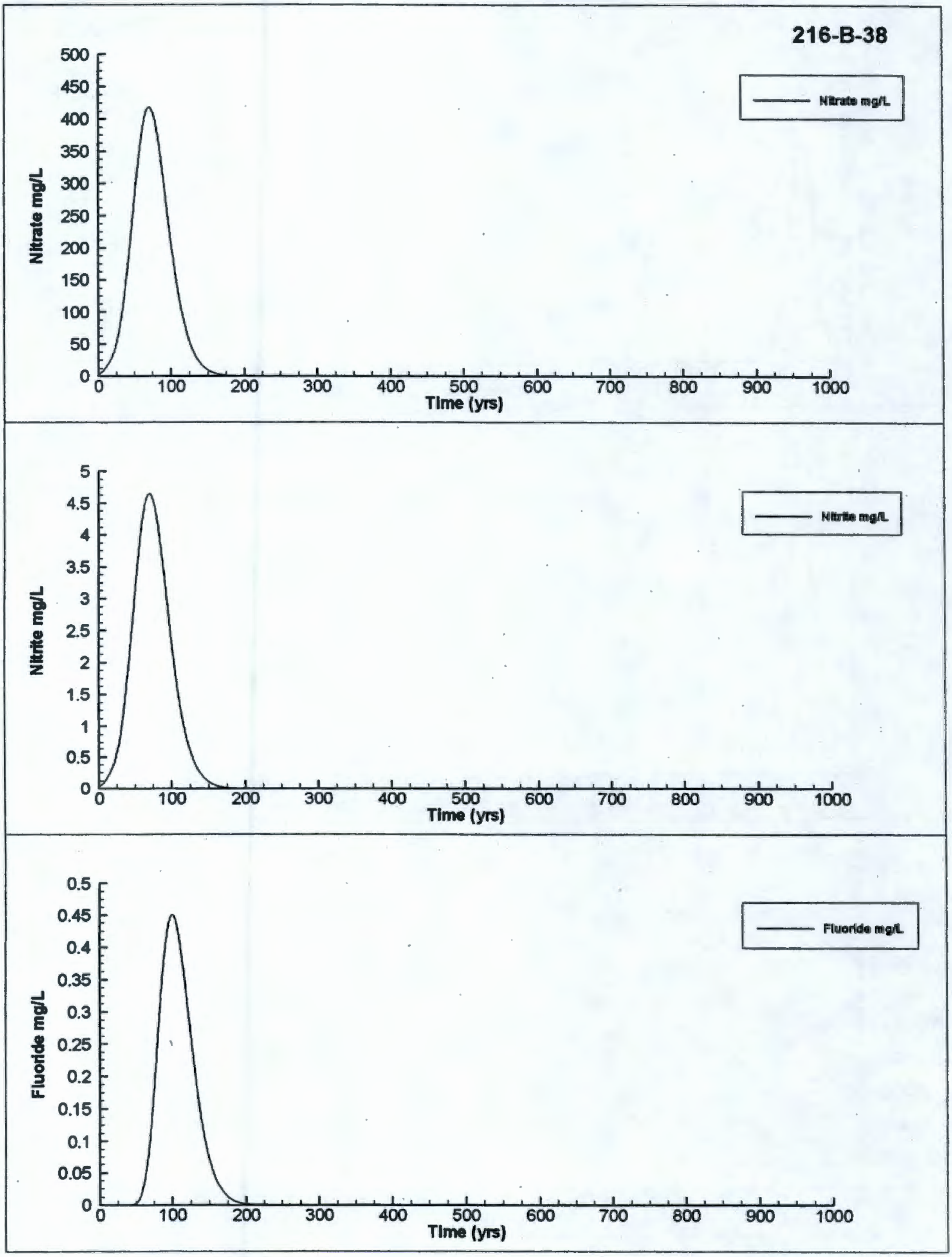


Figure 4-15. Contaminant Breakthrough Curves in Groundwater for U-233/234, U-238, and Sr-90 at the 216-B-38 Trench.

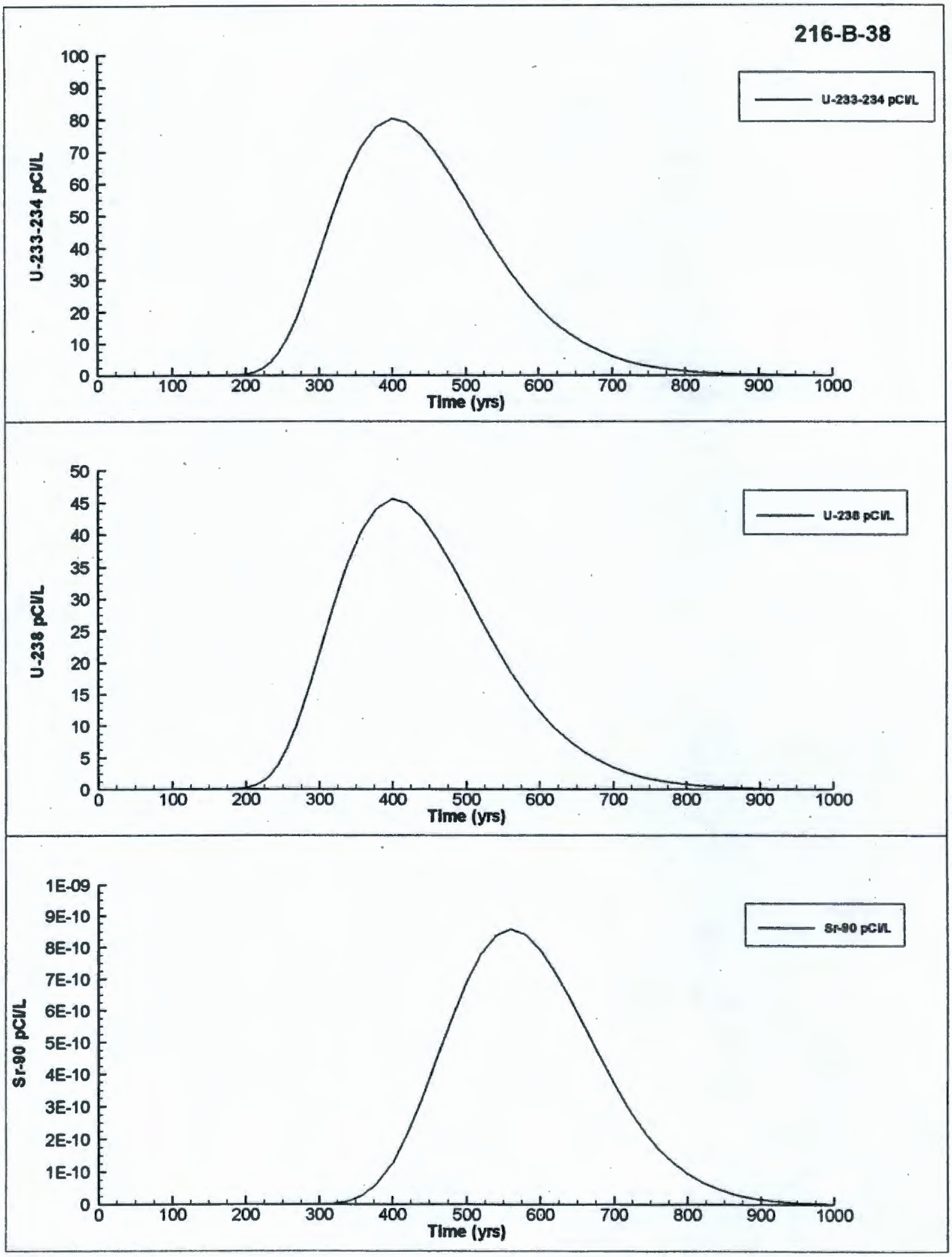


Table 4-1. Modeling Soil Properties. (2 Pages)

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

Table 4-2. Comparisons of Modeled Kd 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*	20
Pu-239/240	3	10*	20
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

Table 4-2. Comparisons of Modeled Kd Values to Published Values. (3 Pages)

*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*	10
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	5
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.			
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	300
C-14	N/A	150*	6
Cs-137	500	20	500
Eu-154	350	20	350
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*	3

Table 4-2. Comparisons of Modeled Kd Values to Published Values. (3 Pages)

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*	300
Cs-137	500	5.5*	10
H-3	0	0.5	0
K-40	N/A	5.5*	5.5
Pu-238	20	5.5*	20
Sr-90	0.5	5.5*	3
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.			

5.0 RISK EVALUATION

5.1 INTRODUCTION

This section provides the results of the qualitative risk assessment (QRA), which includes the human health risk assessment and RESRAD modeling. 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 1995b) 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 section also includes the ecological risk screening of 200-TW-1, 200-TW-2, and 200-PW-5 contaminants against screening concentrations in MTCA (WAC 173-340-900, Table 749-3) for nonradionuclides and in *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE-ORNL 2000) for radionuclides. This document was prepared for DOE by the Biota Dose Assessment Committee (BDAC) and presents screening levels (biota concentration guides [BCGs]) for radionuclides as well as a methodology for conducting ecological risk assessments for radionuclides. The 200 Area Ecological Evaluation report (DOE-RL 2002) has additional details on the BDAC document.

5.2 CONCEPTUAL SITE MODEL - HUMAN EXPOSURE

This conceptual site model (CSM) provides a current understanding of the sources of contamination, physical setting, 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 Environmental Setting

Section 2.0 of the 200-TW-1 and 200-TW-2 work plan provides the site description and the environmental setting of these OUs (DOE-RL 2001). The environmental setting described in Section 2.0 of the work plan was incorporated into the conceptual site model to characterize potential exposure pathways.

5.2.2 Characterization of Land Use

The land use boundary around the 200 East and 200 West Areas has been designated as industrial-exclusive in the HCP EIS (DOE 1999a). 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 the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999a) and the associated *Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999b), the 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 1999a). The waste sites meet the definition of an industrial property under WAC 173-340-200 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.

5.2.3 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, MTCA guidance, and the HSRAM. 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.

5.2.4 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 West Area facilities (primarily B, T, and U Plants and the Reduction-Oxidation Plant [REDOX]) are the primary source and release mechanisms at the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. Liquid effluents (i.e., 1^{st} and 2^{nd} 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 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 15 ft (0 to 4.6 m) 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 15 ft (0 and 4.6 m) 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 these 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 have been evaluated in the *Hanford Site Groundwater Monitoring for Fiscal Year 2001* (Hartman et al. 2002) and will continue to be evaluated through the ongoing groundwater program at the Hanford site. The potential for contaminants to migrate from the soil to groundwater was evaluated for these OUs by comparing soil concentrations to the MTCA groundwater protection standards for the nonradiological constituents followed by fate and transport modeling for selected contaminants. For radiological constituents, fate and transport modeling were used to evaluate this potential (see Section 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:

- *Hanford Site Risk Assessment Methodology* (DOE-RL 1995b)
- *Risk Assessment Guidance for Superfund—Volume I: Human Health Evaluation Manual, Part A (Interim Final) (RAGS), EPA/540-1-89/002* (EPA 1989)
- *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors* (EPA 1991)
- *Exposure Factor Handbook* (EPA 1997)
- *Proposed Guidelines for Carcinogen Risk Assessment* (EPA 1996)
- *Supplemental Guidance to RAGS: Calculating the Concentration Term* (EPA 1992).

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 contaminants of potential concern (COPCs) was conducted for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs during the DQO process (Todd 2000).

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

All non-radiological constituents detected at least once were included in the QRA. The following summarizes the major attributes of data included in the QRA:

- 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 15 ft (0 to 4.6 m) zone were used as the estimated exposure point concentrations for calculating risks associated with direct exposure to contaminants. All nonradiological contaminants 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 216-B-46 crib (200-TW-1). Ten nonradiological and nine radiological constituents were detected in shallow zone soil at least once from 216-T-26 crib (200-TW-1). 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). Fourteen nonradiological and 13 radiological constituents were detected in shallow zone soil at least once from the 216-B-7A crib (200-TW-2). 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).

During the RI activities, soil samples were analyzed for general chemical parameters. Although measurable concentrations of these constituents were reported, they will not be evaluated in the QRA. General contaminant parameters not included in this QRA include ammonia, chloride, fluoride, nitrate, nitrite, pH, phosphate, sulfate, sulfide, and total organic carbon.

These parameters are discussed in Section 3.2.1.4.

5.3.2.2 Criteria for Selection of Non-Radiological COPCs 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 MTCA 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). 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 MTCA Method C soil cleanup values. Because background criteria have not been developed for VOCs and semi-volatile organic compounds (SVOCs) 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 15 ft (0 to 4.6 m) 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 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 216-T-26 Crib and 216-B-38 Trench, uranium did not have an available background level.

For 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 MTCA 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 MTCA cleanup levels. This comparison was performed in accordance with WAC 173-340-740.

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

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 QRA.

5.4 RESRAD MODELING

The RESRAD modeling 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 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 COPCs in Shallow-zone Soil Samples.

Data evaluated include shallow-zone soil samples collected from the 200-TW-1 and 200-TW-2 representative sites and 2001 RI activities and surface soil samples from the 200-PW-5 representative site collected during 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 15 ft [0 to 4.6 m] bgs) were considered in the RESRAD model. The following the major data attributes of data 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 15-ft (0 to 4.6 m) depth range were used as estimated exposure point concentrations. All radiological constituents 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 RESRAD Assumptions and Input Parameters

Site-specific data were used where available as input parameters to the RESRAD model. In addition, exposure assumptions from MTCA 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 model simulate the current conditions found at the waste sites based on the results of the RI activities.

An industrial exposure scenario was used for the waste sites located inside the 200 Area exclusive land-use boundary (as defined in the HCP EIS [DOE 1999a]). The industrial scenario assumes that no groundwater from the waste site will be used for drinking or irrigation purposes.

For the 200-TW-1 and PW-5 OU, a single scenario was modeled for each waste site (the 216-B-46, 216-T-26, and 216-B-57 Cribs). A contaminated zone is assumed to exist from 0 to 15 ft (0 to 4.6 m) with radiological exposure point concentrations provided in Table 5-5. No cover material was assumed (i.e., no credit was taken for the shielding effect of the clean backfill that has been placed over the sites). This scenario represents the worst, or bounding, case for surface-type exposures to workers.

For the 200-TW-2 OU, the same no-cover scenario was considered in addition to a scenario 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 the contaminated zone. The two sites were modeled with cover thicknesses of 0.3 to 3 m (1 and 10 ft), respectively.

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
- Thorium-228

For 216-T-26 Crib, the following isotopes did not have available background levels or exceeded the 90th percentile background values:

- Radium-226
- Radium-228
- Thorium-228
- Thorium-230

For 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
- Radium-226
- Radium-228
- Thorium-228
- Thorium-230
- Total beta radiostrontium

For 216-B-7A Crib, the following isotopes did not have available background levels or exceeded the 90th percentile background values:

- Carbon-14
- Cesium-137
- Radium-226
- Radium-228
- Thorium-228
- Thorium-230
- Total beta radiostrontium

For 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
- Strontium-90
- Thorium-228

5.4.4 RESRAD Results

Each waste site was modeled separately and calculation times were carried out to 1,000 years. The RESRAD modeling results are summarized in Tables 5-8 through 5-15 and 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 OU

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 3.1 mrem/yr occurs at year 0; the dose decreases to 0.36 mrem/yr over 1,000 years. The total dose from this exposure area does not exceed the target dose level of 100 mrem/year for the industrial scenario. The primary radionuclide associated with total dose is radium-226 over the 1,000-year 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 4.5×10^{-5} occurs at year 0; the risk decreases to 7.8×10^{-6} after 1,000 years. The primary risk contributor is radium-226 over the 1,000-year period.

216-T-26 Crib. The results of the RESRAD dose estimate for the shallow-zone soil with no cover are presented in Table 5-8 and Figure 5-5. The maximum total dose of 2.3 mrem/yr occurs in year 0; the dose decreases to 0.31 mrem/yr in 1,000 years. The total dose from this exposure area does not exceed the target dose level of 100 mrem/year for the industrial scenario at any time. Thorium-228 is the primary radionuclide for the first two years; thereafter, radium-226 becomes the dominant radionuclide.

The results of the RESRAD risk estimate for the shallow-zone soil with no cover are presented in Table 5-9 and Figure 5-6. The maximum risk of 2.3 x 10^{-5} occurs at year 0, the risk decreases to 7.0 x 10^{-6} after 1,000 years. The primary risk contributor is radium-226 over the entire 1,000-year period.

5.4.4.2 200-TW-2 OU

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 17.2 mrem/yr occurs at year 0; the dose decreases to 0.35 mrem/yr at 1,000 years. The total dose from this exposure area does not exceed the target dose level of 100 mrem/year for the industrial scenario at any time. The primary radionuclide associated with total dose is cesium-137 for the first 130 years, radium-226 from 130 to 900 years, and thorium-230 thereafter.

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 2.7 x 10^{-4} occurs at year 0 and the risk decreases to 7.9 x 10^{-6} after 1,000 years. The primary risk contributor is cesium-137 for the first 130 years, radium-226 from 130 to 900 years, and thorium-230 thereafter.

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 0.10 mrem/yr at year 0, decreases slightly to a minimum of 0.06 mrem/yr at year 60, increases to a maximum of 0.55 at year 300, and decreases to 0.35 mrem/yr at year 1,000. The total dose from this exposure area does not exceed the target dose level of 100 mrem/year for the industrial scenario at any time. The primary radionuclide associated with total dose is cesium-137 for the first 110 years, radium-228 between years 110 and 900, and thorium-230 thereafter.

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 2.0 x 10^{-6} at year 0, decreases to a minimum of 1.7 x 10^{-6} at year 30, increases to a maximum of 1.2 x 10^{-5} at 500 years and decreases to 7.9 x 10^{-6} at year 1,000. The primary risk contributor is cesium-137 for the first 110 years, radium-228 between years 110 and 900, and thorium-230 thereafter.

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 decreases to 1.6 mrem/yr at 1,000 years. The total dose from this exposure area exceeds the target dose level of 100 mrem/year for the industrial scenario until 300 years have passed. The primary radionuclide associated with the total dose is cesium-137 for the first 520 years. After 520 years, the primary radionuclide becomes plutonium-239.

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 of 2.1 occurs at year 0; the risk decreases to 1.6 x 10^{-5} after 1,000 years. The primary risk contributor is cesium-137 for the first 520 years. After 520 years, the primary risk contributor becomes radium-226.

216-B-38 Trench – With Cover. The results of the RESRAD dose estimate for the shallow-zone soil with 10 feet of cover are presented in Table 5-12 and Figure 5-13. The total dose decreases slightly from 3.8 x 10^{-13} mrem/yr at year 0 to a minimum of 4.0 x 10^{-14} mrem/yr at year 239. The dose increases from year 239 to a maximum of 2.7 x 10^{-11} mrem/yr at year 1,000. The total dose from this exposure area does not exceed the target dose level of 100 mrem/year for the industrial scenario at any time. The primary radionuclide associated with the total dose is cesium-137 for the first 300 years, and radium-226 thereafter.

The results of the RESRAD risk estimate for the shallow-zone soil with 10 feet of cover are presented in Table 5-13 and Figure 5-14. The total risk decreases slightly from 7.1 x 10^{-18} at year 0 to 8.4 x 10^{-19} at year 239. The risk then increases to a maximum of 7.3 x 10^{-16} at year 1,000. The primary risk contributor is cesium-137 for the first 300 years, and the primary contributor becomes radium-226 thereafter

5.4.4.3 200-PW-5 OU

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 total dose decreases from a maximum of 3.4 mrem/yr at year 0 to a minimum of 0.41 mrem/yr at year 1,000. The total dose from this exposure area does not exceed the target dose level of 100 mrem/year for the industrial scenario at any time. The primary radionuclide associated with the total dose is radium-226 at all times.

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 5.2 x 10^{-5} at year 0 to a minimum of 9.1 x 10^{-6} at year 1,000. The primary risk contributor is radium-226 at all times.

5.5 ECOLOGICAL RISK SCREENING

Tables 5-3, 5-4, and 5-7 provide the screening of contaminants against ecological screening levels. The ecological evaluation for 200-TW-1, 200-TW-2, and 200-PW-5 OUs will follow the tiered EPA approach, starting with a screening-level evaluation. Further evaluation under the EPA approach will be conducted as part of the 200 Area-wide approach and the FS for these OUs.

For the screening-level ecological risk assessment, the Implementation Plan (DOE-RL 1999) serves as an initial summary of ecological information. The *Ecological Evaluation of the Hanford 200 Areas – Phase 1: Compilation of Existing 200 Area Ecological Data* (DOE-RL 2002) represents a substantial portion of the problem formulation and toxicity evaluation elements of the screening-level risk assessment (See Figure 2-1 in the 200 Area Ecological Evaluation document). The DQO report and the work plan complete the problem formulation step.

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. Assembling radionuclide concentration data and knowledge of sources, receptors, and routes of exposure for the area to be evaluated.
2. Applying an easy-to-use general screening methodology that provides limiting radionuclide concentration values (i.e., BCGs) in soil, sediment, and water.
3. If needed, conducting 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 the EPA (1998).

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

The BCGs contained in DOE-ORNL's technical standard guidance 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:

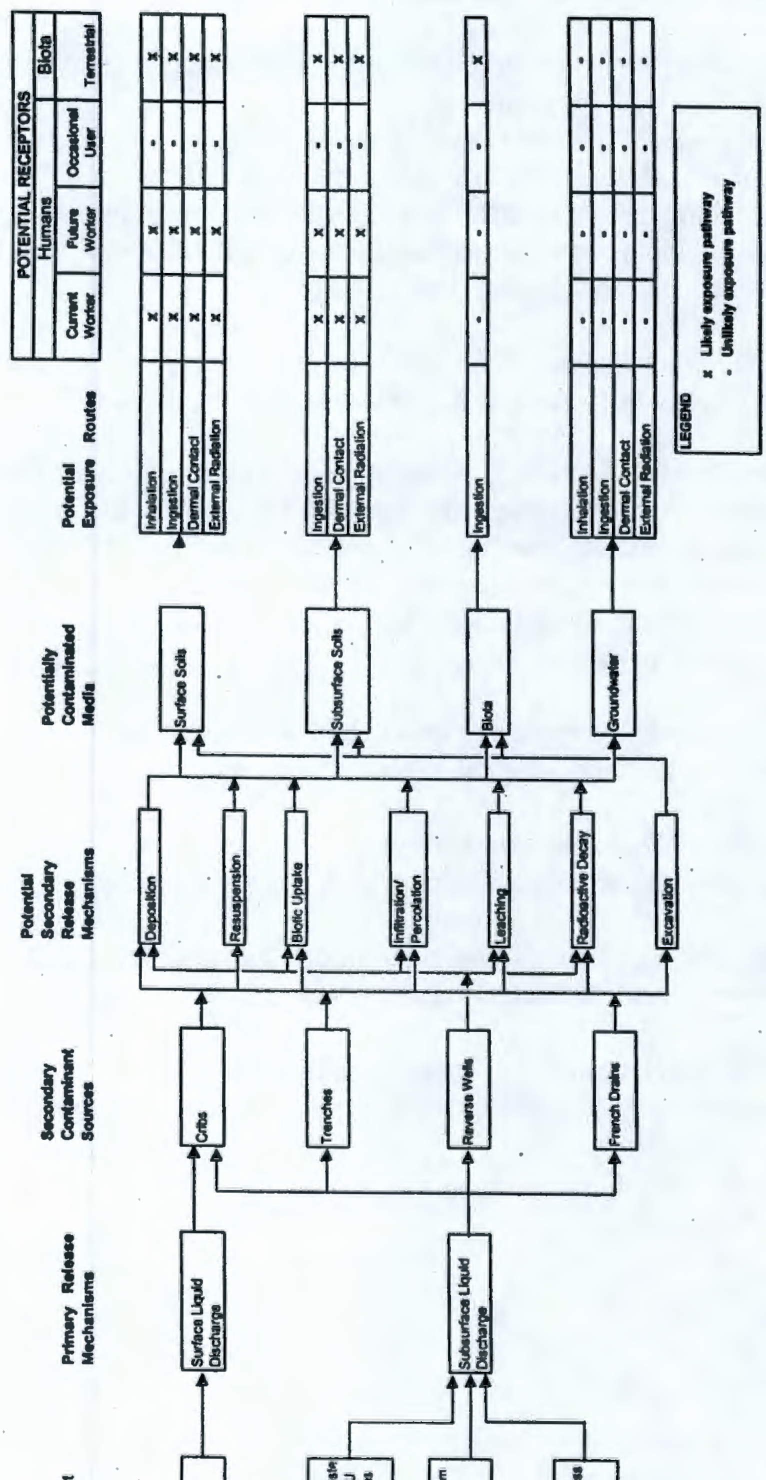
- For the 200-TW-1 OU, no contaminants were identified above the ecological screening levels for nonradionuclides or radionuclides.

- 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-ORNL 2000).

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



Potentially Contaminated Media	Potential Exposure Routes	Current Worker	Future Worker	Occasional User	Terrestrial (Biota)
Surface Soils	Inhalation	x	x	-	x
	Ingestion	x	x	-	x
	Dermal Contact	x	x	-	x
	External Radiation	x	x	-	x
Subsurface Soils	Ingestion	x	x	-	x
	Dermal Contact	x	x	-	x
	External Radiation	x	x	-	x
Biota	Ingestion	-	-	-	x
Groundwater	Inhalation	-	-	-	-
	Ingestion	-	-	-	-
	Dermal Contact	-	-	-	-
	External Radiation	-	-	-	-

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

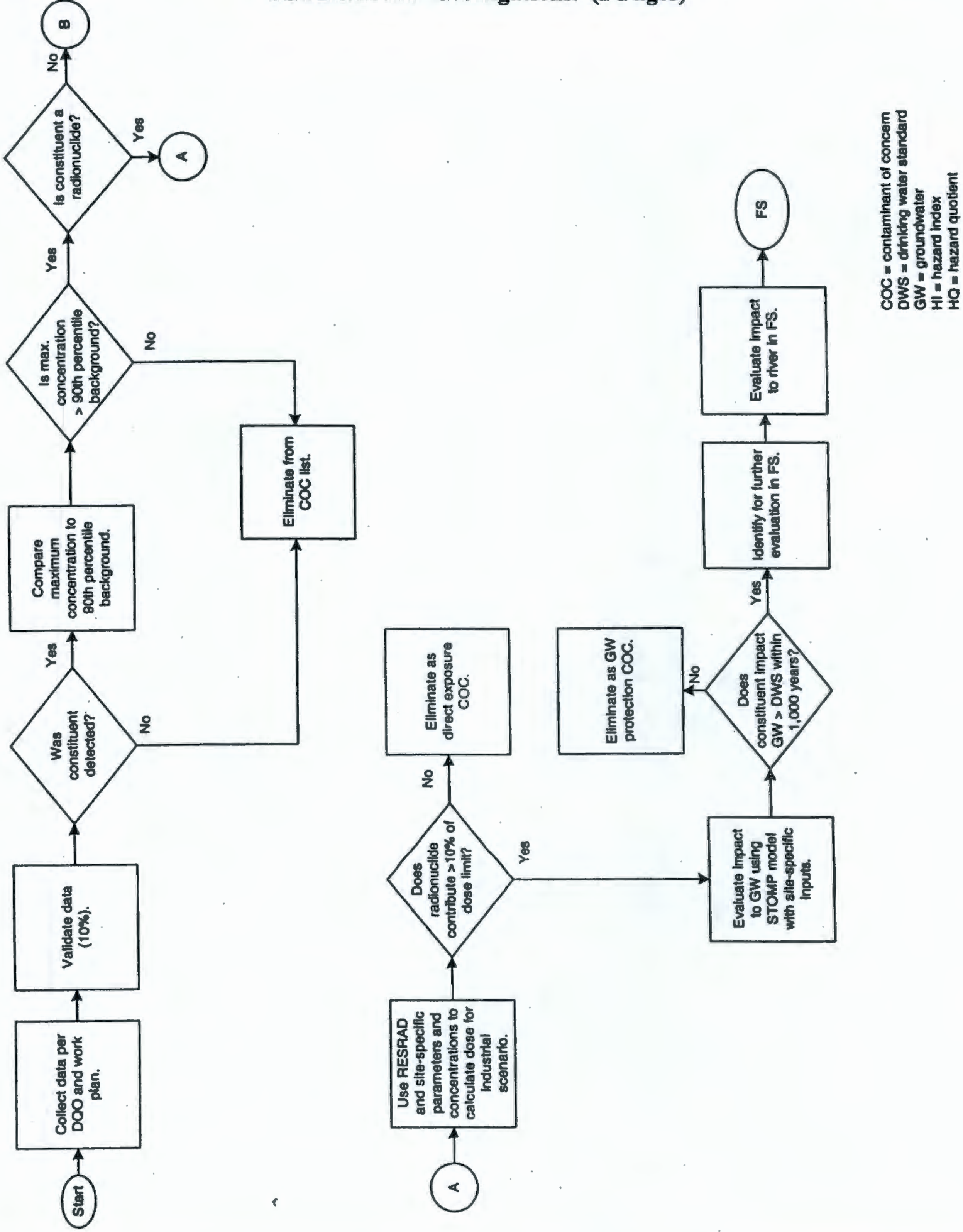


Figure 5-2. Data Evaluation Process for the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Unit Remedial Investigations. (2 Pages)

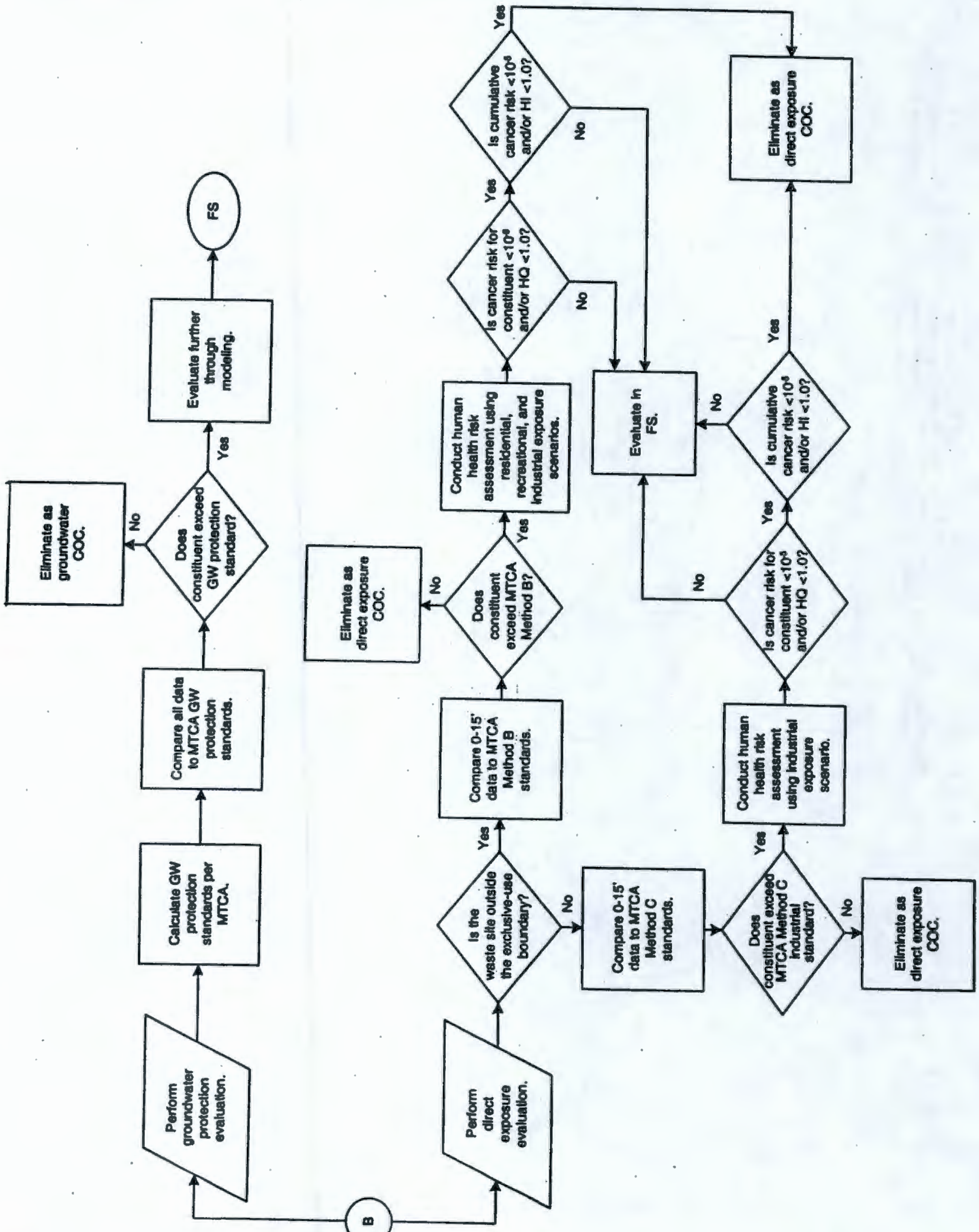
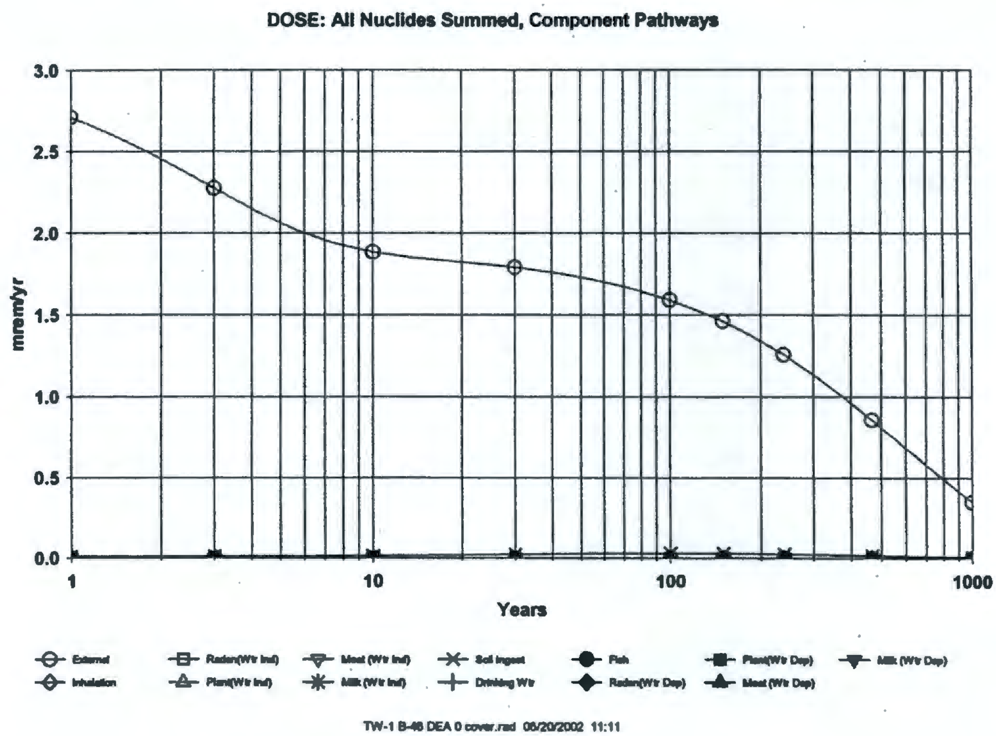


Figure 5-3. RESRAD Analysis for the 200-TW-1 OU, 216-B-46 Crib – All Radionuclides, All Pathways Dose Estimate (No Cover, Direct Contact Scenario)



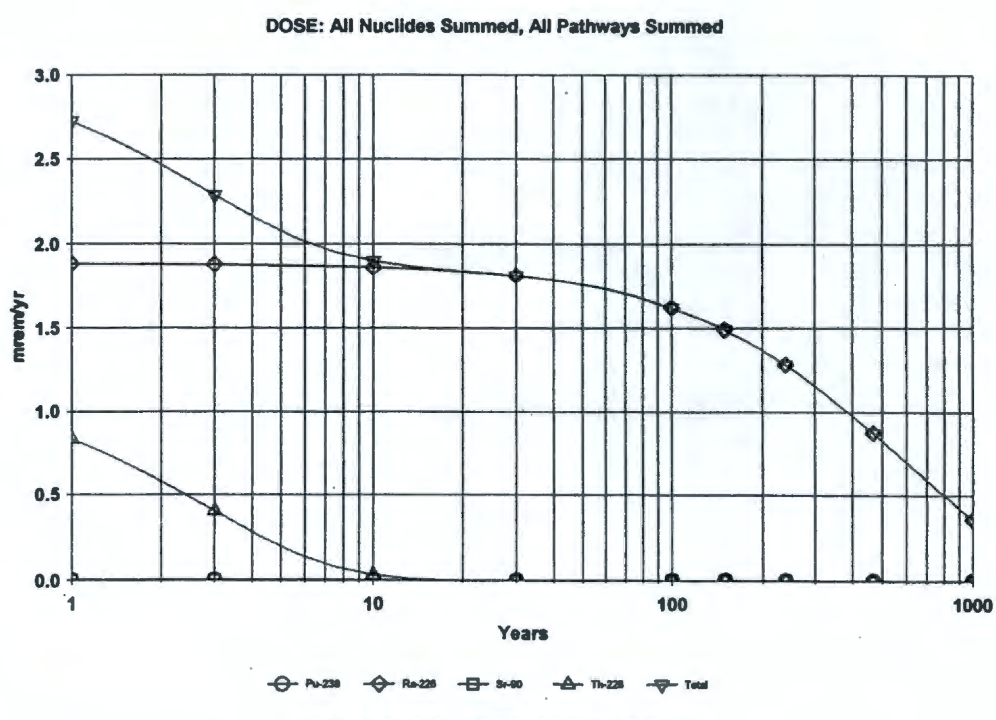
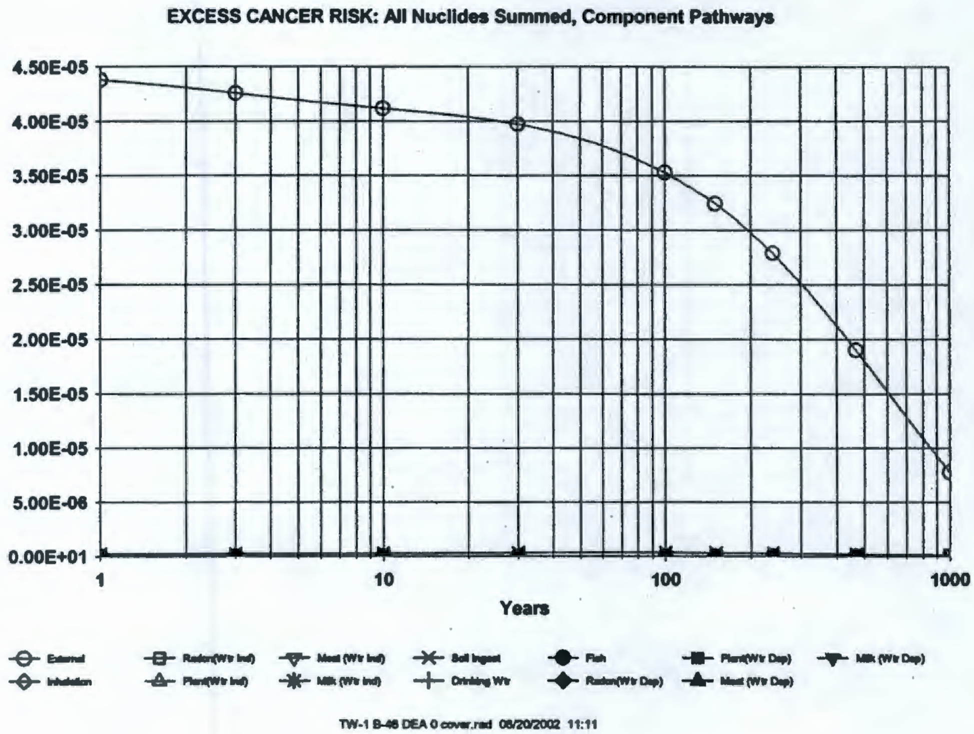


Figure 5-4. RESRAD Analysis for the 210-TW-1 OU, 216-B-46 Crib – All Radionuclides, All Pathways Risk Estimate (No Cover, Direct Contact Scenario)



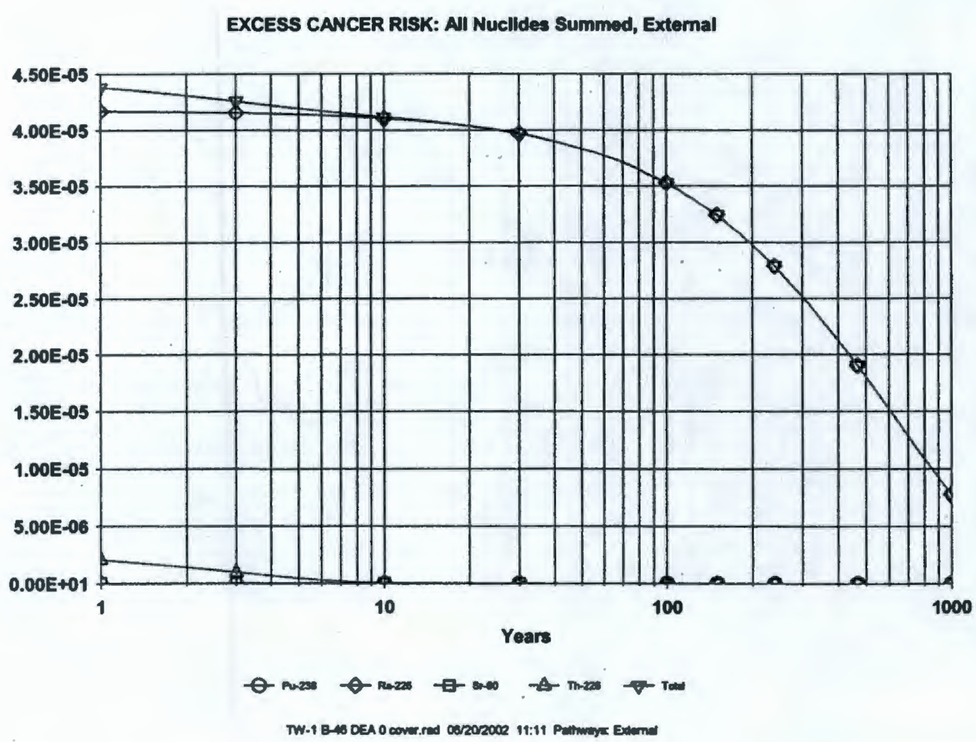
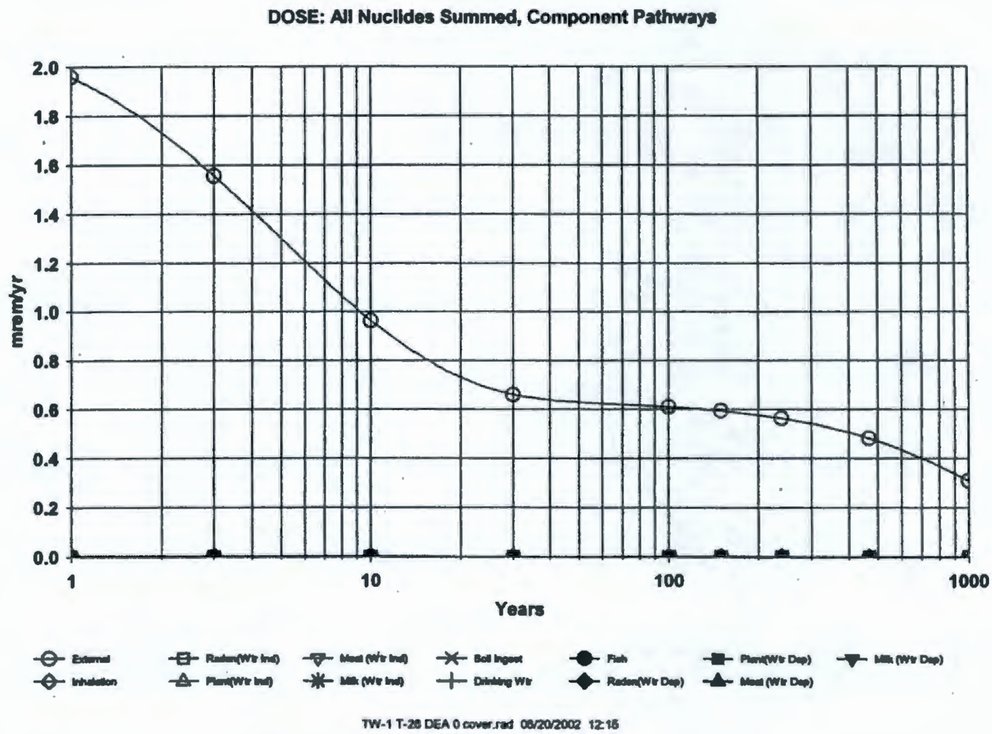


Figure 5-5. RESRAD Analysis for the 200-TW-1 OU, 216-T-26 Crib – All Radionuclides, All Pathways Dose Estimate (No Cover, Direct Contact Scenario)



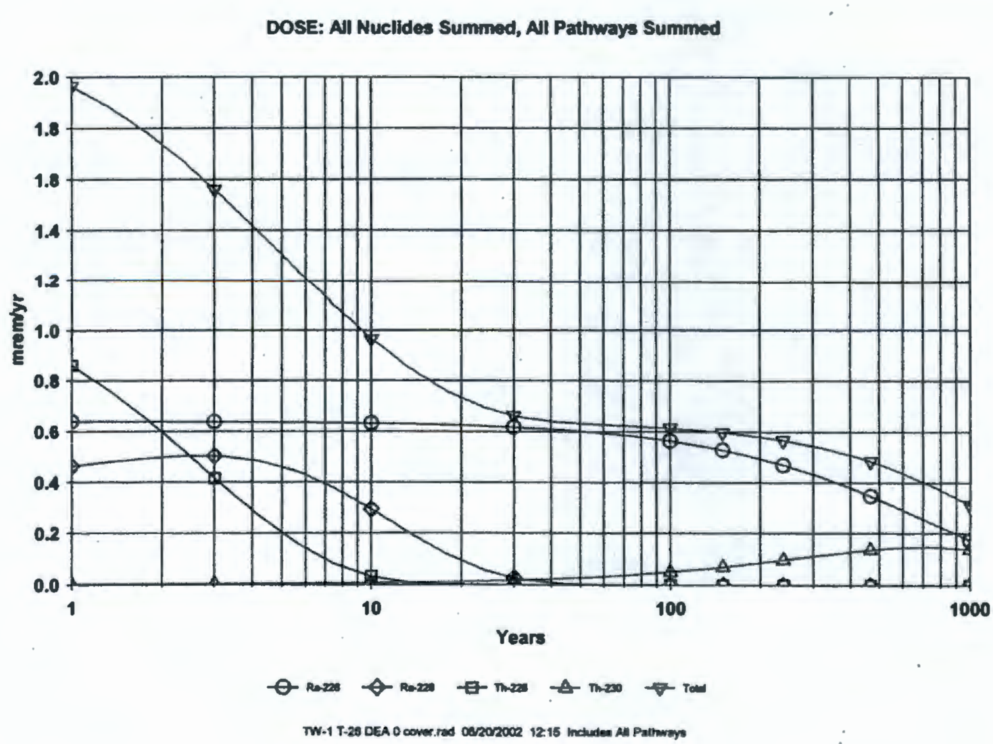
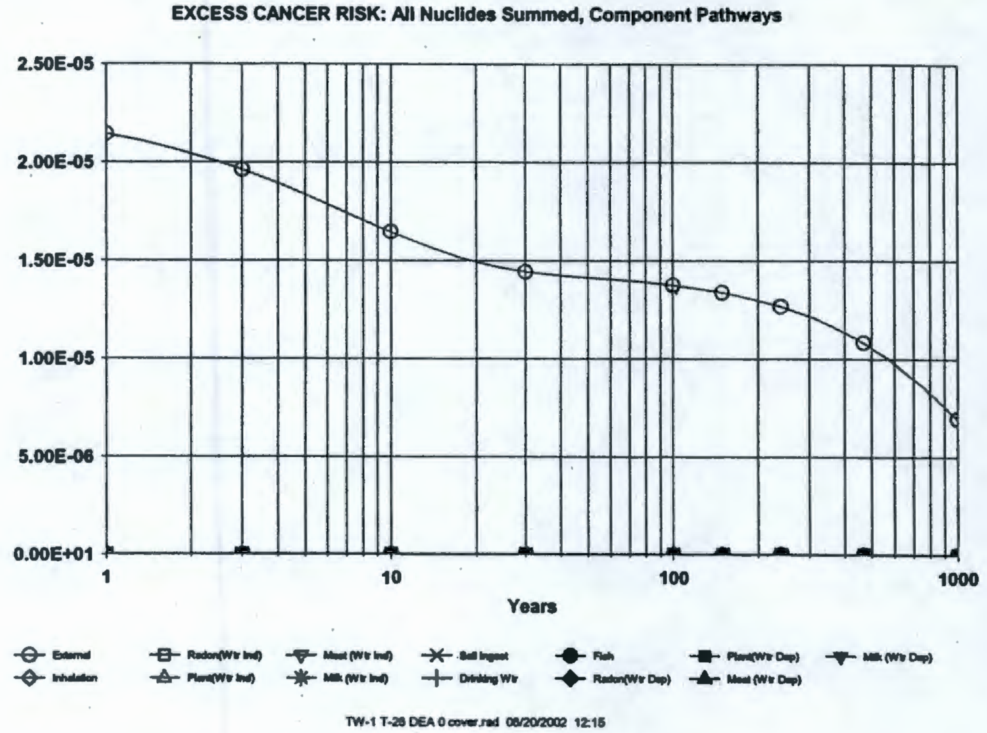


Figure 5-6. RESRAD Analysis for the 200-TW-1 OU, 216-T-26 Crib – All Radionuclides, All Pathways Risk Estimate (No Cover, Direct Contact Scenario)



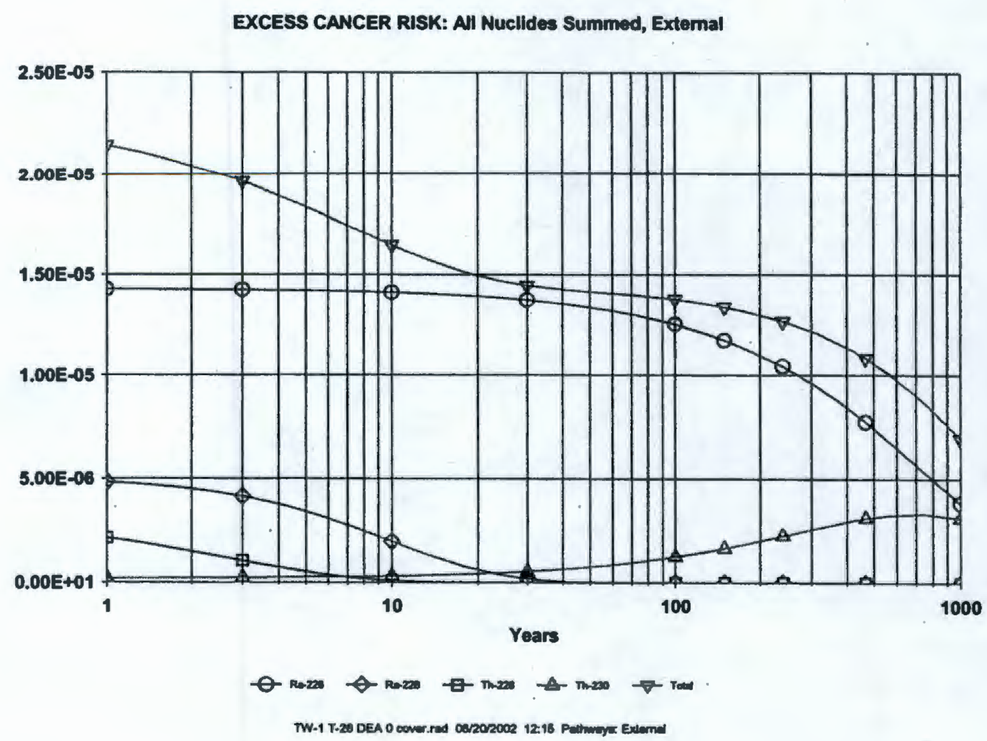
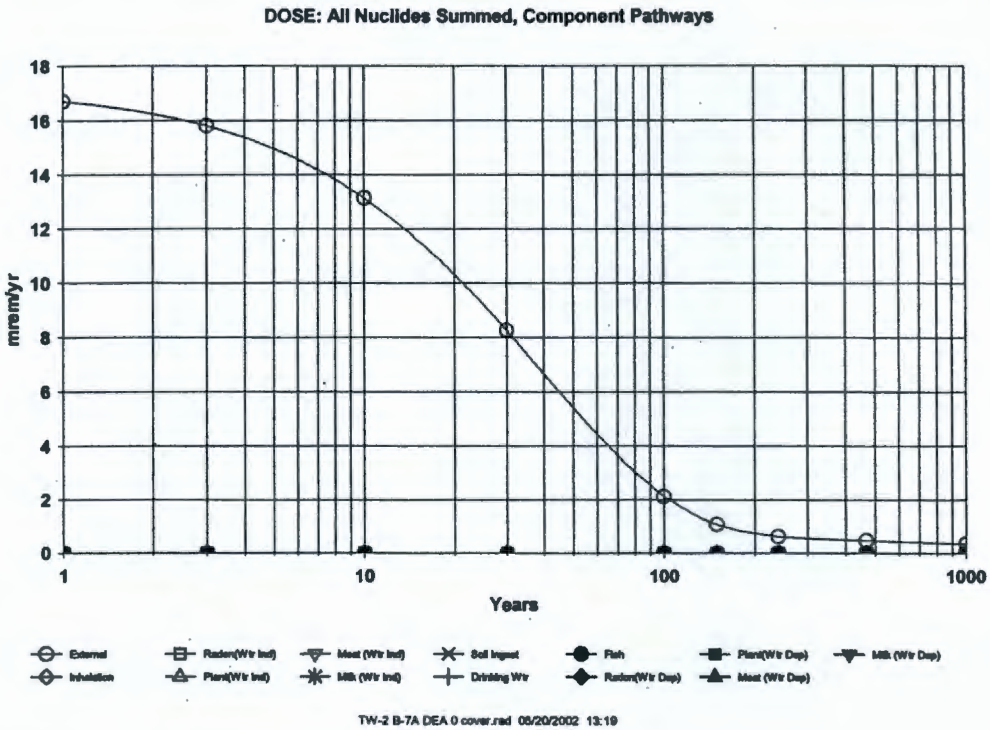


Figure 5-7. RESRAD Analysis for the 200-TW-2 OU, 216-B-7A Crib – All Radionuclides, All Pathways Dose Estimate (No Cover, Direct Contact Scenario)



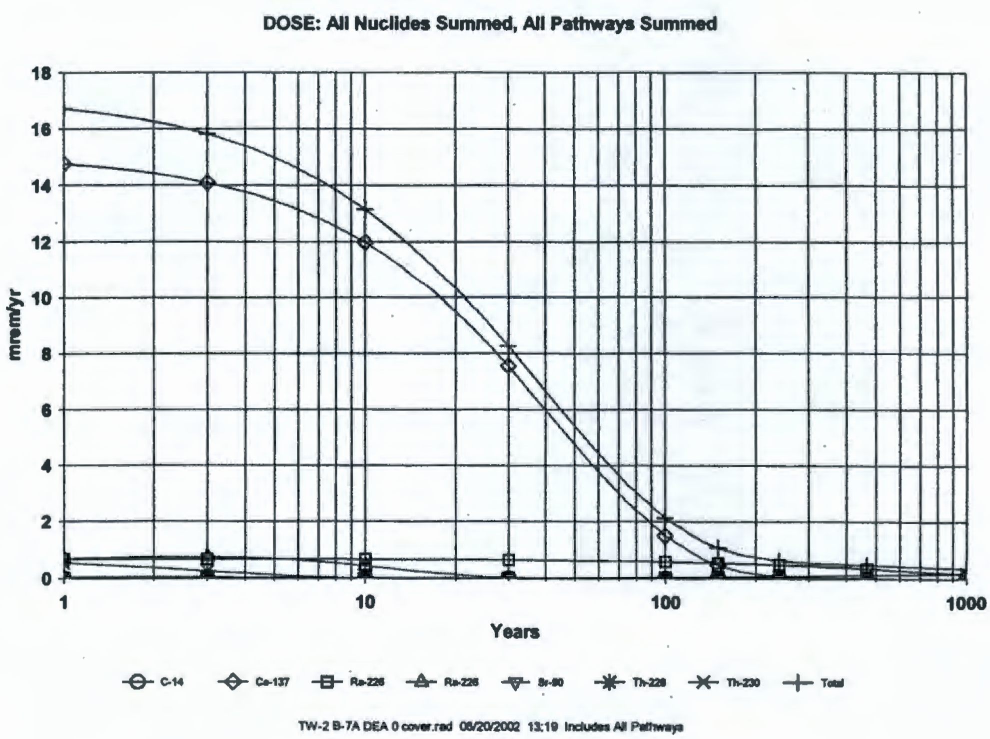
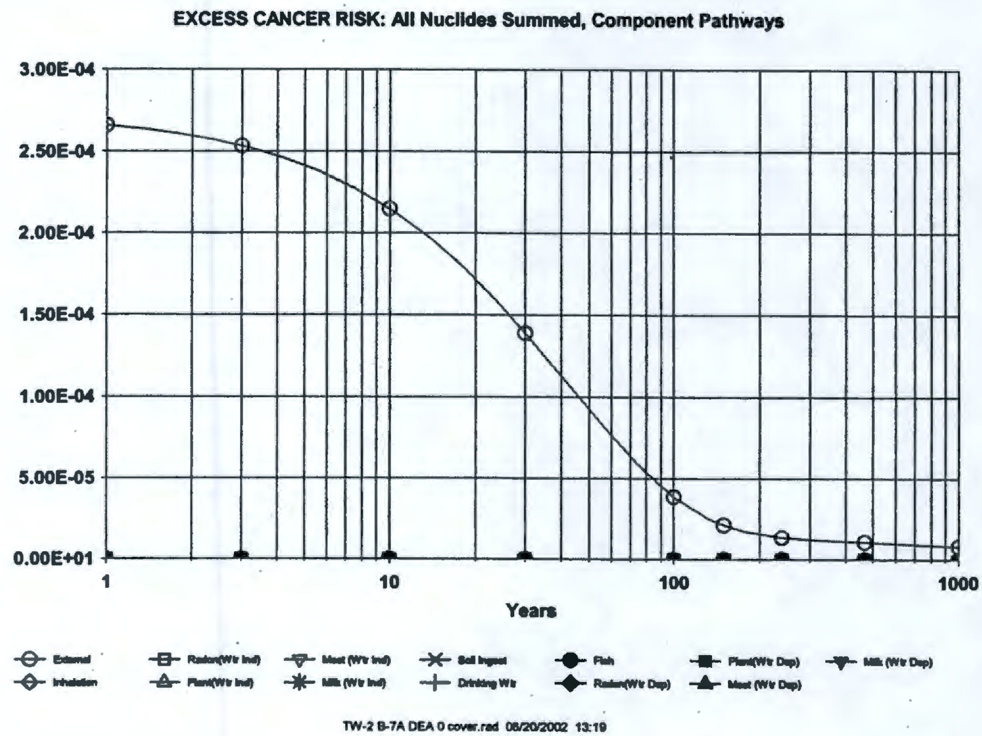


Figure 5-8. RESRAD Analysis for the 200-TW-2 OU, 216-B-7A Crib – All Radionuclides, All Pathways Risk Estimate (No Cover, Direct Contact Scenario)



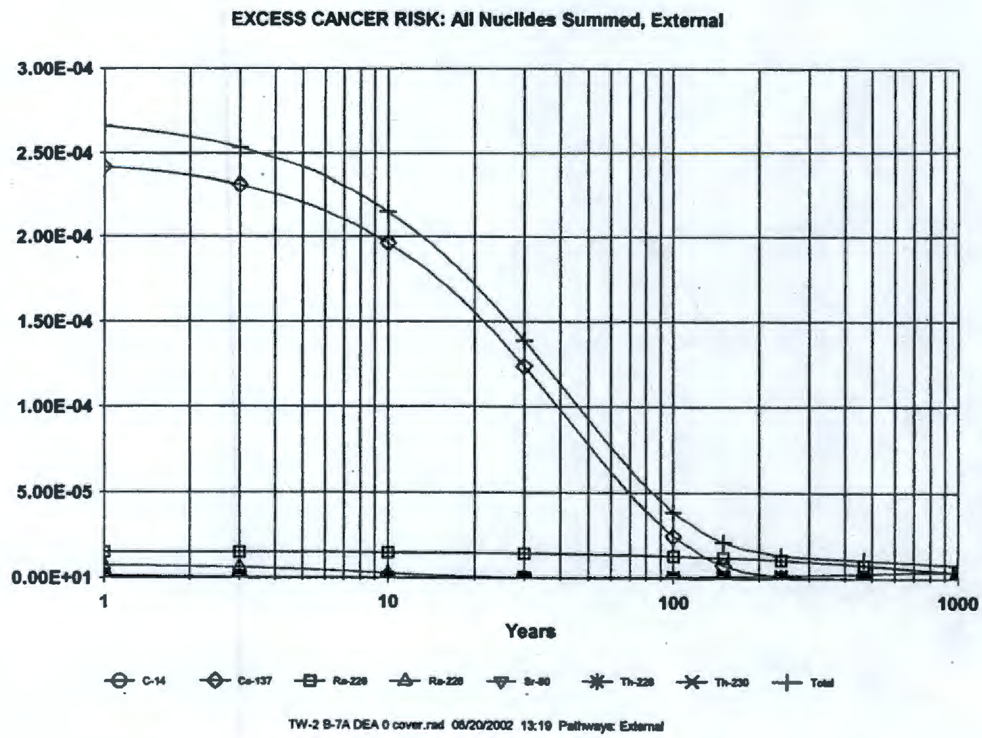
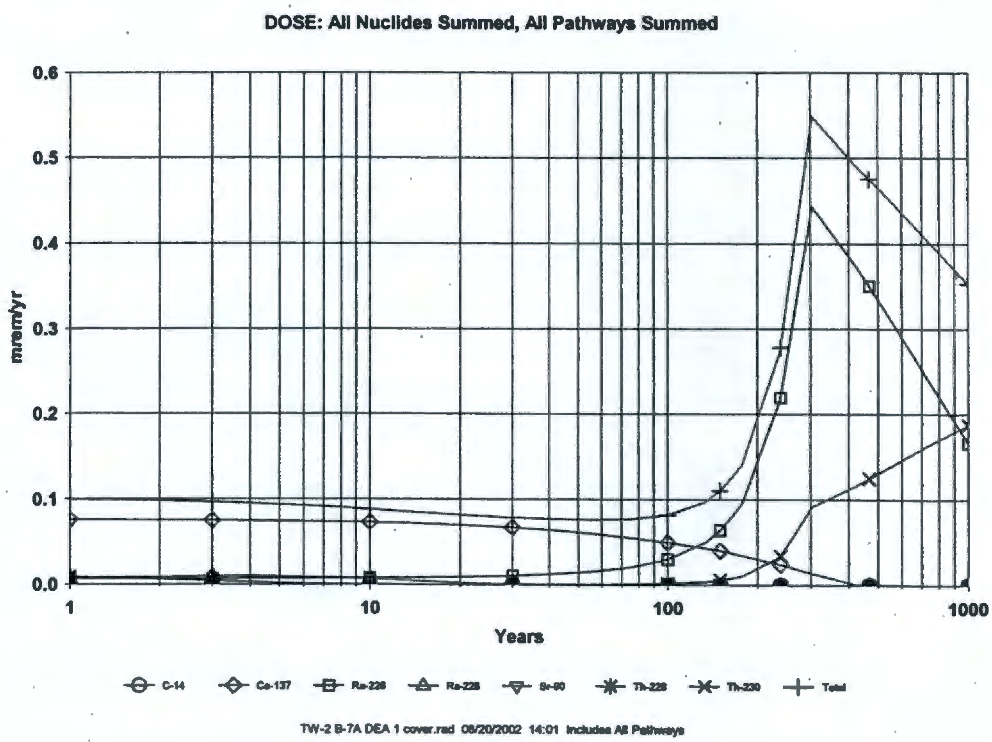


Figure 5-9. RESRAD Analysis for the 200-TW-2 OU, 216-B-7A Crib – All Radionuclides, All Pathways Dose Estimate (1-ft Cover, Direct Contact Scenario)



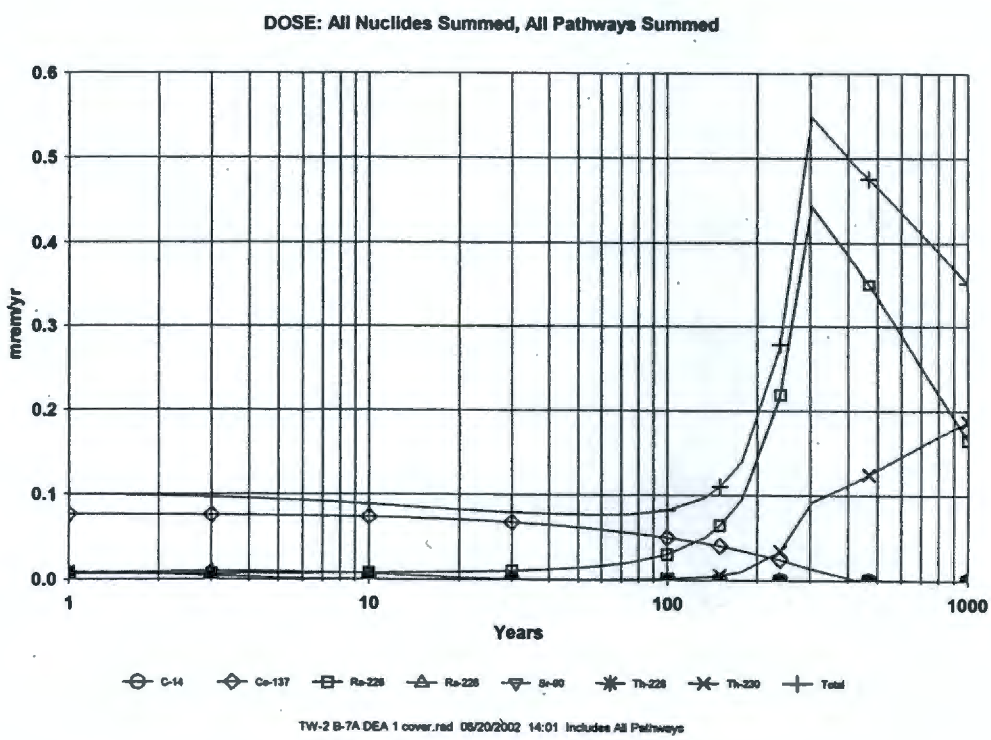
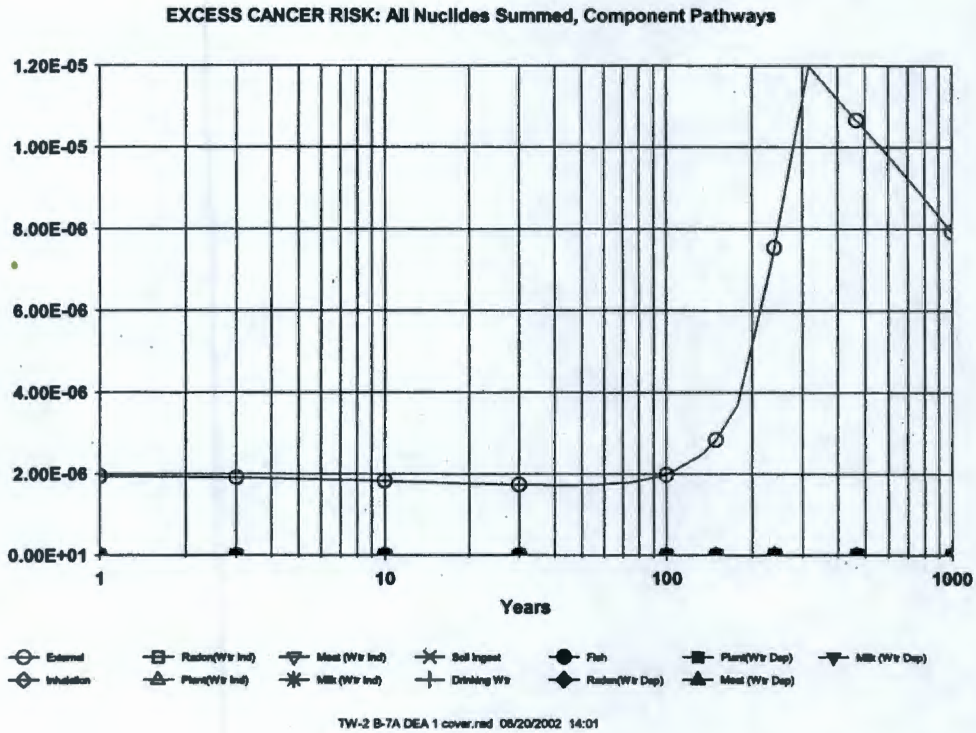


Figure 5-10. RESRAD Analysis for the 200-TW-2 OU, 216-B-7A Crib – All Radionuclides, All Pathways Risk Estimate (1-ft Cover, Direct Contact Scenario)



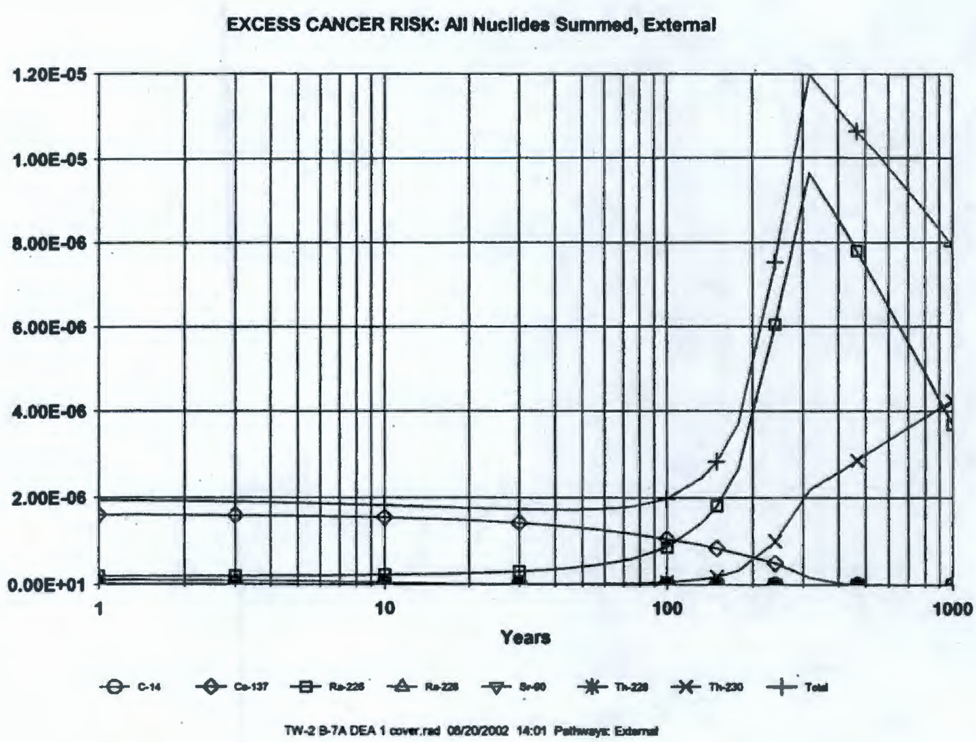
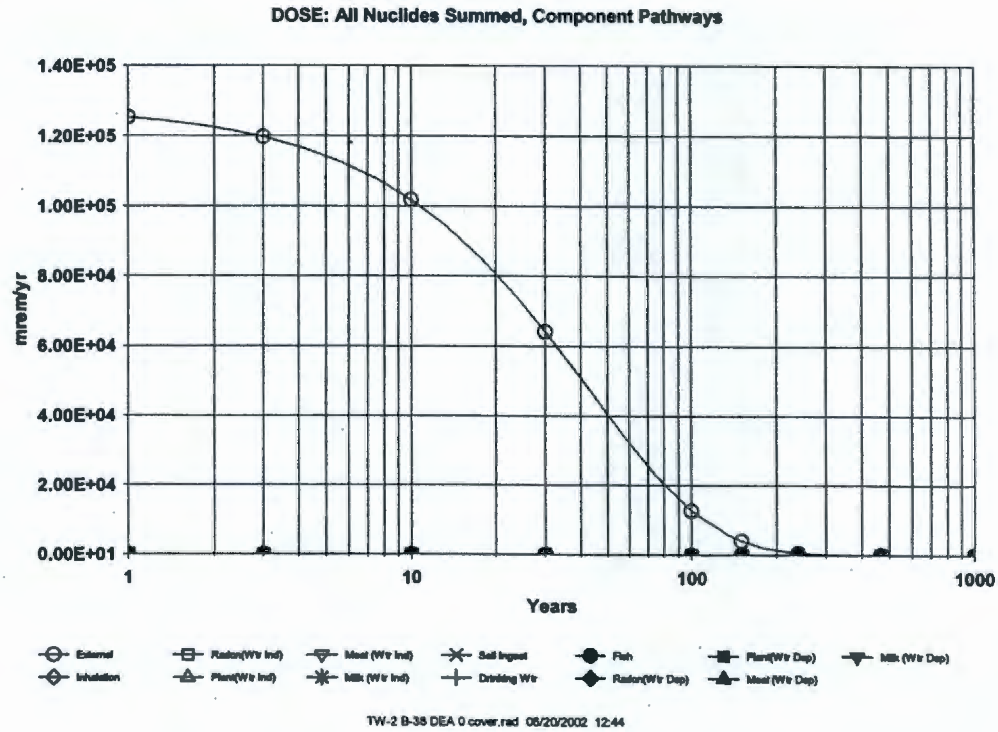


Figure 5-11. RESRAD Analysis for the 200-TW-2 OU, 216-B-38 Trench – All Radionuclides, All Pathways Dose Estimate (No Cover, Direct Contact Scenario)



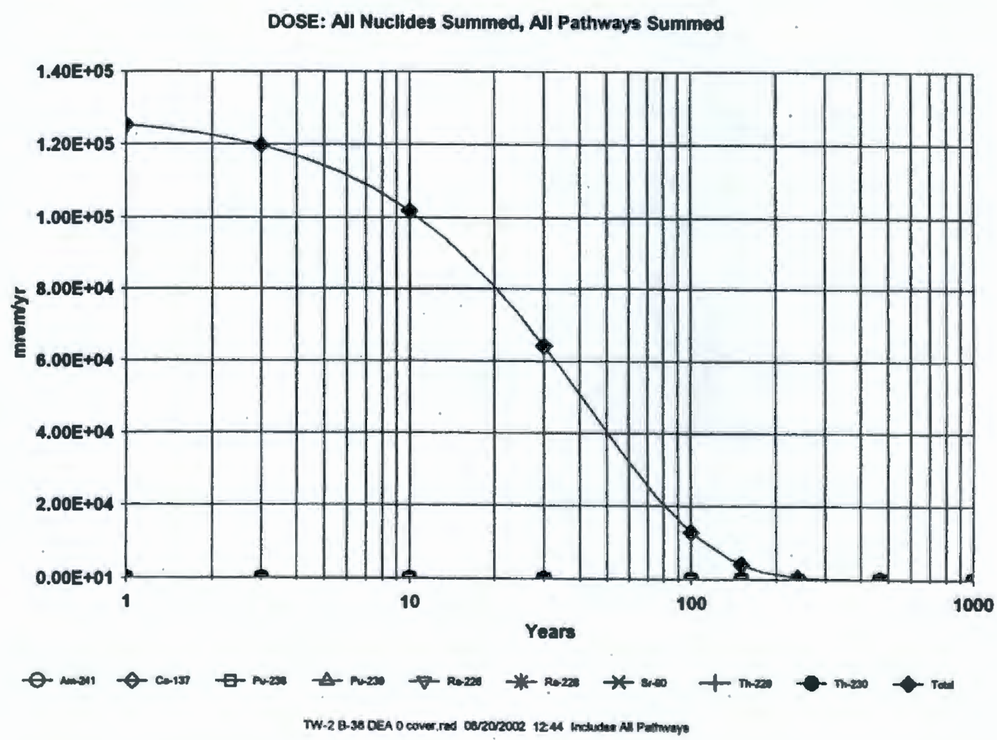
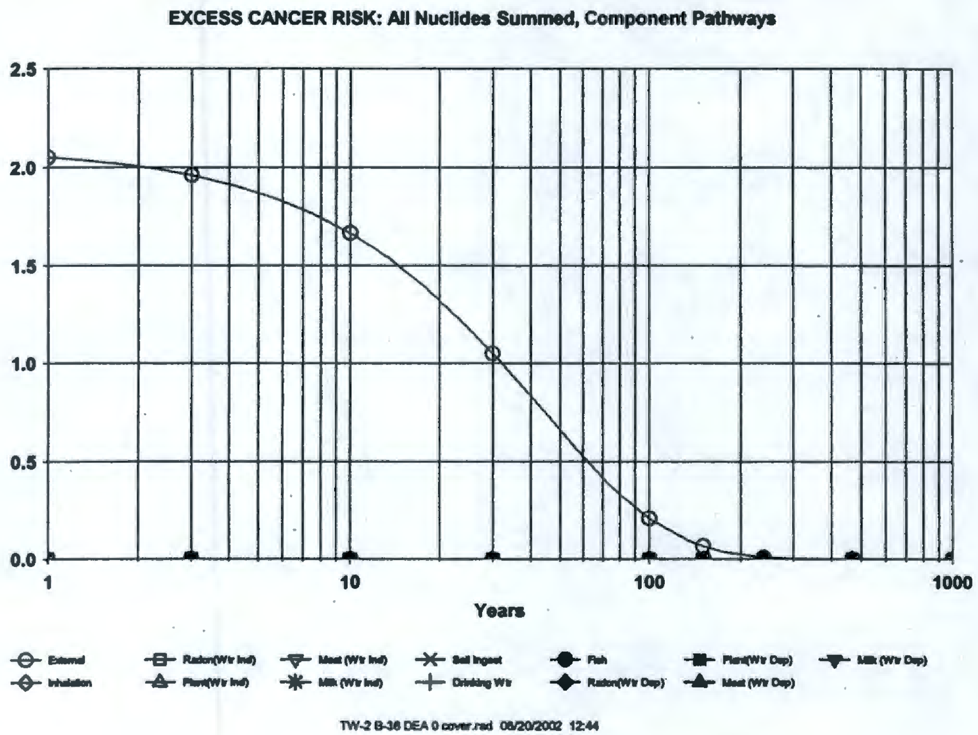


Figure 5-12. RESRAD Analysis for the 200-TW-2 OU, 216-B-38 Trench – All Radionuclides, All Pathways Risk Estimate (No Cover, Direct Contact Scenario)



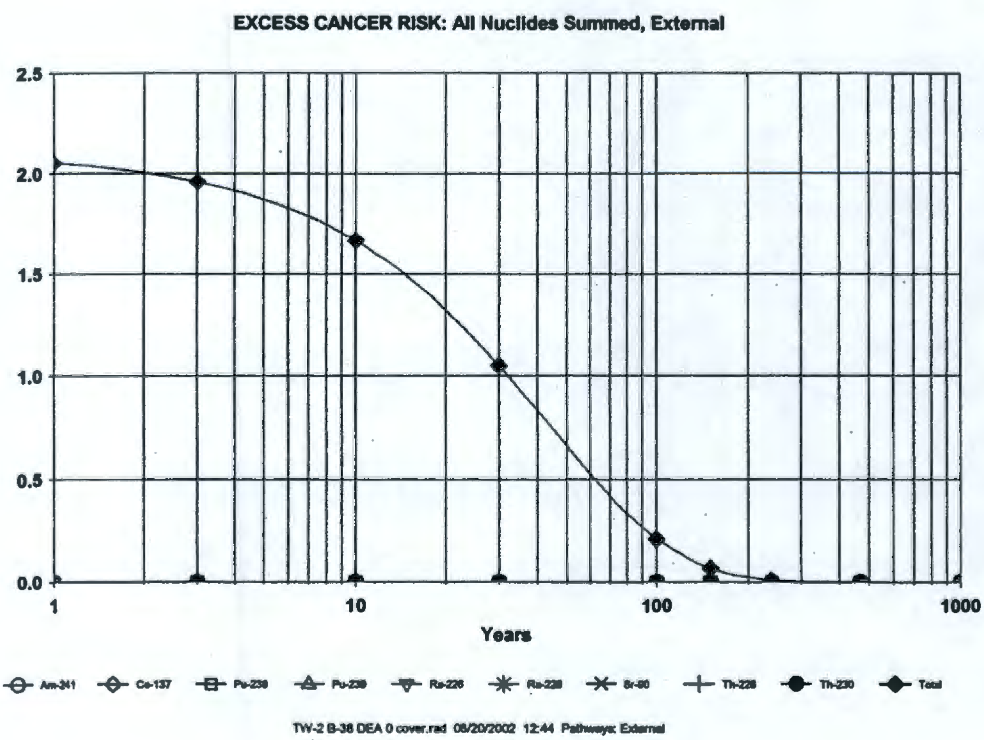
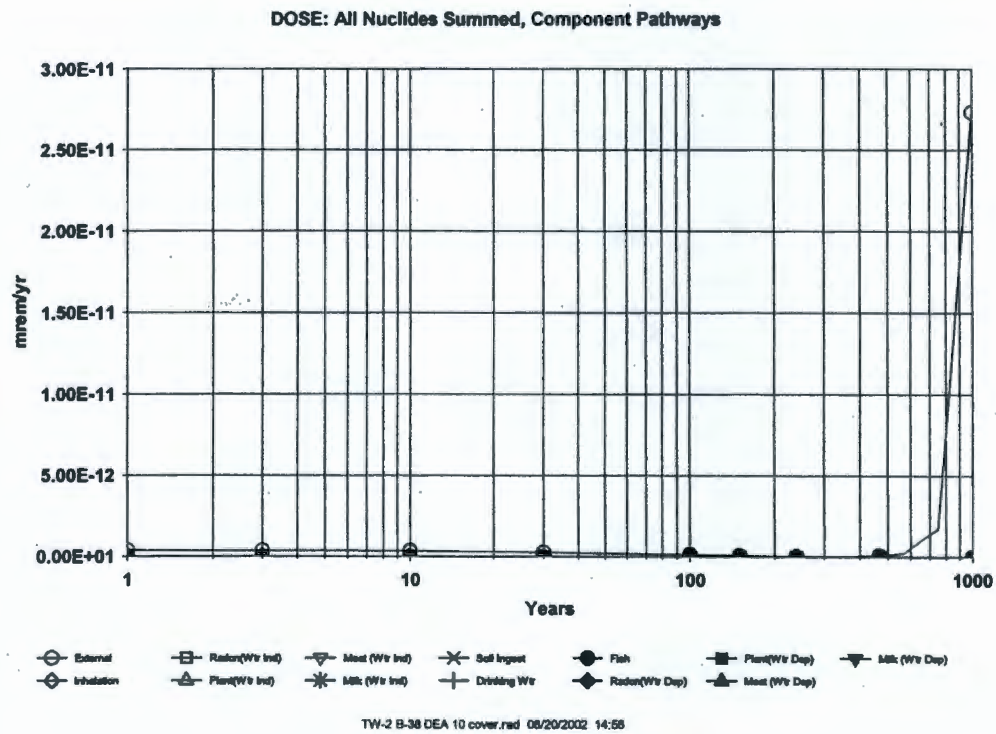


Figure 5-13. RESRAD Analysis for the 200-TW-2 OU, 216-B-38 Trench – All Radionuclides, All Pathways Dose Estimate (10-ft Cover, Direct Contact Scenario)



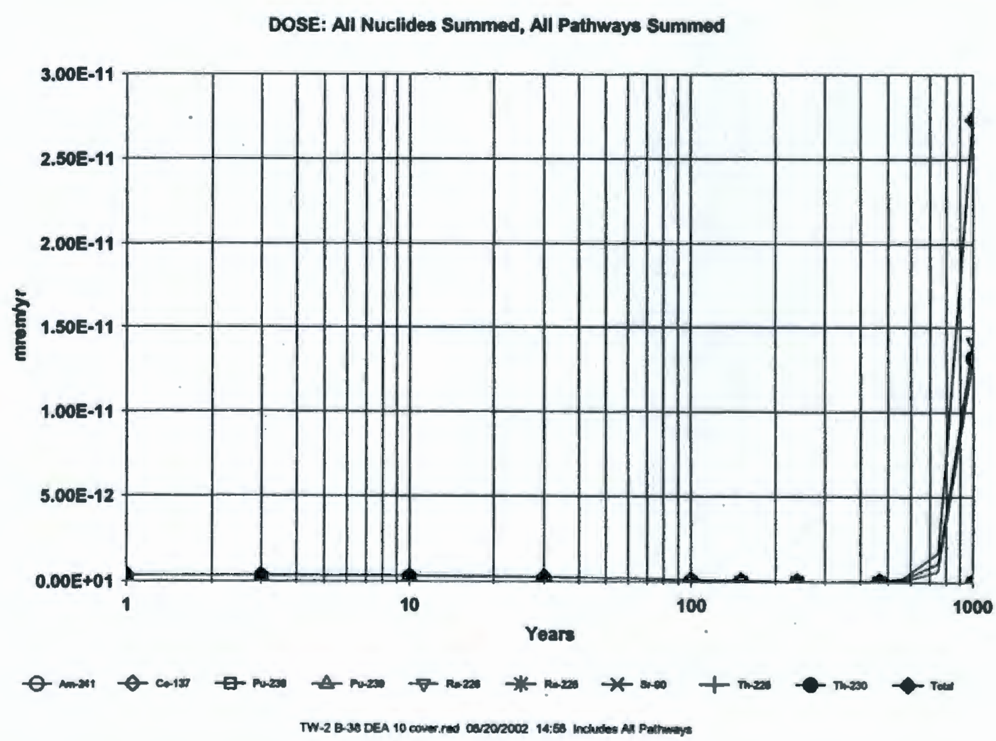
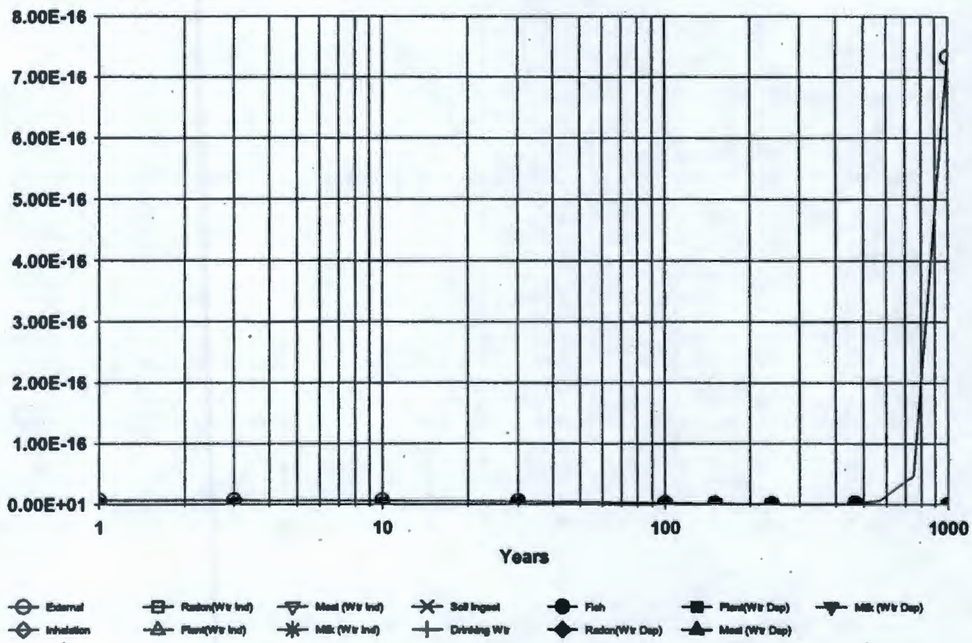


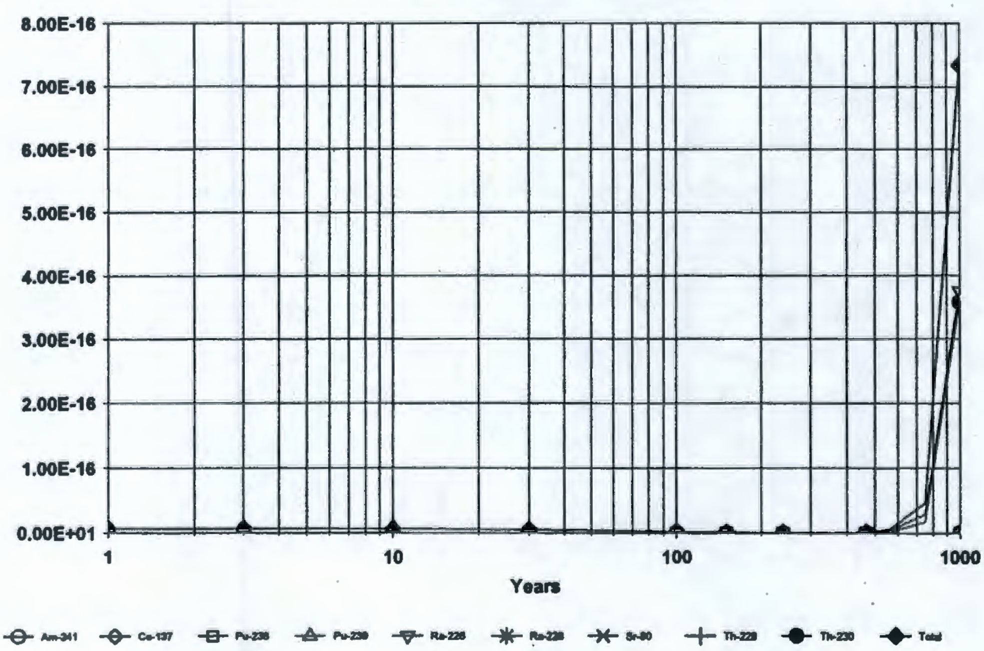
Figure 5-14. RESRAD Analysis for the 200-TW-2 OU, 216-B-38 Trench – All Radionuclides, All Pathways Risk Estimate (10-ft Cover, Direct Contact Scenario)

EXCESS CANCER RISK: All Nuclides Summed, Component Pathways



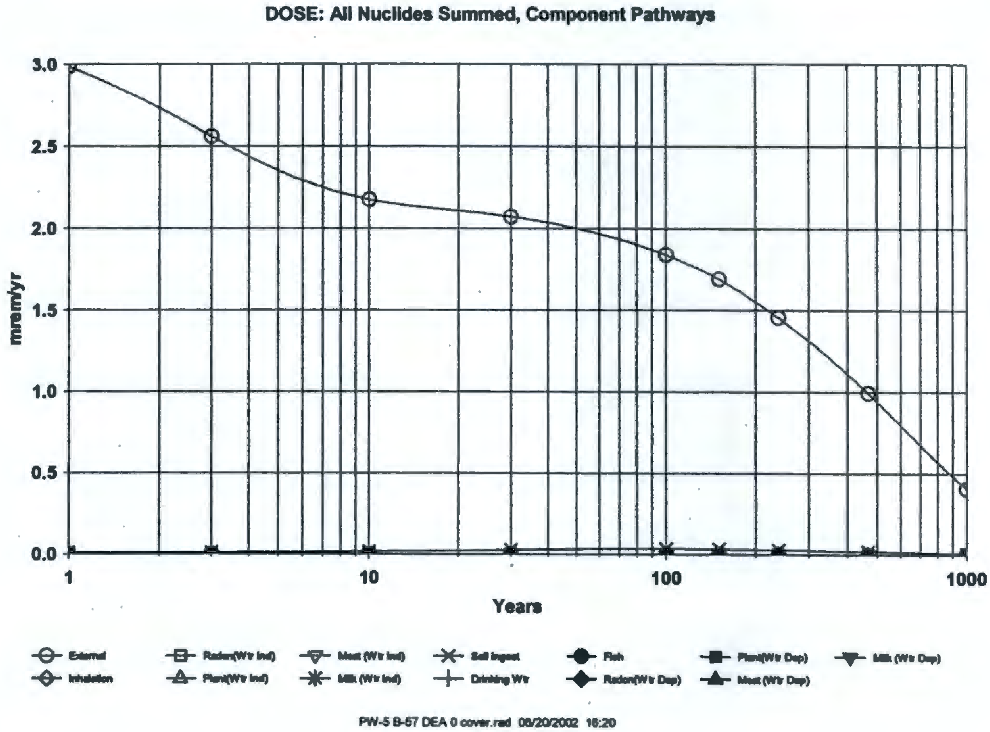
TW-2 B-38 DEA 10 cover.rad 08/20/2002 14:58

EXCESS CANCER RISK: All Nuclides Summed, External



TW-2 B-38 DEA 10 cover.rad 08/20/2002 14:58 Pathways: External

Figure 5-15. RESRAD Analysis for the 200-PW-5 OU, 216-B-57 Crib – All Radionuclides, All Pathways Dose Estimate (No Cover, Direct Contact Scenario)



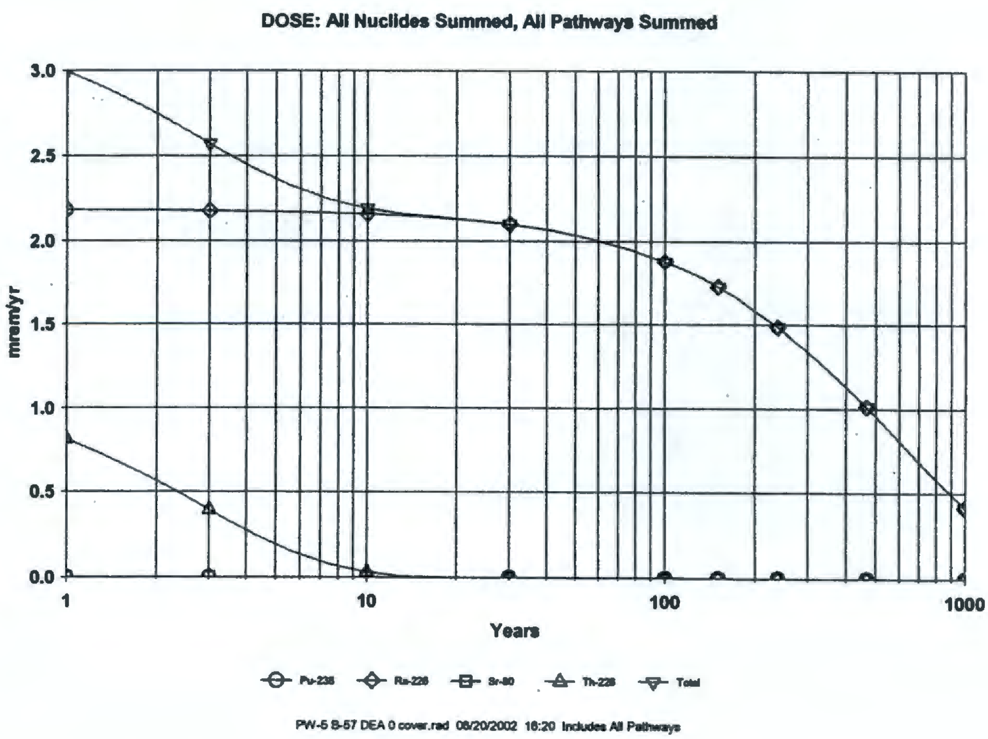
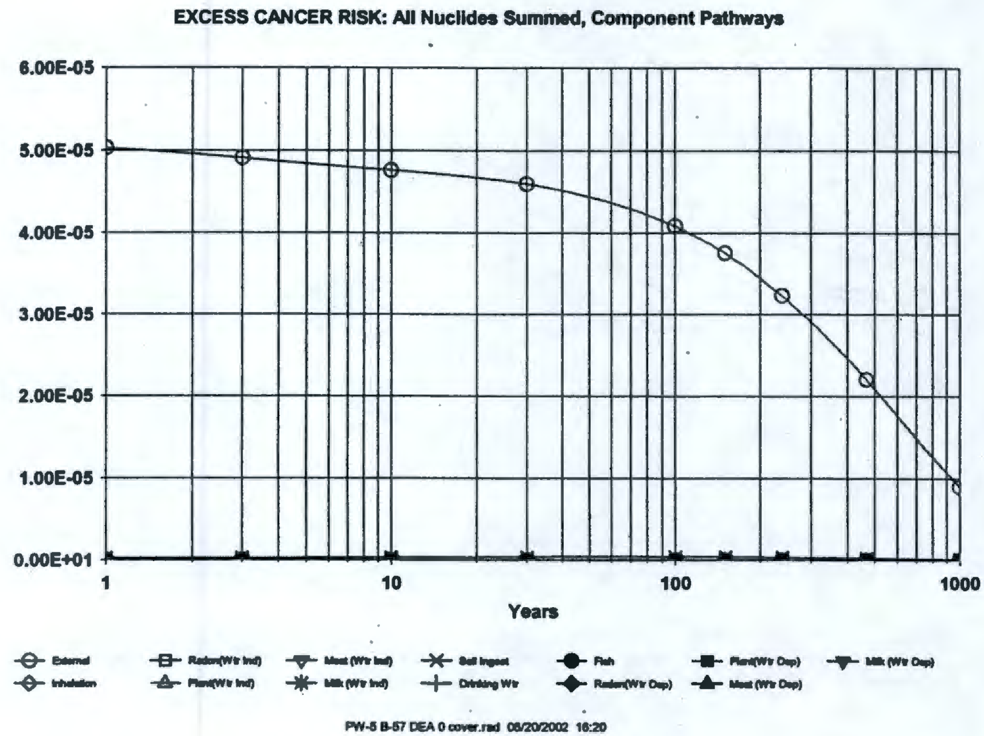


Figure 5-16. RESRAD Analysis for the 200-PW-5 OU, 216-B-57 Crib – All Radionuclides, All Pathways Risk Estimate (No Cover, Direct Contact Scenario)



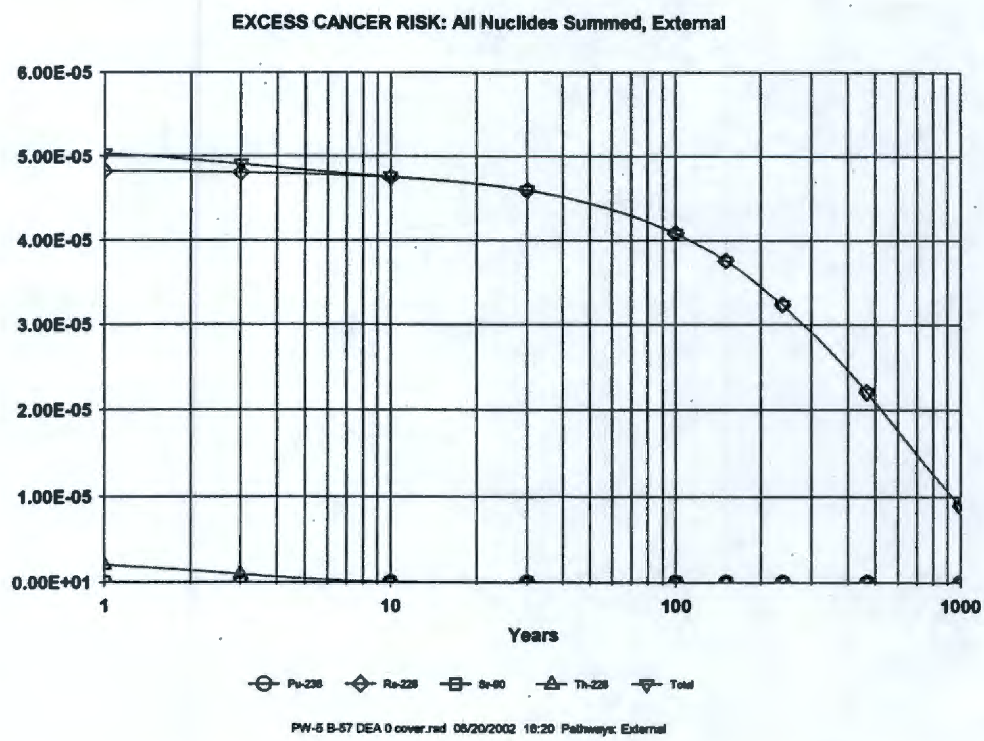


Table 5-1. Summary of the Shallow-Zone Soil Samples Used in the Risk Assessment for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs.

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 OUs. (6 Pages)

Constituent Name	Constituent Class	Units	Number of Samples	Number of Detects	Frequency of Detect	Minimum Nondetect	Maximum Nondetect	Minimium 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

Table 5-2. Summary Statistics for Shallow-Zone Soil Samples for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. (6 Pages)

Constituent Name	Constituent Class	Units	Number of Samples	Number of Detects	Frequency of Detect	Minimum Nondetect	Maximum Nondetect	Minimium Result	Maximum Result	Exposure Point Concentration
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
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

Table 5-2. Summary Statistics for Shallow-Zone Soil Samples for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. (6 Pages)

Constituent Name	Constituent Class	Units	Number of Samples	Number of Detects	Frequency of Detect	Minimum Nondetect	Maximum Nondetect	Minimium Result	Maximum Result	Exposure Point Concentration
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
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

Table 5-2. Summary Statistics for Shallow-Zone Soil Samples for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. (6 Pages)

Constituent Name	Constituent Class	Units	Number of Samples	Number of Detects	Frequency of Detect	Minimum Nondetect	Maximum Nondetect	Minimium Result	Maximum Result	Exposure Point Concentration
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
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

Table 5-2. Summary Statistics for Shallow-Zone Soil Samples for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. (6 Pages)

Constituent Name	Constituent Class	Units	Number of Samples	Number of Detects	Frequency of Detect	Minimum Nondetect	Maximum Nondetect	Minimium Result	Maximum Result	Exposure Point Concentration
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
Iron	METAL	mg/kg	2	2	100%	--	--	7,500	8,800	8,800
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

Table 5-2. Summary Statistics for Shallow-Zone Soil Samples for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. (6 Pages)

Constituent Name	Constituent Class	Units	Number of Samples	Number of Detects	Frequency of Detect	Minimum Nondetect	Maximum Nondetect	Minimium Result	Maximum Result	Exposure Point Concentration
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

Table 5-3. Comparison of Maximum Shallow-Zone Soil Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (4 Pages)

Constituent Name	Constituent Class	Units	Maximum Result	90th Percentile Background Concentration	Does Maximum Concentration Exceed Background?	MTCA 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		--	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

Table 5-3. Comparison of Maximum Shallow-Zone Soil Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (4 Pages)

Constituent Name	Constituent Class	Units	Maximum Result	90th Percentile Background Concentration	Does Maximum Concentration Exceed Background?	MTCA Table 749-3 Wildlife	COEC?	Justification
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
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

Table 5-3. Comparison of Maximum Shallow-Zone Soil Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (4 Pages)

Constituent Name	Constituent Class	Units	Maximum Result	90th Percentile Background Concentration	Does Maximum Concentration Exceed Background?	MTCA Table 749-3 Wildlife	COEC?	Justification
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
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

Table 5-3. Comparison of Maximum Shallow-Zone Soil Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (4 Pages)

Constituent Name	Constituent Class	Units	Maximum Result	90th Percentile Background Concentration	Does Maximum Concentration Exceed Background?	MTCA Table 749-3 Wildlife	COEC?	Justification
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

Table 5-4. Comparison of Shallow-Zone Soil Exposure Point Concentrations to MTCA Method C Soil Cleanup Levels. (3 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

Table 5-4. Comparison of Shallow-Zone Soil Exposure Point Concentrations to MTCA Method C Soil Cleanup Levels. (3 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
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
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

Table 5-4. Comparison of Shallow-Zone Soil Exposure Point Concentrations to MTCA Method C Soil Cleanup Levels. (3 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
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

-- means no screening concentration for wildlife receptors in MTCA
CUL - cleanup level
EPC - exposure point concentration = maximum concentration
COEC - contaminant of ecological concern
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 OUs – Radionuclides. (3 Pages)

Constituent Name	Constituent Class	Number of Samples	Number of Detects	Frequency of Detect	Units	Minimum Nondetect	Maximum Nondetect	Minimium 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

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

Constituent Name	Constituent Class	Number of Samples	Number of Detects	Frequency of Detect	Units	Minimum Nondetect	Maximum Nondetect	Minimium Result	Maximum Result	Exposure Point Concentration
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
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%	µg/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

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

Constituent Name	Constituent Class	Number of Samples	Number of Detects	Frequency of Detect	Units	Minimum Nondetect	Maximum Nondetect	Minimium Result	Maximum Result	Exposure Point Concentration
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%	µg/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
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

Table 5-6. RESRAD Input Parameters. (3 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	
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 2001) and refinement of the model as part of this RI.
R011-Contaminated Zone (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	6.1	6.1	5.2	9.1	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/year	100	100	100	100	100	
	Elapsed Time Since Waste Placement	year	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 4-X
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.
	Cover depth (Cover)	m	--	--	1	10	--	Represents actual conditions of cover based on RI results
	Cover material density	g/cm^3	1.81	1.5	2.01	1.4	1.81	Site-specific
	Cover erosion rate	m/year	0.001	0.001	0.001	0.001	0.001	RESRAD Default

Table 5-6. RESRAD Input Parameters. (3 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	
	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/year	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 Khaleel and Freeman 1995.
	CZ Field Capacity	unitless	0.43	0.183	0.25	0.25	0.43	Site-specific values based on physical property samples from RI and Khaleel and Freeman 1995.
	CZ Hydraulic conductivity	m/year	6570	21900	21900	21900	6570	WHC-SD-EN-SE-004 (WHC 1993c).
	CZ b parameter	unitless	4.05	4.05	4.05	4.05	4.05	RESRAD Table E:2; Environmenteal Restoration Contractor (ERC) memorandum dated June 30, 1999, McMahon to Fancher (BHI 1999a)
	Humidity in air	g/cm^3	8	8	8	8	8	RESRAD Default
	Evapotranspiration coefficient		0.656	0.656	0.656	0.656	0.656	EPA, Region 10 guidance; Letter from EPA
	Precipitation	m./year	0.16	0.16	0.16	0.16	0.16	Based on 16 cm (6.3 inches) average annual rainfall (DOE-RL 1992)
	Irrigation rate	m/year	0	0	0	0	0	RESRAD Default
	Irrigation mode		Overhead	Overhead	Overhead	Overhead	Overhead	RESRAD Default
	Runoff coefficient		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	1.00E+06	RESRAD Default
	Accuracy for water/soil computations		0.001	0.001	0.001	0.001	0.001	RESRAD Default
R017 – Inhalation and External Gamma	Inhalation rate	m^3/year	7300	7300	7300	7300	7300	WDOH 1997
	Mass loading for inhalation	g/m^3	0.0001	0.0001	0.0001	0.0001	0.0001	WDOH 1997
	Dilution length for airborne dust	m	3	3	3	3	3	RESRAD Default

Table 5-6. RESRAD Input Parameters. (3 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	
	Exposure duration	year	30	30	30	30	30	MTCA
	Inhalation shielding factor		0.4	0.4	0.4	0.4	0.4	RESRAD Default
	External gamma hielding factor		0.8	0.8	0.8	0.8	0.8	WDOH 1997
	Indoor time fraction (Industrial Scenario)		0.137	0.137	0.137	0.137	0.137	200 Area Industrial scenario; On-site 2000 hrs/yr (indoors 60%)
	Outdoor time fraction (Industrial Scenario)		0.091	0.091	0.091	0.091	0.091	200 Area Industrial scenario; On-site 2000 hrs/yr (outdoors 40%)
	Shape factor		1	1	1	1	1	RESRAD Default

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	NA	No	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	NA	No	2200	No	Below BCG

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-T-26 Crib									
Potassium-40	1	1	100%	8.5	17	No	NA	No	Below background
Radium-226	1	1	100%	0.37	NA	No	3.0	No	Below BCG
Radium-228	1	1	100%	0.34	NA	No	2.0	No	Below BCG
Thorium-228	1	1	100%	0.94	NA	No	2200	No	Below BCG
Thorium-230	1	1	100%	0.74	NA	No	2700	No	Below BCG
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	NA	No	3.0	No	Below BCG
Radium-228	3	2	67%	0.974	NA	No	2.0	No	Below BCG
Thorium-228	3	2	67%	0.839	NA	No	2200	No	Below BCG
Thorium-230	2	2	100%	0.621	NA	No	2700	No	Below BCG
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

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
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	NA	No	3.0	No	Below BCG
Radium-228	4	4	100%	0.763	NA	No	2.0	No	Below BCG
Thorium-228	4	3	75%	0.884	NA	No	2200	No	Below BCG
Thorium-230	4	3	75%	0.729	NA	No	2700	No	Below BCG
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
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	NA	No	3.0	No	Below BCG
Strontium-90	4	4	100%	67	0.18	**Yes**	20	**Yes**	
Thorium-228	6	6	100%	0.77	NA	No	2200	No	Below BCG

Table 5-8. Summary of RESRAD Modeling for Radionuclide Total Dose Rates for the 216-B-46 and 216-T-26 Cribs.

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
			216-B-46		
No Cover, Direct Contact	3.1	0	Radium-226	61.0%	Ground
	2.7	1	Radium-226	69.2%	Ground
	2.3	3	Radium-226	82.2%	Ground
	1.9	10	Radium-226	98.2%	Ground
	1.8	30	Radium-226	99.9%	Ground
	1.6	100	Radium-226	100.0%	Ground
	1.5	150	Radium-226	100.0%	Ground
	1.3	239	Radium-226	100.0%	Ground
	0.87	467	Radium-226	100.0%	Ground
	0.36	1000	Radium-226	100.0%	Ground
			216-T-26		
No Cover, Direct Contact	2.3	0	Thorium-228	54.8%	Ground
	2.0	1	Thorium-228	43.8%	Ground
	1.6	3	Radium-226	40.9%	Ground
	1.0	10	Radium-226	65.4%	Ground
	0.66	30	Radium-226	93.1%	Ground
	0.61	100	Radium-226	91.8%	Ground
	0.60	150	Radium-226	88.3%	Ground
	0.57	239	Radium-226	82.9%	Ground
	0.48	467	Radium-226	71.8%	Ground
	0.31	1000	Radium-226	55.4%	Ground

Table 5-9. Summary of RESRAD Modeling for Radionuclide Risk for the 216-B-46 and 216-T-26 Cribs.

Scenario	Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Risk	Primary Pathway
216-B-46					
No Cover, Direct Contact	4.50E-05	0	Radium-226	93.2%	Ground
	4.40E-05	1	Radium-226	95.2%	Ground
	4.28E-05	3	Radium-226	97.5%	Ground
	4.15E-05	10	Radium-226	99.7%	Ground
	4.01E-05	30	Radium-226	99.9%	Ground
	3.57E-05	100	Radium-226	100.0%	Ground
	3.28E-05	150	Radium-226	100.0%	Ground
	2.82E-05	239	Radium-226	100.0%	Ground
	1.92E-05	467	Radium-226	100.0%	Ground
	7.83E-06	1000	Radium-226	100.0%	Ground
216-T-26					
No Cover, Direct Contact	2.27E-05	0	Radium-226	63.0%	Ground
	2.15E-05	1	Radium-226	66.5%	Ground
	1.97E-05	3	Radium-226	72.4%	Ground
	1.65E-05	10	Radium-226	85.7%	Ground
	1.45E-05	30	Radium-226	95.0%	Ground
	1.38E-05	100	Radium-226	91.0%	Ground
	1.34E-05	150	Radium-226	87.6%	Ground
	1.27E-05	239	Radium-226	82.2%	Ground
	1.09E-05	467	Radium-226	71.3%	Ground
	6.97E-06	1000	Radium-226	55.2%	Ground

Table 5-10. Summary of RESRAD 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	17.2	0	Cesium-137	88.0%	Ground
	16.7	1	Cesium-137	88.3%	Ground
	15.8	3	Cesium-137	89.0%	Ground
	13.2	10	Cesium-137	91.1%	Ground
	8.3	30	Cesium-137	91.3%	Ground
	2.1	100	Cesium-137	70.5%	Ground
	1.1	150	Radium-226	51.2%	Ground
	0.62	239	Radium-226	78.0%	Ground
	0.48	467	Radium-226	73.7%	Ground
	0.35	1000	Thorium-230	53.1%	Ground
1-ft Cover, Direct Contact	0.10	0	Cesium-137	75.7%	Ground
	0.10	1	Cesium-137	76.3%	Ground
	0.10	3	Cesium-137	77.9%	Ground
	0.09	10	Cesium-137	82.8%	Ground
	0.08	30	Cesium-137	85.2%	Ground
	0.08	100	Cesium-137	60.8%	Ground
	0.11	150	Radium-226	58.3%	Ground
	0.28	239	Radium-226	78.9%	Ground
	0.48	467	Radium-226	73.7%	Ground
	0.35	1000	Thorium-230	53.1%	Ground

Table 5-11. Summary of RESRAD 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	2.73E-04	0	Cesium-137	90.6%	Ground
	2.66E-04	1	Cesium-137	90.8%	Ground
	2.53E-04	3	Cesium-137	91.0%	Ground
	2.15E-04	10	Cesium-137	91.3%	Ground
	1.39E-04	30	Cesium-137	89.0%	Ground
	3.85E-05	100	Cesium-137	63.6%	Ground
	2.11E-05	150	Radium-226	57.7%	Ground
	1.35E-05	239	Radium-226	79.6%	Ground
	1.07E-05	467	Radium-226	73.2%	Ground
	7.93E-06	1000	Thorium-230	53.5%	Ground
1-ft Cover, Direct Contact	1.95E-06	0	Cesium-137	82.6%	Ground
	1.93E-06	1	Cesium-137	82.9%	Ground
	1.90E-06	3	Cesium-137	83.5%	Ground
	1.82E-06	10	Cesium-137	84.6%	Ground
	1.73E-06	30	Cesium-137	81.7%	Ground
	1.97E-06	100	Cesium-137	53.2%	Ground
	2.83E-06	150	Radium-226	63.9%	Ground
	7.55E-06	239	Radium-226	80.2%	Ground
	1.07E-05	467	Radium-226	73.2%	Ground
	7.93E-06	1000	Thorium-230	53.5%	Ground

Table 5-12. Summary of RESRAD 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	100.0%	Ground
	125,400	1	Cesium-137	100.0%	Ground
	119,700	3	Cesium-137	100.0%	Ground
	101,800	10	Cesium-137	100.0%	Ground
	64,143	30	Cesium-137	100.0%	Ground
	12,720	100	Cesium-137	99.9%	Ground
	4,006	150	Cesium-137	99.9%	Ground
	514	239	Cesium-137	99.5%	Ground
	4.8	467	Cesium-137	54.8%	Ground
	1.6	1000	Plutonium-239	55.3%	Ground
10-ft Cover, Direct Contact	3.75E-13	0	Cesium-137	94.4%	Ground
	3.72E-13	1	Cesium-137	94.3%	Ground
	3.64E-13	3	Cesium-137	94.5%	Ground
	3.32E-13	10	Cesium-137	96.7%	Ground
	2.66E-13	30	Cesium-137	99.3%	Ground
	1.34E-13	100	Cesium-137	98.9%	Ground
	8.38E-14	150	Cesium-137	97.0%	Ground
	4.06E-14	239	Cesium-137	83.6%	Ground
	8.22E-14	467	Radium-226	74.0%	Ground
	2.73E-11	1000	Radium-226	51.9%	Ground

Table 5-13. Summary of RESRAD 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	2.10E+00	0	Cesium-137	100.0%	Ground
	2.05E+00	1	Cesium-137	100.0%	Ground
	1.96E+00	3	Cesium-137	100.0%	Ground
	1.67E+00	10	Cesium-137	100.0%	Ground
	1.05E+00	30	Cesium-137	100.0%	Ground
	2.08E-01	100	Cesium-137	100.0%	Ground
	6.56E-02	150	Cesium-137	100.0%	Ground
	8.40E-03	239	Cesium-137	99.7%	Ground
	6.60E-05	467	Cesium-137	65.3%	Ground
	1.58E-05	1000	Radium-226	39.6%	Ground
10-ft Cover, Direct Contact	7.13E-18	0	Cesium-137	97.0%	Ground
	7.04E-18	1	Cesium-137	97.2%	Ground
	6.88E-18	3	Cesium-137	97.6%	Ground
	6.36E-18	10	Cesium-137	98.6%	Ground
	5.18E-18	30	Cesium-137	99.5%	Ground
	2.63E-18	100	Cesium-137	98.5%	Ground
	1.65E-18	150	Cesium-137	95.9%	Ground
	8.40E-19	239	Cesium-137	78.8%	Ground
	2.17E-18	467	Radium-226	74.2%	Ground
	7.34E-16	1000	Radium-226	51.2%	Ground

Table 5-14. Summary of RESRAD 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	3.4	0	Radium-226	65.1%	Ground
	3.0	1	Radium-226	72.8%	Ground
	2.6	3	Radium-226	84.7%	Ground
	2.2	10	Radium-226	98.6%	Ground
	2.1	30	Radium-226	100%	Ground
	1.9	100	Radium-226	100%	Ground
	1.7	150	Radium-226	100%	Ground
	1.5	239	Radium-226	100%	Ground
	1.0	467	Radium-226	100%	Ground
	0.41	1000	Radium-226	100%	Ground

Table 5-15. Summary of RESRAD 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	5.15E-05	0	Radium-226	94.3%	Ground
	5.06E-05	1	Radium-226	96.0%	Ground
	4.94E-05	3	Radium-226	98.0%	Ground
	4.79E-05	10	Radium-226	99.8%	Ground
	4.64E-05	30	Radium-226	100%	Ground
	4.13E-05	100	Radium-226	100%	Ground
	3.80E-05	150	Radium-226	100%	Ground
	3.27E-05	239	Radium-226	100%	Ground
	2.23E-05	467	Radium-226	100%	Ground
	9.06E-06	1000	Radium-226	100%	Ground

6.0 CONCLUSIONS

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 a ROD and permit modification as described in the Implementation Plan (DOE-RL 1999).

6.1 GENERAL CONCLUSIONS

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, 216-B-7A Crib and 216-B-38 Trench, were evaluated for the 200-TW-2 OU during the recent RI activities. A third 200-TW-2 representative site, 216-B-5 Reverse Well, was evaluated previously by Smith et al. (1980). A representative site for the 200-PW-5 OU, 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 216-B-57 in 1997 and continues to be monitored and evaluated annually.

The evaluation of the representative sites involved site characterization, a qualitative risk evaluation, fate and transport modeling, and a refinement of the contaminant distribution models. Contaminants of concern were identified for each of the sites following a data evaluation process that is based on HSRAM, regulatory guidance, and professional judgement. Contaminants that were identified as COCs for the waste sites will be carried forward into the FS for evaluation of remedial alternatives. The COCs and the contaminant distribution and exposure models are summarized Sections 6.1.1 and 6.1.2.

6.1.1 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. Estimates for cancer risk and hazard quotients/hazard index were also generated. Radiological constituents were screened based on detection and background. Radiological dose and cancer risk to receptors were evaluated using RESRAD. Contaminants with the potential to impact groundwater were evaluated using the STOMP code. The COCs, relative risks, and radiological dose rates for each waste site are summarized in Table 5-1. Based on the results of the data evaluation, Table 6-1 identifies those COCs that must be considered for remedial action in the FS.

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

6.1.2 Contaminant Distribution Models and Exposure Models

The conceptual contaminant distribution models and the conceptual exposure model developed for the waste sites and the 200-TW-1 and 200-TW-2 OUs in the work plan (DOE-RL 2001) were refined based on the data obtained during the RI and other data collection activities. The contaminant distribution models are presented in Section 3.3, but can generally 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 tritium or technetium) have passed through the vadose zone and are either not present or are present only at low concentrations.

The exposure pathway model for the OU 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.

6.2 FEASIBILITY STUDY AND RCRA TSD UNIT CLOSURE PLAN

6.2.1 General FS Strategy

Based on the results of the RI, as presented in this RI report, remedial alternatives will be developed and evaluated against evaluation criteria in the FS. The FS process consists of the following steps:

1. Define RAOs.

2. Identify general response actions to satisfy RAOs.

3. Identify potential technologies and process options associated with each general response action.

4. Screen process options to select a representative process for each type of technology based on their effectiveness, implementability, and cost.

5. Assemble viable technologies or process options into alternatives representing a range of treatment and containment alternatives plus a no-action alternative.

6. Evaluate alternatives and present information needed to support remedy selection.

Although some refinement is expected during the FS, Appendix D of the Implementation Plan (DOE-RL 1999a) 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 this work plan. 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 transuranic waste) was identified in the Implementation Plan because of the potential for with this OU to contain transuranic 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 (see Section 3.2.2.6).

During the detailed analysis, each alternative will be evaluated against the following criteria (40 CFR 300.430):

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost

- State acceptance.

One additional modifying criterion, community acceptance, will be applied following the FS at the proposed plan and ROD phase.

National Environmental Policy Act of 1969 (NEPA) values will also be evaluated as part of the DOE's responsibility under this authority. NEPA values include impacts to natural, cultural, and historical resources; socioeconomic aspects; and irreversible and irretrievable commitments of resources.

RCRA corrective action performance standards (WAC 173-303-646[2]) will be used to evaluate alternative compliance with RCRA corrective action requirements. These standards state that corrective action must accomplish the following:

- Protect human health and the environment from all releases of dangerous wastes and dangerous constituents, including releases from all solid waste management units at the facility

- Occur regardless of the time at which waste was managed at the facility or placed in such units and regardless of whether such facilities or units were intended for the management of solid or dangerous waste

- Be implemented by the owner/operator beyond the facility boundary, where necessary to protect human health and the environment.

The FS will also include supporting information needed to complete the detailed analysis and meet regulatory integration needs, including the following:

- Summarize the RI, including the nature and extent of contamination, the contaminant distribution models, and an assessment of the risks to help establish the need for remediation and to estimate the volume of contaminated media

- Refine the conceptual exposure pathway model to identify pathways that may need to be addressed by remedial action

- Provide a detailed evaluation of ARARs, starting with potential ARARs identified in the Implementation Plan (Section 4.0, DOE-RL 1999)

- Refine potential RAOs and preliminary remediation goals identified in the Implementation Plan (Section 5.0, DOE-RL 1999), based on the results of the RI, ARAR evaluation, and current land-use considerations

- Refine the list of remedial alternatives identified in the Implementation Plan (Appendix D, DOE-RL 1999), based on the RI

- Provide corrective action recommendations for RPP sites to fulfill the requirements for a corrective measures study

- Provide criteria by which analogous waste sites within the OUs not previously characterized will be evaluated after the ROD to confirm that the contaminant distribution model for the site is consistent with the preferred alternative. Contingencies to move a waste site to a more appropriate waste group will also be developed.

Additional RCRA integration guidance for preparing an FS/closure plan is provided in Section 2.4 of the Implementation Plan (DOE-RL 1999).

6.2.2 Site-Specific FS Activities

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 of the contaminant distribution models and relative risks developed in the RI report for the representative sites to the analogous sites. Sites that are determined not to be analogous to the representative sites will 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 to support the confirmatory sampling for these analogous sites.

6.2.3 Proposed Plan and Proposed RCRA Permit Modification

The decision-making process for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs will be based on the use of a proposed plan and a ROD.A modification to the RCRA Hanford Facility Permit will be used to incorporate the decision into the permit for the RPP sites. Following the completion of the FS, a proposed plan will be prepared that identifies the preferred remedial alternative for the OUs (which will include RCRA corrective action requirements). In addition to identifying the preferred alternative, the proposed plan will summarize the completed RI/FS and identify performance standards and ARARs applicable to the OU.

The proposed plan will also include a draft permit modification with unit-specific permit conditions for RPP sites in the 200-TW-2 OU for incorporation into the Hanford Facility RCRA Permit as appropriate. After the public review process is complete, Ecology, as the lead regulatory agency for the 200-TW-2 OU, be responsible for and gain the approval of EPA on the ROD. The Hanford Facility RCRA Permit will subsequently be modified by Ecology to incorporate the ROD (and subsequent amendments) by reference, authorizing the RCRA actions.

6.3 POST-ROD 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 1999). The basic approach is that the representative sites contain similar types, concentrations, and distributions of contaminants as the other sites in the OU because the sites are grouped based on similar site histories and processes. The sites, therefore, share similar risks and need for remedial action. The data collected for the representative sites will be considered to be analogous to the remaining sites.

After the ROD and modification to the RCRA Hanford Facility Permit have been issued, a remedial design report (RDR) and remedial action work plan (RAWP) will be prepared to detail the scope of the remedial action which will include RCRA corrective action requirements. As part of this activity, DQOs will be established and sampling and analysis plans prepared to direct confirmatory and verification sampling and analysis efforts. Table 6-1 identifies constituents to be evaluated for remedial action in the FS for the representative sites. However, because the representative sites are analogous to the other sites in the OUs, some additional constituents may need to be evaluated at the analogous sites during the confirmatory sampling phase. Table 6-2 provides a preliminary list of contaminants detected during the RI that will support confirmatory sampling. Several constituents identified as COCs in Table A1-1 of the work plan (DOE-RL 2001) were eliminated from Table 5-2 for one of the following reasons:

- The constituent was not detected during the RI activities;
- The constituent was detected at or near the site background concentrations;
- The constituent was infrequently detected and at concentrations below PRGs.

Additional evaluation of the analogous waste sites during the confirmatory sampling DQO may increase or reduce the list of constituents to be analyzed through confirmatory sampling. Prior to the start of remediation, confirmatory sampling may be performed to ensure that sufficient characterization data are available to confirm that the selected remedy in the ROD is appropriate for all the waste sites within the OU, to collect data necessary for the remedial design, and to support future risk assessments, if needed.

Verification sampling will be performed after the remedial action is complete to determine if ROD requirements have been met and if the remedy was effective. Additional guidance for confirmatory and verification sampling is provided in Section 6.2 of the Implementation Plan (DOE-RL 1999).

The RDR/RAWP will include an integrated schedule of remediation activities for the OUs and will satisfy the requirements for a RPP corrective measures implementation work plan and corrective measures design report. Following the completion of the remediation effort, closeout activities will be performed as specified in the ROD, RDR/RAWP, and the Permit.

Table 6-1. Contaminants of Concern, Risk, and Dose Summary.

Site	Nonradiological			Radiological[a]			
	Total Excess Lifetime Cancer Risk from Shallow Nonradiological COCs	Nonradiological COCs That Exceeded Maximum Concentration Limits	Nonradiological COCs That Exceeded MTCA 749-3 Concentrations	Total Maximum Excess Lifetime Cancer Risk from Radiological COCs	Total Maximum Dose Rate/Time	Primary Risk Contributor	Radiological COCs that Exceed Maximum Concentration Limits
216-B-46 Crib	None	Nitrate, Nitrite, and Cyanide	None	4.5×10^{-5} for no cover.	3.1 mrem/yr @ 0 years for no cover scenario.	Radium-226	Cobalt-60, Technetium-99, Radium-226, Uranium-238, Plutonium-239
216-T-26 Crib	None	Nitrate, Nitrite, and Cyanide	None	2.27×10^{-5} for no cover.	2.3 mrem/yr @ years for no cover scenario.	Radium-226	Technetium-99, Tritium, Uranium-233/234/238, Plutonium-239
216-B-7A Crib	None	Nitrate, Fluoride	None	2.73×10^{-4} for no cover scenario; 1.07×10^{-5} for 1 ft cover scenario.	17.2 mrem/yr @ 0 years for no cover scenario 1; 0.35 mrem/yr @ 1000 years for 1 ft cover scenario.	Cesium-137, Radium-226, and Thorium-230 for no cover scenario and for 1 ft cover scenario	Carbon-14, Strontium-90, Uranium-233/234/238
216-B-38 Trench	None	Nitrate, Nitrite	None	2.1×10^{0} for no cover scenario; 7.34×10^{-16} for 10 ft cover scenario.	128,300 mrem/yr @ 0 years for no cover scenario; 2.73×10^{-11} mrem/yr @ 1000 years for 10 ft cover scenario.	Cesium-137 and Radium-226 for no cover and for 10 ft cover scenario	Technetium-99, Uranium-233/234/238
216-B-5 Reverse Well	None	Contaminants injected at or near water table	None	NA	NA	NA	Contaminants injected at or near water table
216-B-57 Crib	None	Hanford Barrier currently exists over waste site	None	5.15×10^{-5} for no cover scenario.	3.4 mrem/yr @ 0 years for no cover scenario.	Radium-226 for no cover scenario.	Hanford Barrier currently exists over waste site

[a] 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.

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 OU waste sites only

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APPENDIX A

PHYSICAL PROPERTY AND QUALITY ASSURANCE DATA

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	(142[illegible])
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	(1420)
B12677	3.3	0.0	93.3	6.7	(1421
B12678	18.5	0.0	3.4	96.6	(142[illegible]

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

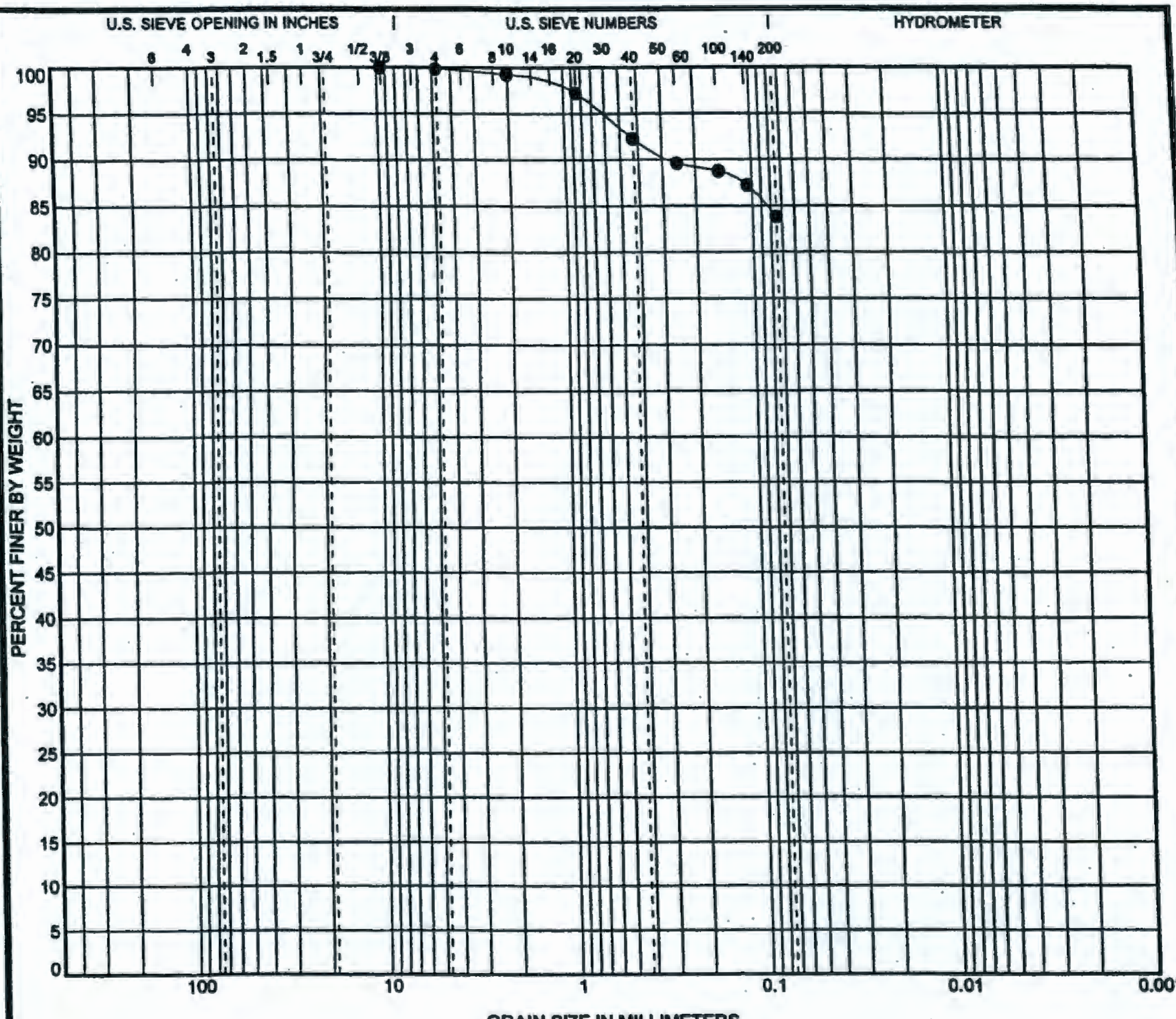
Date: 7/20/01

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 8/22/01

Logo

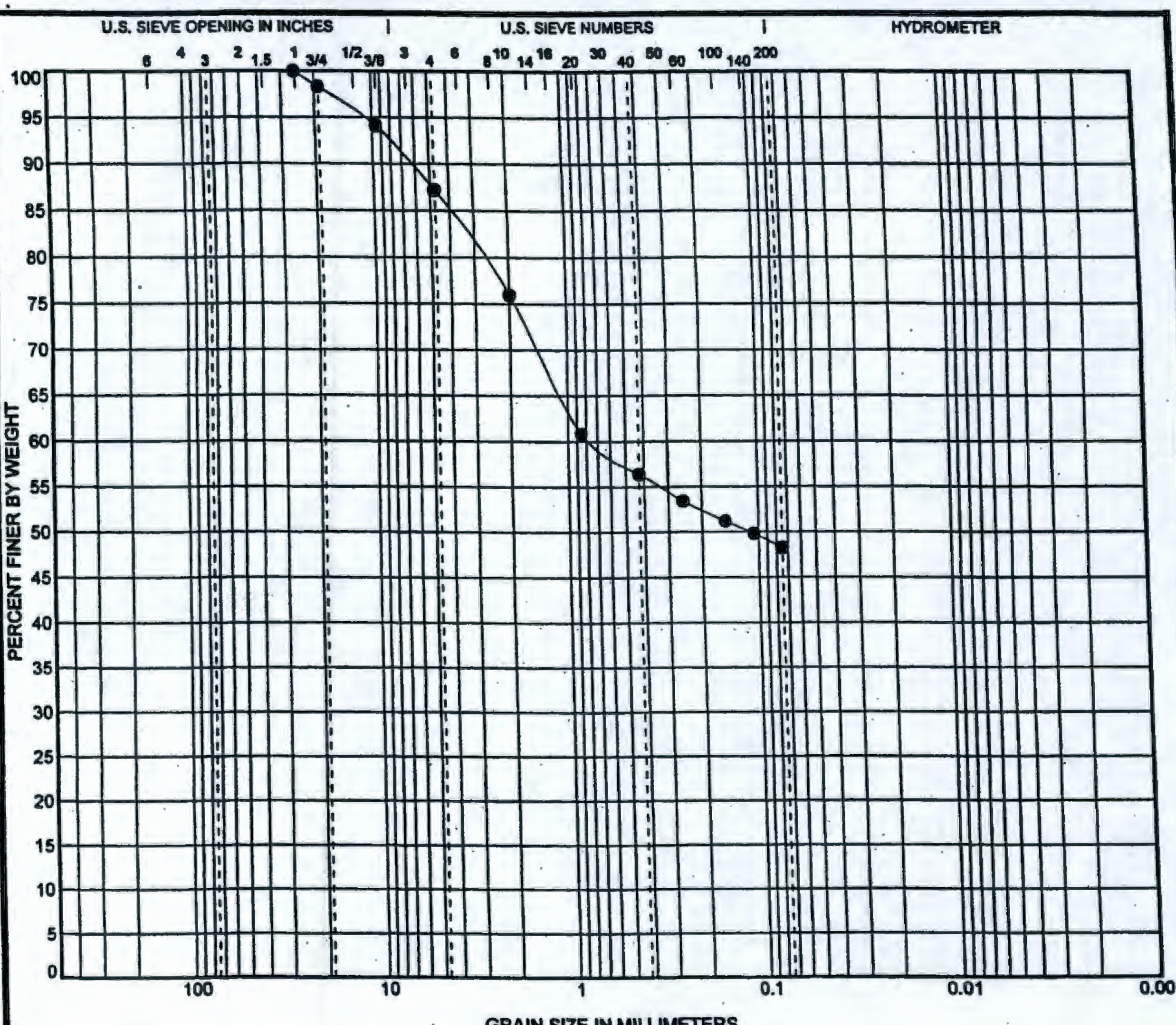
Maxim Technologies, Inc.
1908 Innerbelt Business Center Drive
St. Louis, Missouri 63114
Telephone: 314-426-0880
Fax: 314-426-4212

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	25.4	0.747			12.8	39.0	48.2	

US GRAIN SIZE EBERLINE.GPJ US LAB.GDT 8/22/01

Logo

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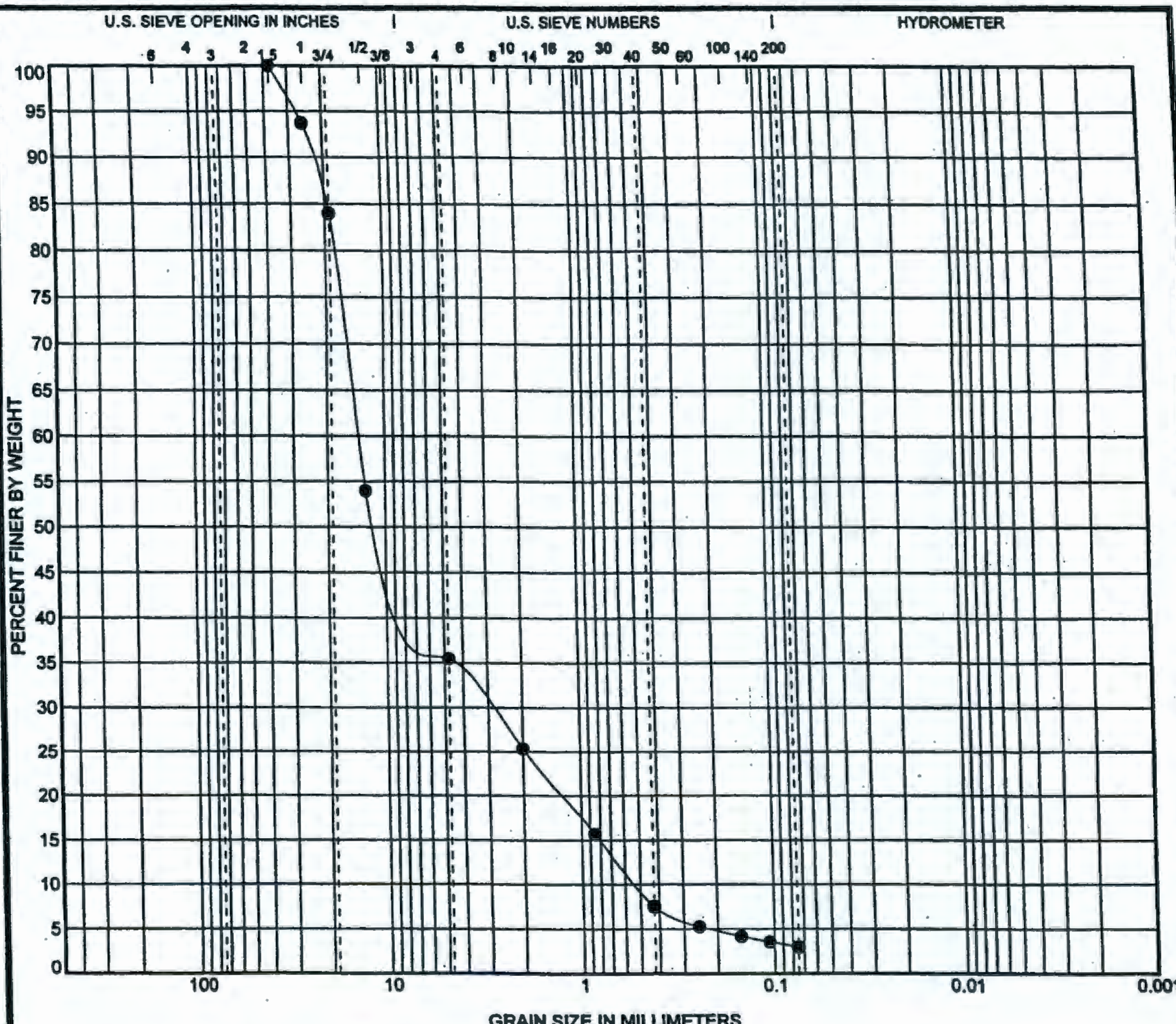
Location:
Number: 9905093



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	

US GRAIN SIZE EBERLINE.GPJ US LAB.GDT 8/22/01

Logo

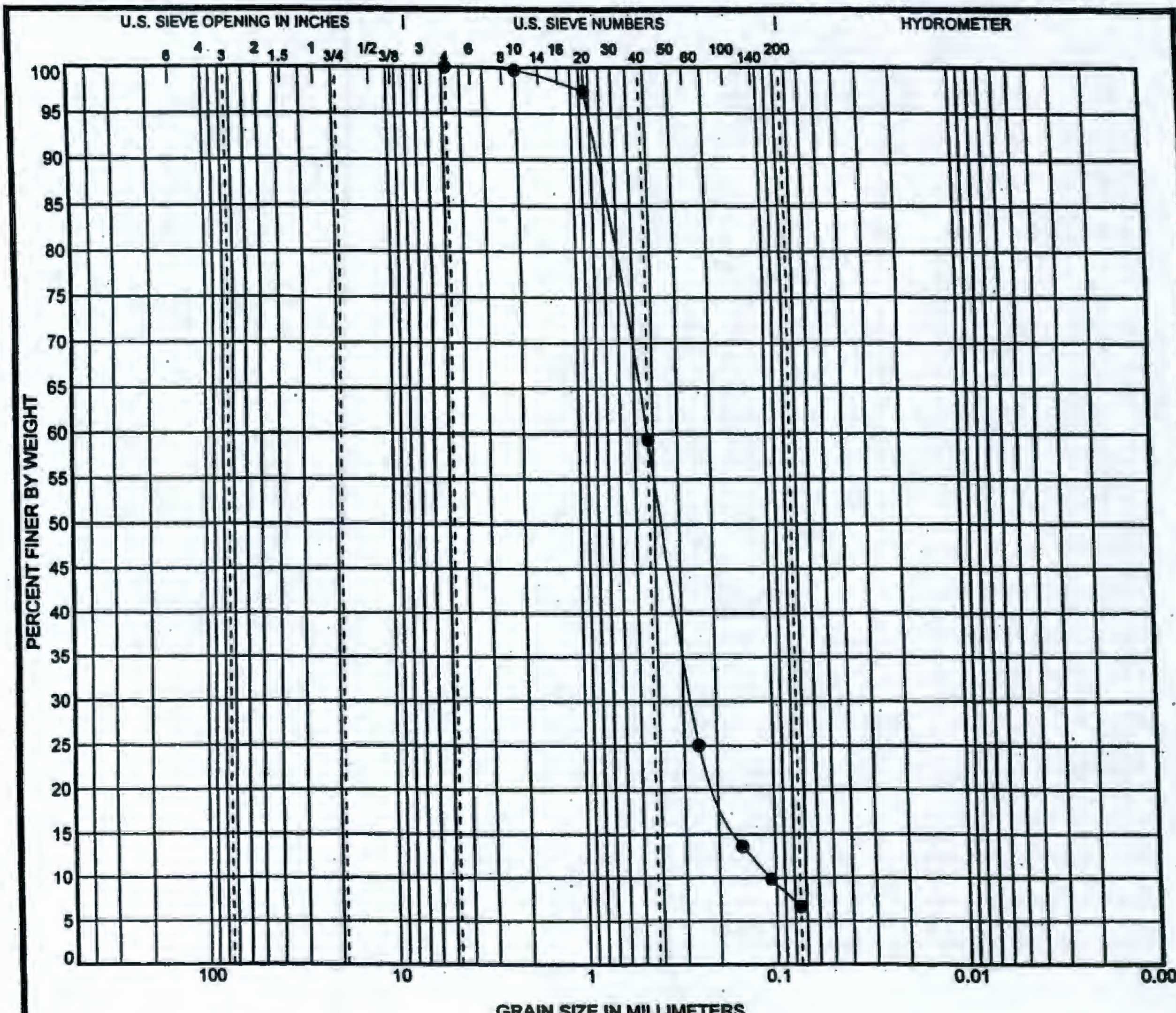
Maxim Technologies, Inc.
1908 Innerbelt Business Center Drive
St. Louis, Missouri 63114
Telephone: 314-426-0880
Fax: 314-426-4212

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
●	0108001-004	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	

US GRAIN SIZE EBERLINE.GPJ US LAB.GDT 8/22/01

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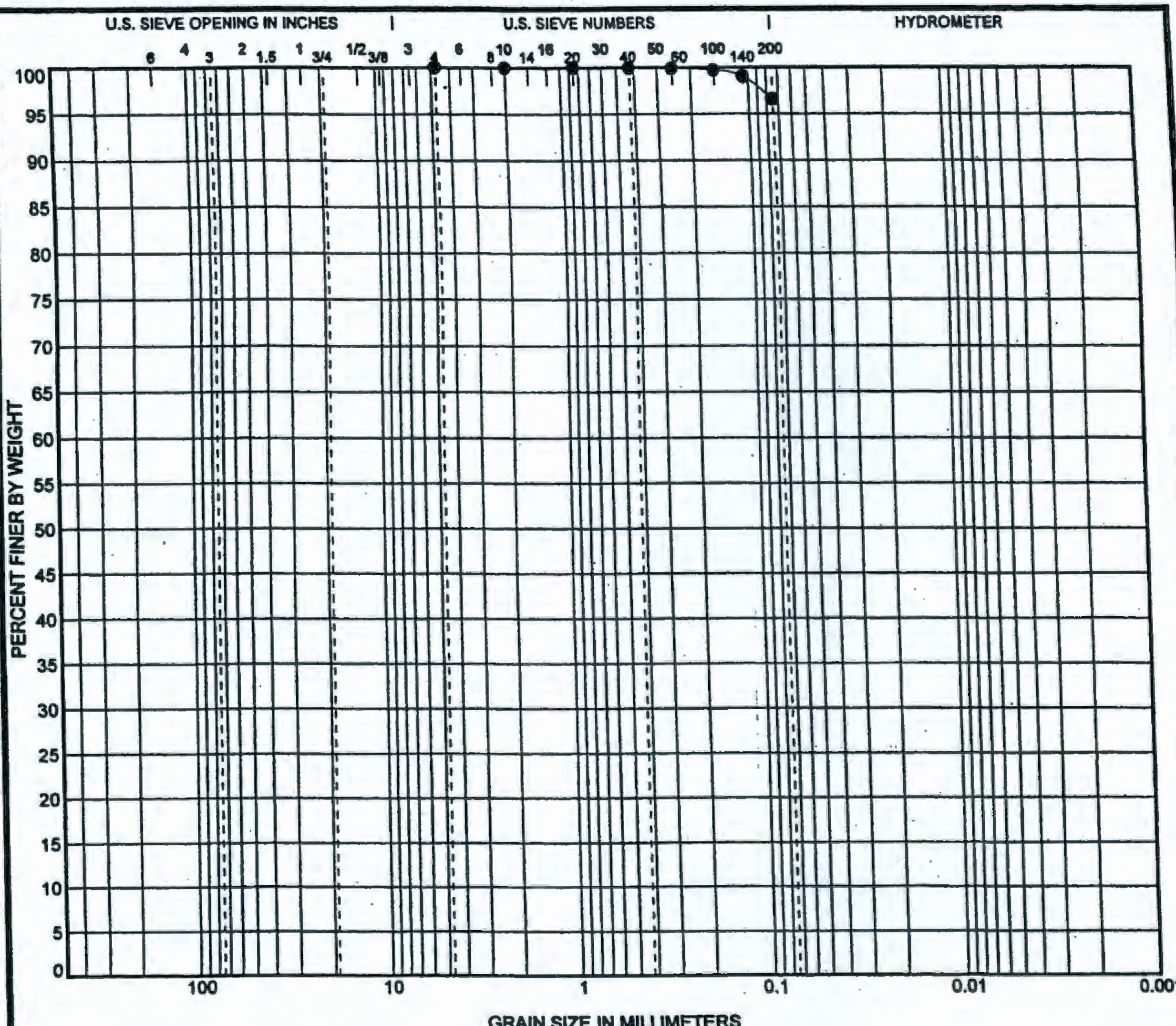
Fax: 314-426-4212

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	

US GRAIN SIZE EBERLINE.GPJ US LAB.GDT 8/22/01

Logo

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Fax: 314-426-4212

GRAIN SIZE DISTRIBUTION

Project: Eberline

Location:

Number: 9905093

Maxim Technologies, Inc. St.-Louis, Missouri

Client Name: Eberline
Maxim Project Number: 9905093

	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)
H1480	0106001-001	B12CB7	SDG3	Sandy Gravel	37.5	6	0.53	–	3.4	nr	nr	nr	nr	nr	nr
H1459	0106001-002	B12CB8	SDG3	Sandy Gravel	9.52	0.6	0.43	0.1	1.4	nr	nr	nr	nr	nr	nr
H1475	0106001-003	B12BR7	SDG3	Silty Sand	19	0.135	0.076	–	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	58.27	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

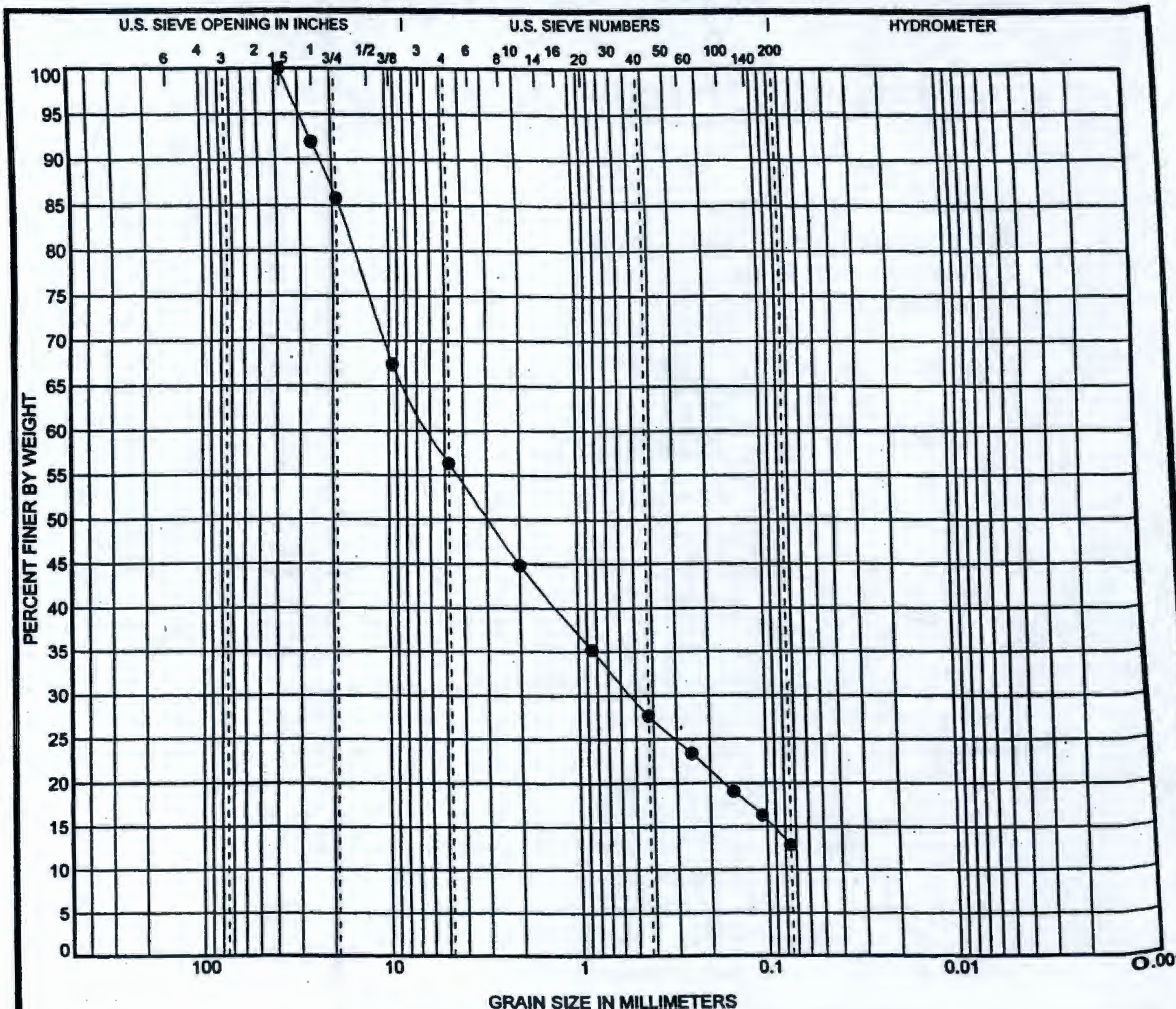
Date: 8/10/01

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



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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	

US_GRAIN_SIZE_BECHTEL.GPJ US_LAB.GDT 10/19/01

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St. Louis, Missouri 63114
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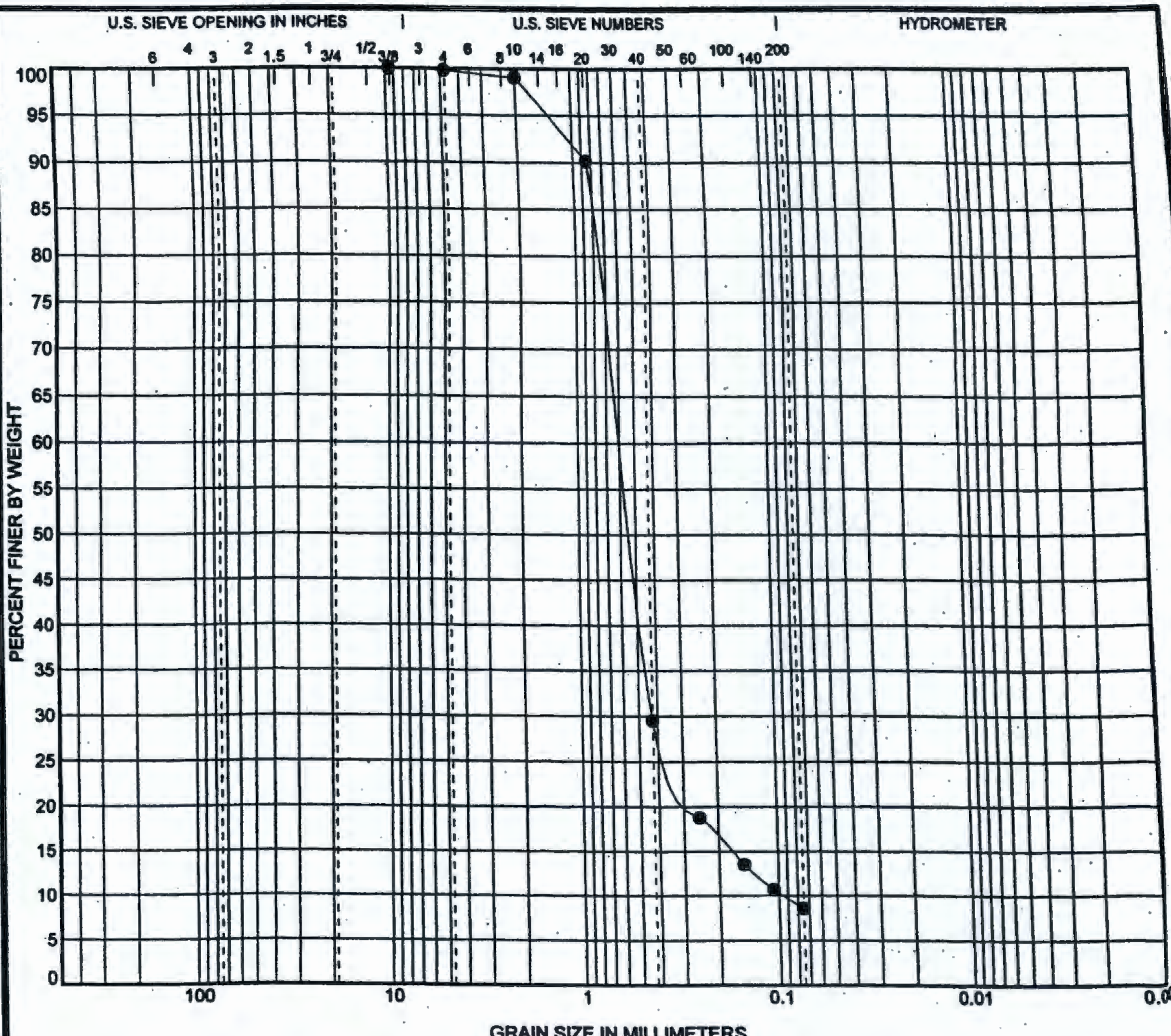
GRAIN SIZE DISTRIBUTION

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
●	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_BECHTEL.GPJ US_LAB.GDT 10/19/01

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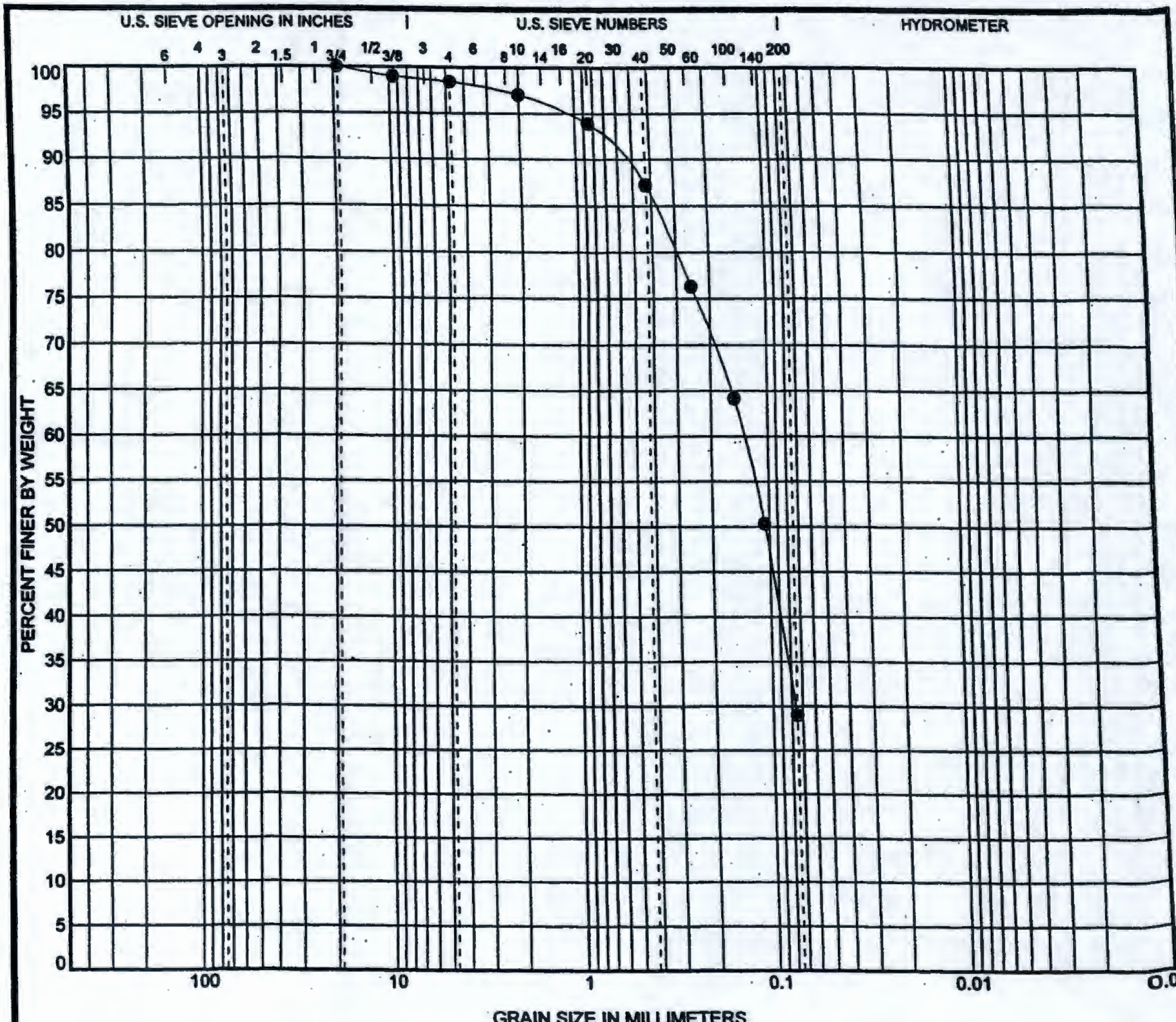
Fax: 314-426-4212

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	

US_GRAIN_SIZE_BECHTEL.GPJ US_LAB.GDT 10/19/01

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GRAIN SIZE DISTRIBUTION

Project: Eberline Services

Location:

Number: 9905093

Appendix A - Physical Property and Quality Assurance Data

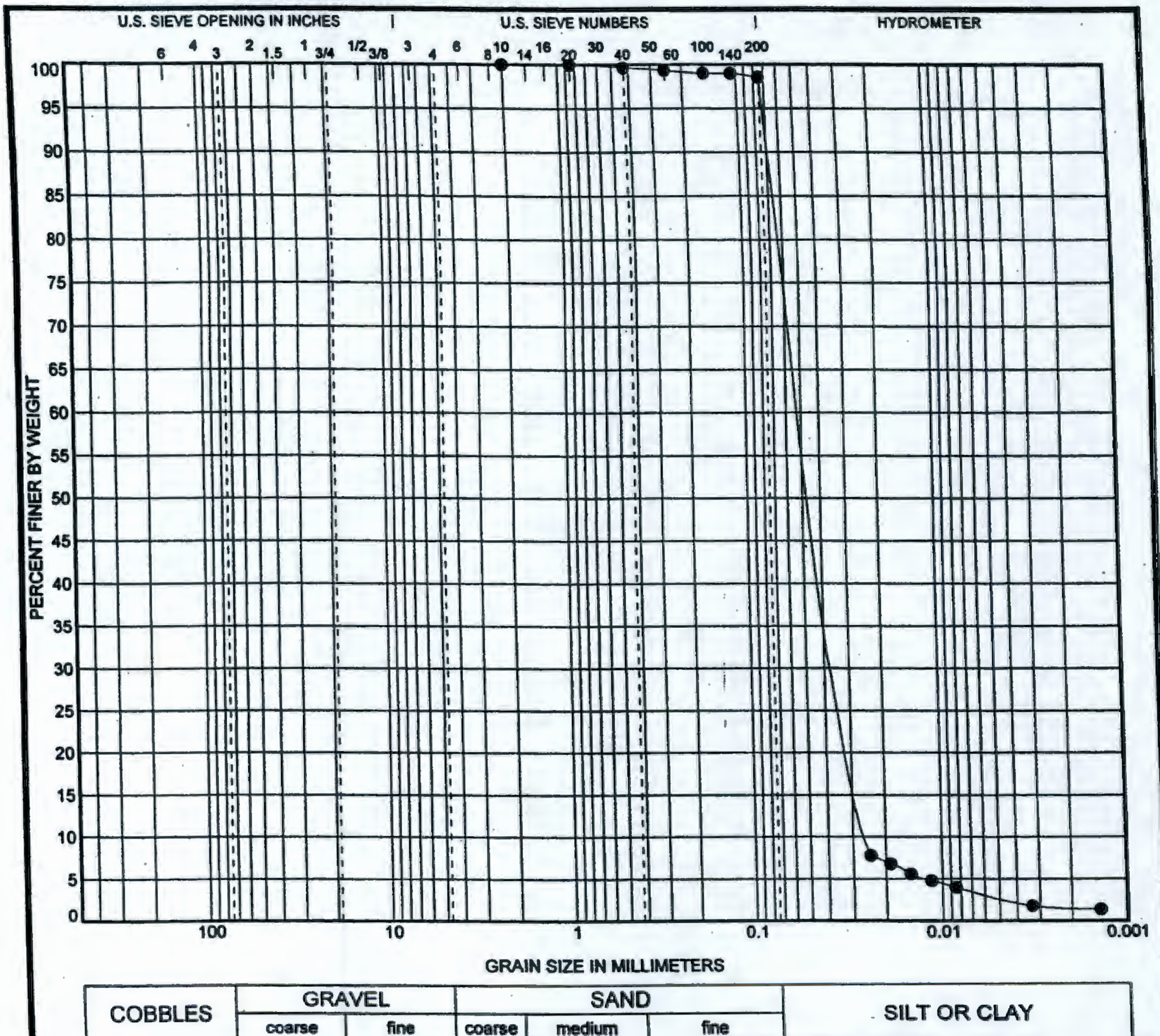
Maxim Technologies, Inc. St.-Louis, Missouri

Client Name: Eberline
Maxim Project Number: 9905093

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	B12BR8	SDG5	Sand with Organic Matter	4.75	0.629	0.408	0.163	nr	nr	2.7	nr	nr	nr	nr	nr	nr
0110003-002	B12BR9	SDG5	Sand with Silt	2.00	0.046	0.032	0.025	nr	nr	22.5	nr	nr	nr	nr	nr	nr

H1524 H1519

nr: not requested

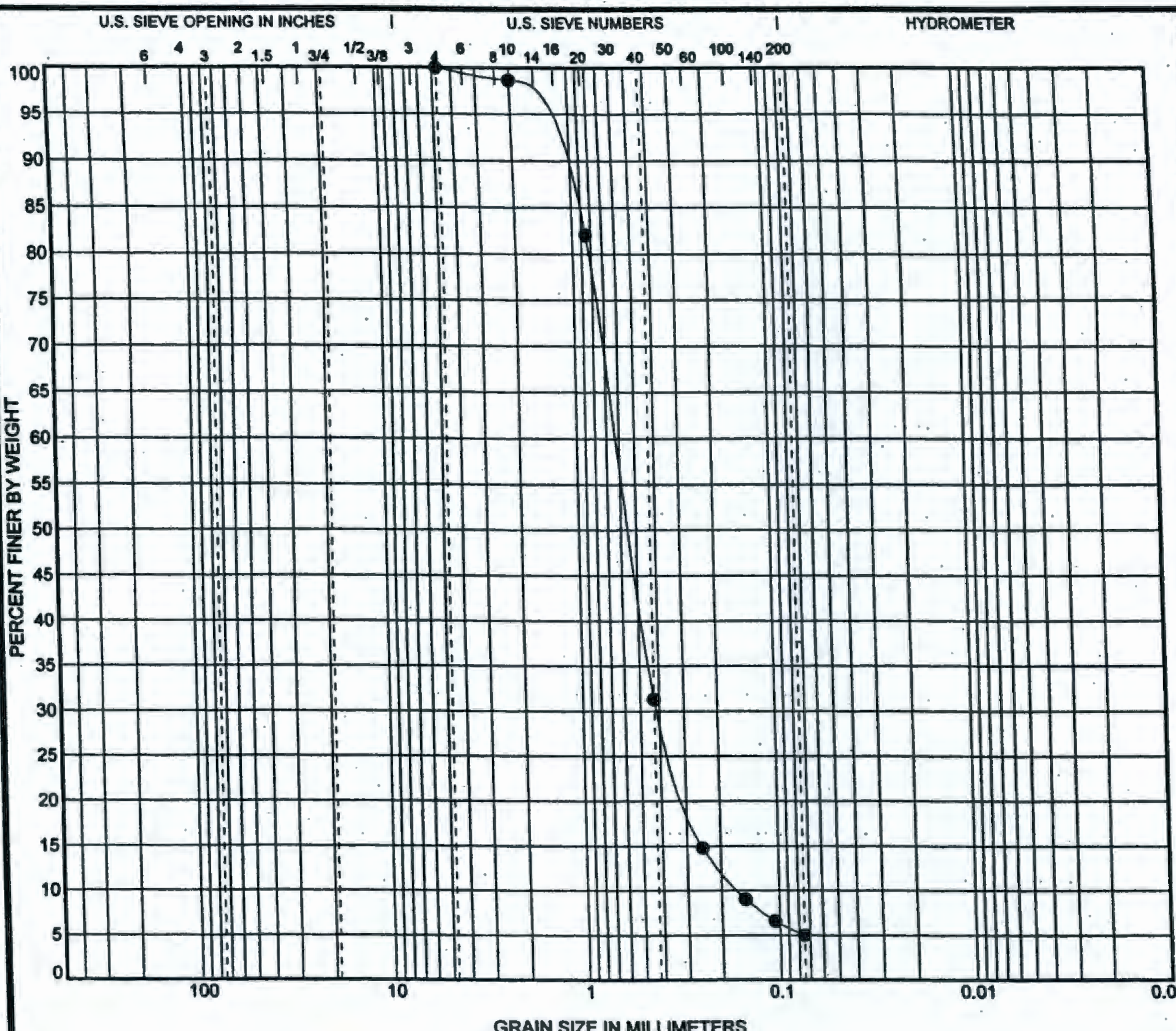


	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	0110003-002	0.0	Soil				0.88	1.87
	B12BR9							

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	0110003-002	0.0	2	0.046	0.032	0.025	0.0	1.5	95.8	2.8

US GRAIN SIZE BECHTEL.GPJ US LAB.GDT 11/12/01

MAXIM TECHNOLOGIES INC 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 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 B12BR8	0.0	Soil				1.62	3.85

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_BECHTEL.GPJ US_LAB.GDT 11/12/01

MAXIM TECHNOLOGIES INC

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GRAIN SIZE DISTRIBUTION

Project: Eberline Services

Location:

Number: 9905093

APPENDIX B

DATA EVALUATION AND DATA SUMMARY TABLES

APPENDIX B

DATA EVALUATION AND DATA SUMMARY TABLES

B.1 DATA VALIDATION AND QUALITY CONTROL

Data validation was performed and field quality control samples were collected in accordance with the Quality Assurance Project Plan, Appendix A, Section A.2 of the *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan* (DOE-RL 2001).

B.1.1 Data Validation

Two sample delivery groups, consisting of at total 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 *Data Validation Procedure for Chemical Analysis* (BHI 2000a) and *Data Validation Procedure for Radiochemical Analysis* (BHI 2000b) 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 B-1 to B-19 and will be entered into the Hanford Environmental Information System database.

B.1.2 Quality Control

Quality control samples were collected to evaluate the potential of cross-contamination and laboratory performance in accordance with the Quality Assurance Project Plan, Appendix A of DOE-RL (2001). 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 (VOCs). Methylene chloride and acetone were the only compounds detected in the trip blank submitted for analysis. However, these compounds were also detected in laboratory blanks and are likely the result of laboratory cross-contamination.

The equipment blank for 200-TW-1 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 was also 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 was also 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.

B.2 REFERENCES

BHI, 2000a, *Data Validation Procedure for Chemical Analysis*, BHI-01435, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2000b, *Data Validation Procedure for Radiochemical Analysis*, BHI-01433, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

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

Table B-1. 216-T-26 Borehole – Radionuclide Analytical Data. (1 of 3)

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 B-1. 216-T-26 Borehole – Radionuclide Analytical Data. (2 of 3)

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 B-1. 216-T-26 Borehole – Radionuclide Analytical Data. (3 of 3)

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 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 B-2. 216-T-26 Borehole – Inorganic (Metals) Analytical Data. (1 of 2)

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 B-2. 216-T-26 Borehole – Inorganic (Metals) Analytical Data. (2 of 2)

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 B-3. 216-T-26 Borehole – General Chemistry Analytical Data. (1 of 2)

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 B-3. 216-T-26 Borehole – General Chemistry Analytical Data. (2 of 2)

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 B-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 B-5. 216-T-26 Borehole – Volatile Organic Compound Analytical Data. (1 of 4)

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 B-5. 216-T-26 Borehole – Volatile Organic Compound Analytical Data. (2 of 4)

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 B-5. 216-T-26 Borehole – Volatile Organic Compound Analytical Data. (3 of 4)

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 B-5. 216-T-26 Borehole – Volatile Organic Compound Analytical Data. (4 of 4)

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 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.

Table B-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (1 of 8)

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 B-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (2 of 8)

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 B-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (3 of 8)

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 B-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (4 of 8)

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 B-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (5 of 8)

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 B-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (6 of 8)

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 B-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (7 of 8)

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 B-6. 216-T-26 Borehole – Semivolatile Organic Compound Analytical Data. (8 of 8)

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 B-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 B-8. 216-B-38 Borehole - Radionuclide Analytical Results. (1 of 3)

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 B-8. 216-B-38 Borehole - Radionuclide Analytical Results. (2 of 3)

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 B-8. 216-B-38 Borehole - Radionuclide Analytical Results. (3 of 3)

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 B-9. 216-B-38 Borehole – Inorganic (Metals) Analytical Data. (1 of 2)

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	9,610.00	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	8,030.00	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 B-9. 216-B-38 Borehole – Inorganic (Metals) Analytical Data. (2 of 2)

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 B-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 B-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 B-12. 216-B-7A Borehole – Radionuclide Analytical Data. (1 of 3)

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 B-12. 216-B-7A Borehole – Radionuclide Analytical Data. (2 of 3)

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 B-12. 216-B-7A Borehole – Radionuclide Analytical Data. (3 of 3)

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 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 B-13. 216-B-7A Borehole – Inorganic (Metals) Analytical Data. (1 of 3)

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 B-13. 216-B-7A Borehole – Inorganic (Metals) Analytical Data. (2 of 3)

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 B-13. 216-B-7A Borehole – Inorganic (Metals) Analytical Data. (3 of 3)

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 B-14. 216-B-7A Borehole - General Chemistry Analytical Data. (1 of 2)

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 B-14. 216-B-7A Borehole - General Chemistry Analytical Data. (2 of 2)

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 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 B-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 B-16. 216-B-7A Borehole – Volatile Organic Compound Analytical Data. (1 of 5)

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 B-16. 216-B-7A Borehole – Volatile Organic Compound Analytical Data. (2 of 5)

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 B-16. 216-B-7A Borehole – Volatile Organic Compound Analytical Data. (3 of 5)

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 B-16. 216-B-7A Borehole – Volatile Organic Compound Analytical Data. (4 of 5)

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 B-16. 216-B-7A Borehole – Volatile Organic Compound Analytical Data. (5 of 5)

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 B-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (1 of 8)

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 B-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (2 of 8)

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 B-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (3 of 8)

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 B-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (4 of 8)

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 B-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (5 of 8)

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 B-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (6 of 8)

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 B-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (7 of 8)

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 B-17. 216-B-7A Borehole – Semivolatile Organic Compound Analytical Data. (8 of 8)

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 B-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 B-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 MDA.

APPENDIX C

MODELING

Figure C-1. 216-B-46 Crib Contaminant Profile Data and Matching Model Input for Cesium-137, Total Beta Radiostrontium, Cobalt-60, and Plutonium-238.

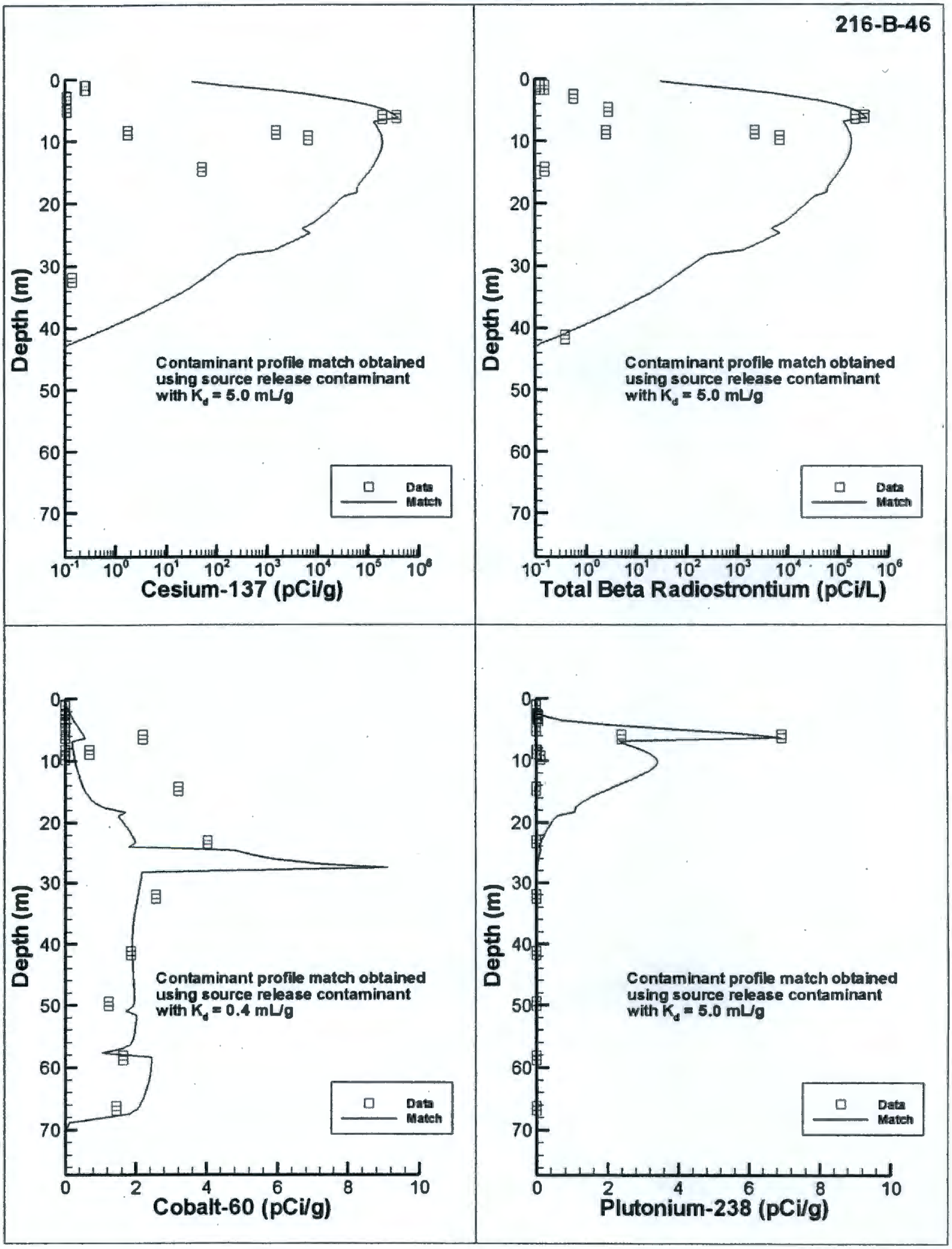

Figure C-2. 216-B-46 Crib Contaminant Profile Data and Matching Model Input for Total Uranium, Technetium-99, Radium-226, and Plutonium-239/240.

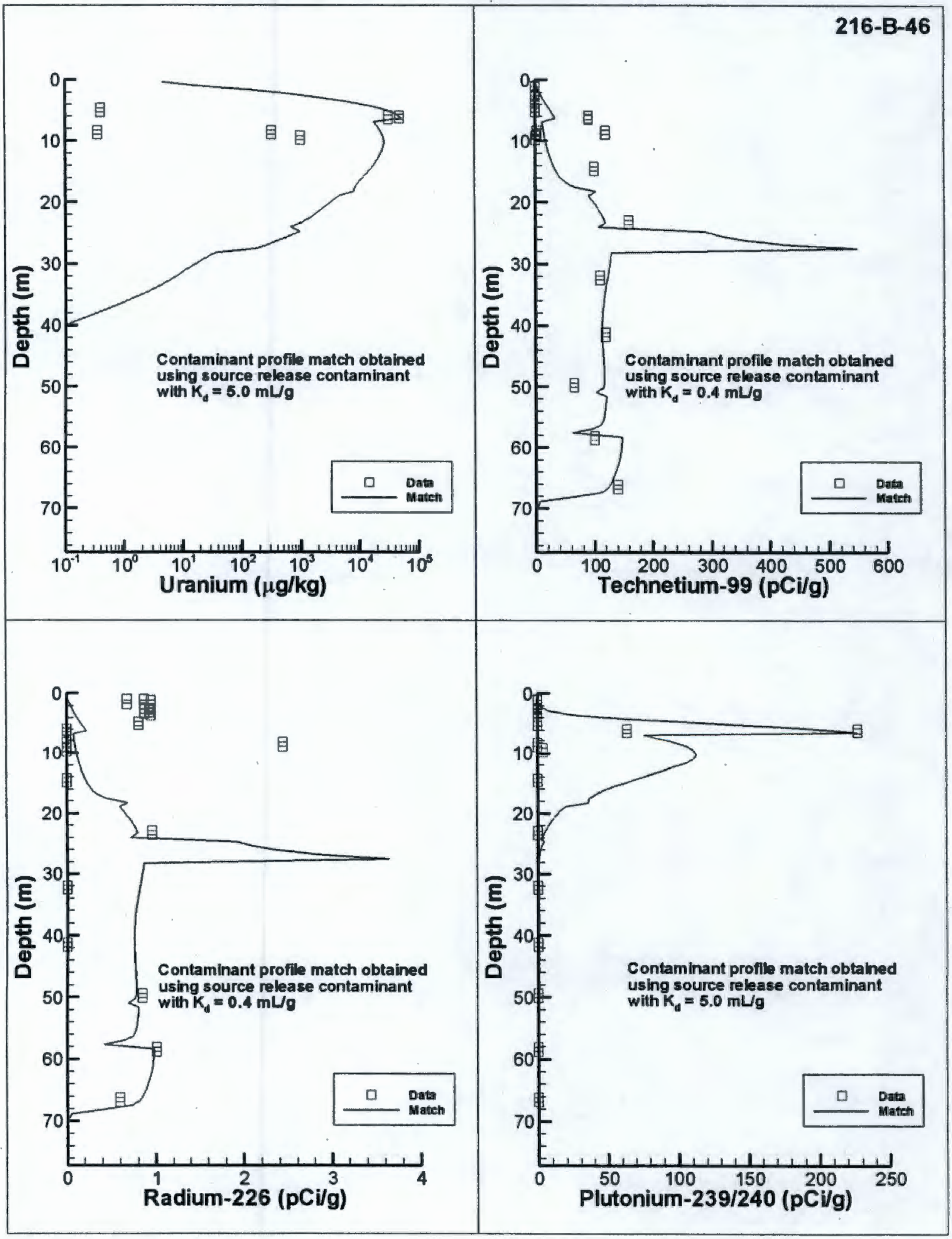

Figure C-3. 216-B-46 Crib Contaminant Profile Data and Matching Model Input for Cyanide, Nitrate, Nitrite, and Sulfate.

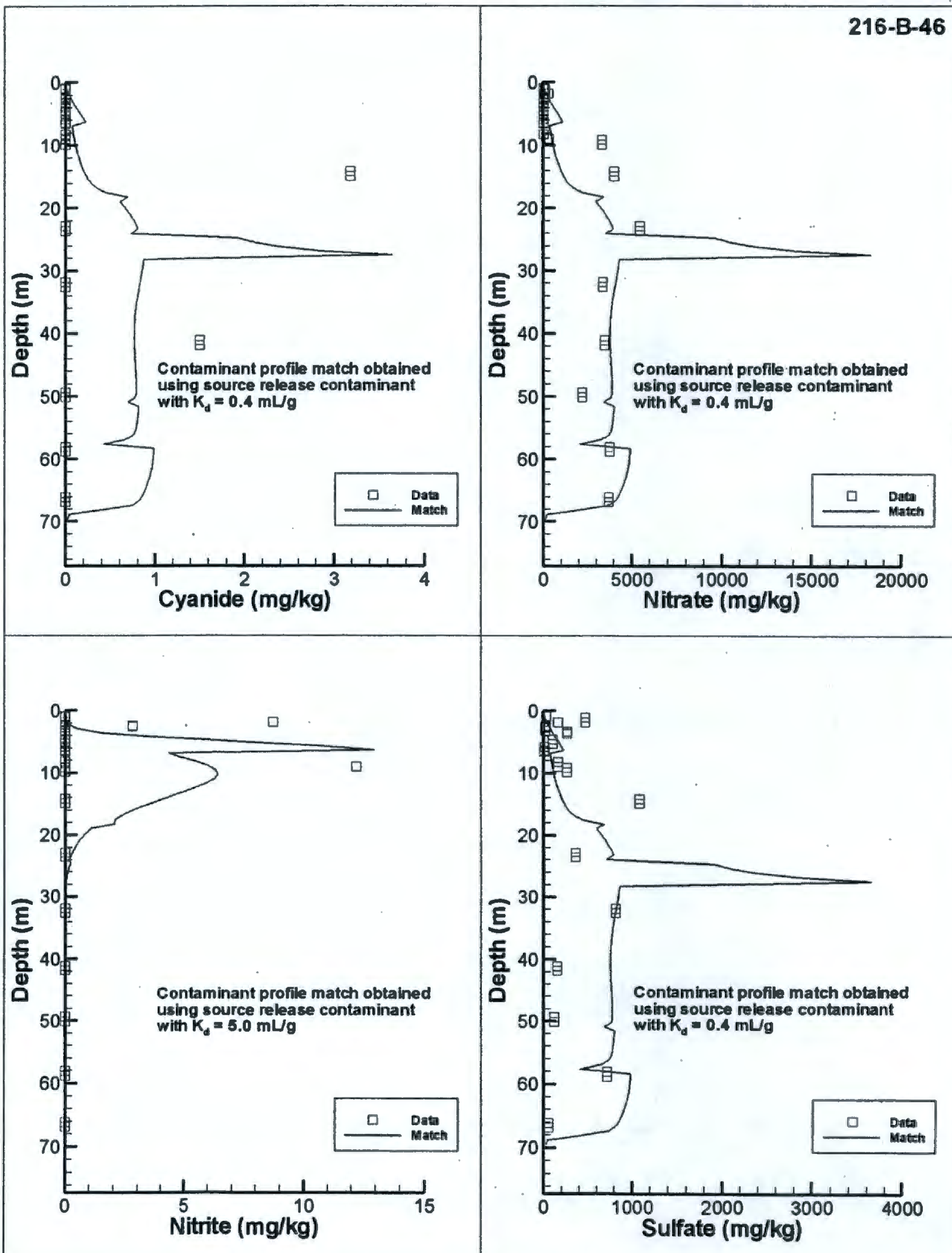

Figure C-4. 216-B-46 Crib Contaminant Profile Data and Matching Model Input for Tritium.

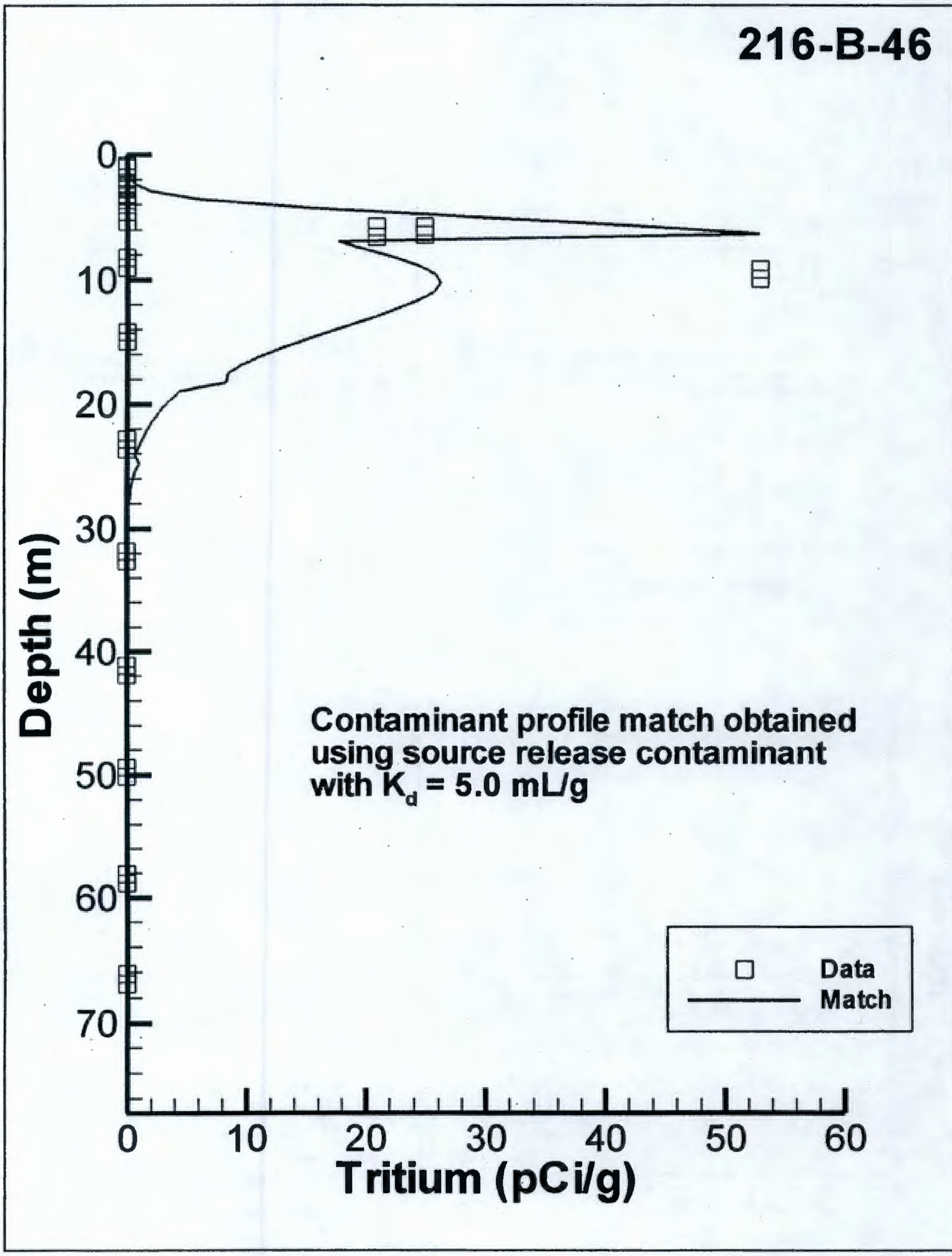

Figure C-5. 216-T-26 Crib Contaminant Profile Data and Matching Model Input for Tritium, Total Beta Radiostrontium, Americium-241, and Cesium-137.

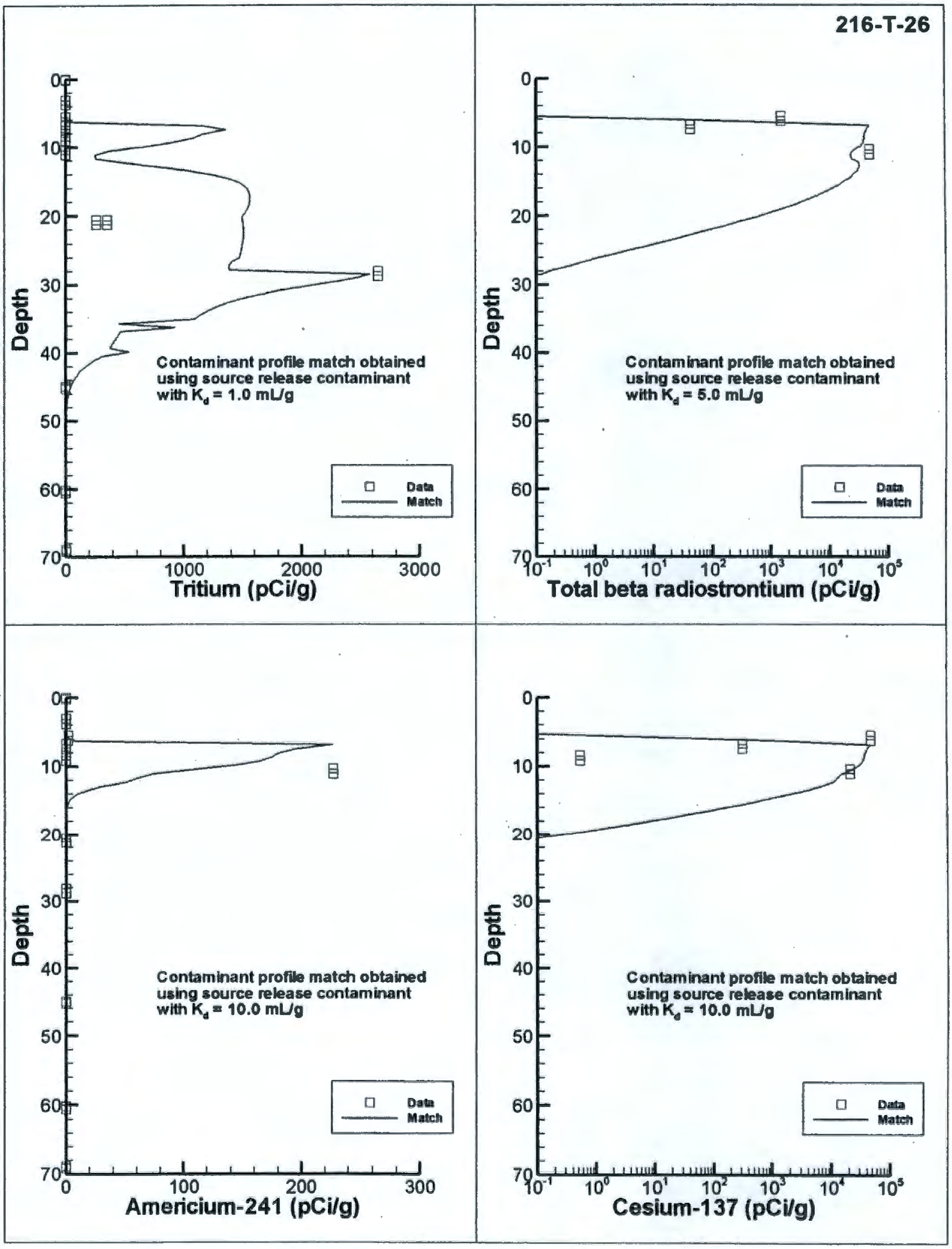

Figure C-6. 216-T-26 Crib Contaminant Profile Data and Matching Model Input for Technetium-99, Uranium-233/234, Uranium-235, and Uranium-238.

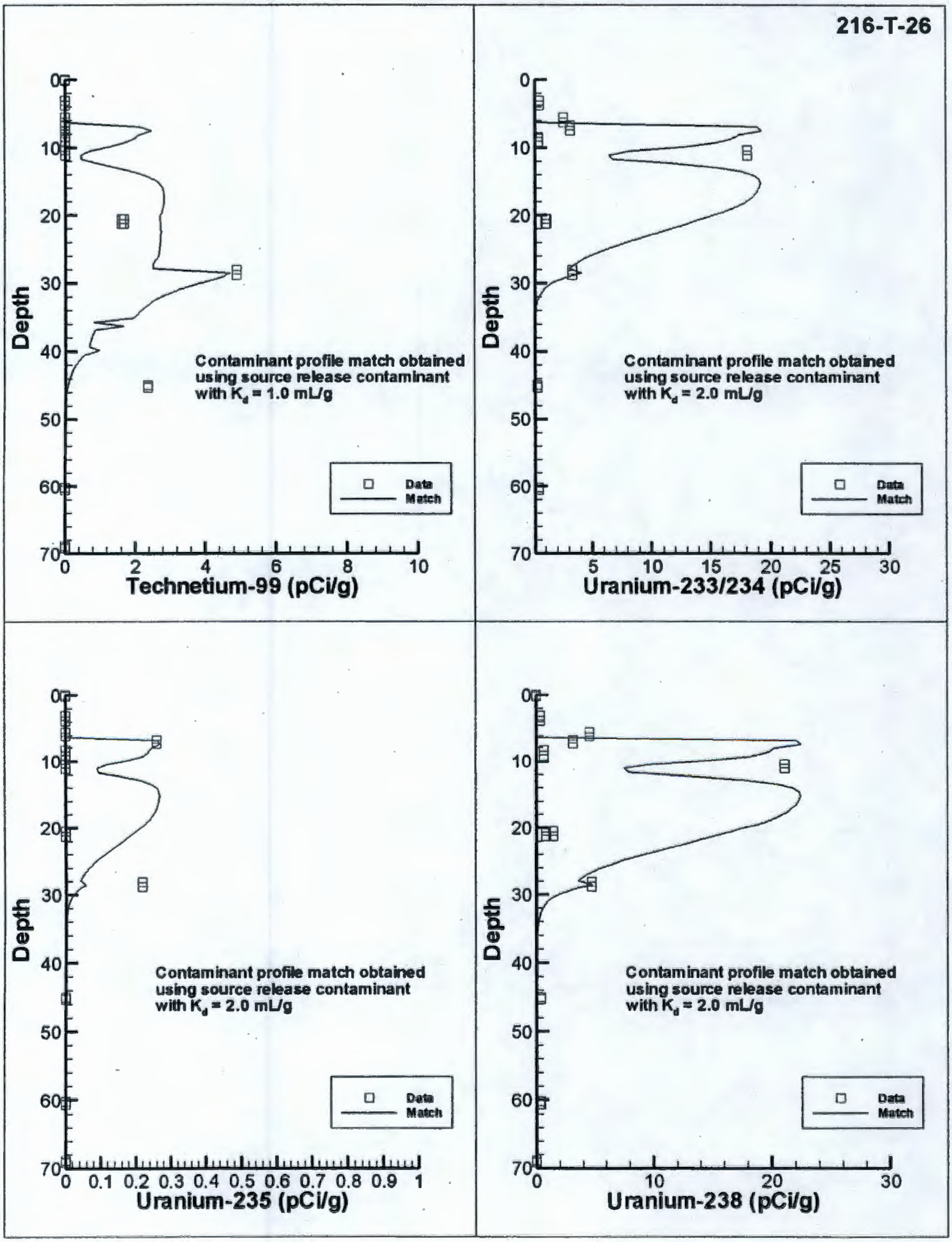

Figure C-7. 216-T-26 Crib Contaminant Profile Data and Matching Model Input for Europium-154, Europium-155, Plutonium-238, and Plutonium-239/240.

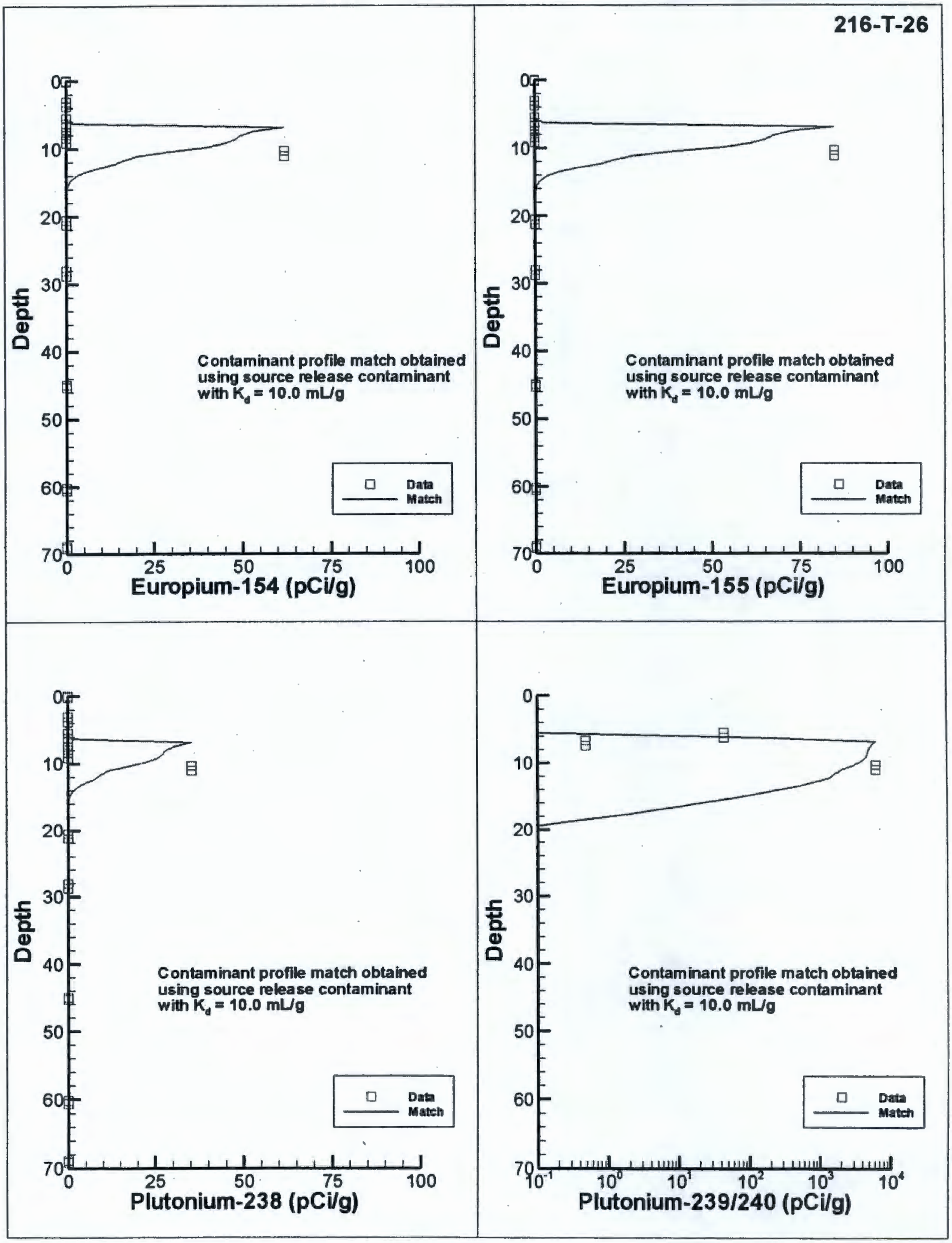

Figure C-8. Crib Contaminant Profile Data and Matching Input for Cyanide, Nitrate, and Nitrite.

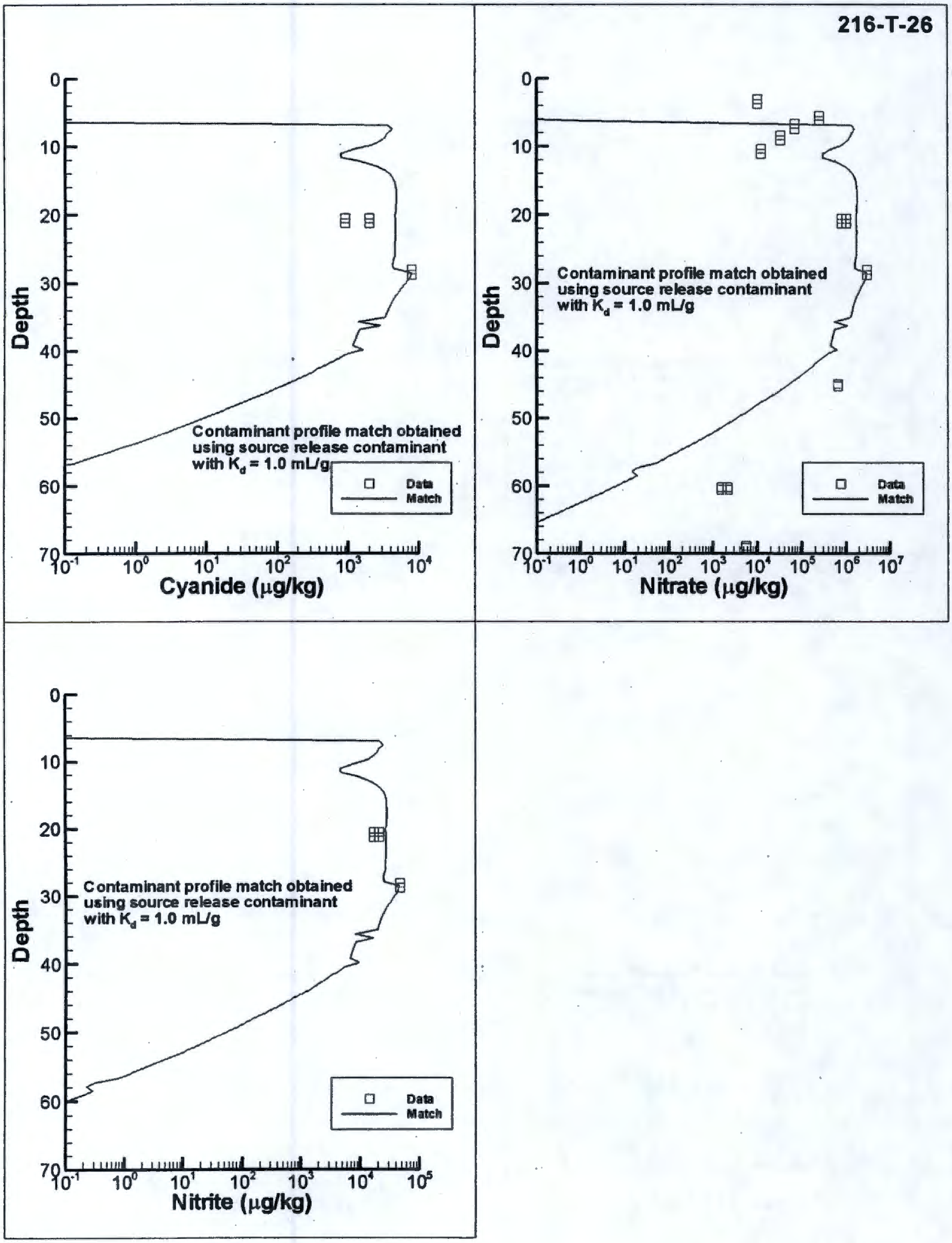

Figure C-9. 216-B-7A Crib Contaminant Profile Data and Matching Model Input for Carbon-14, Cesium-137, Plutonium-238, and Plutonium-239/240.

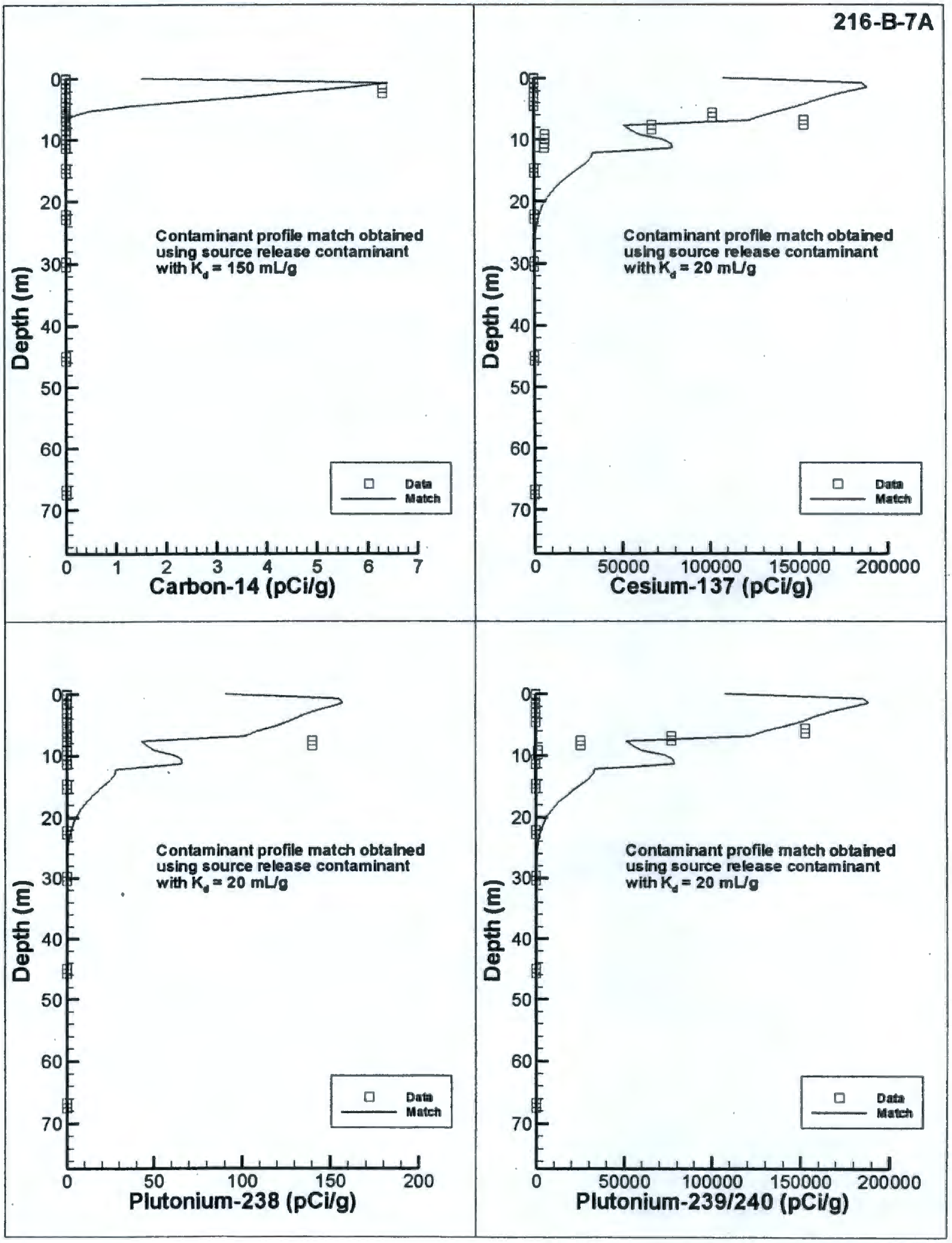

Figure C-10. 216-B-7A Crib Contaminant Profile Data and Matching Model Input for Technetium-99, Total Beta Radiostrontium, Fluoride, and Nitrate.

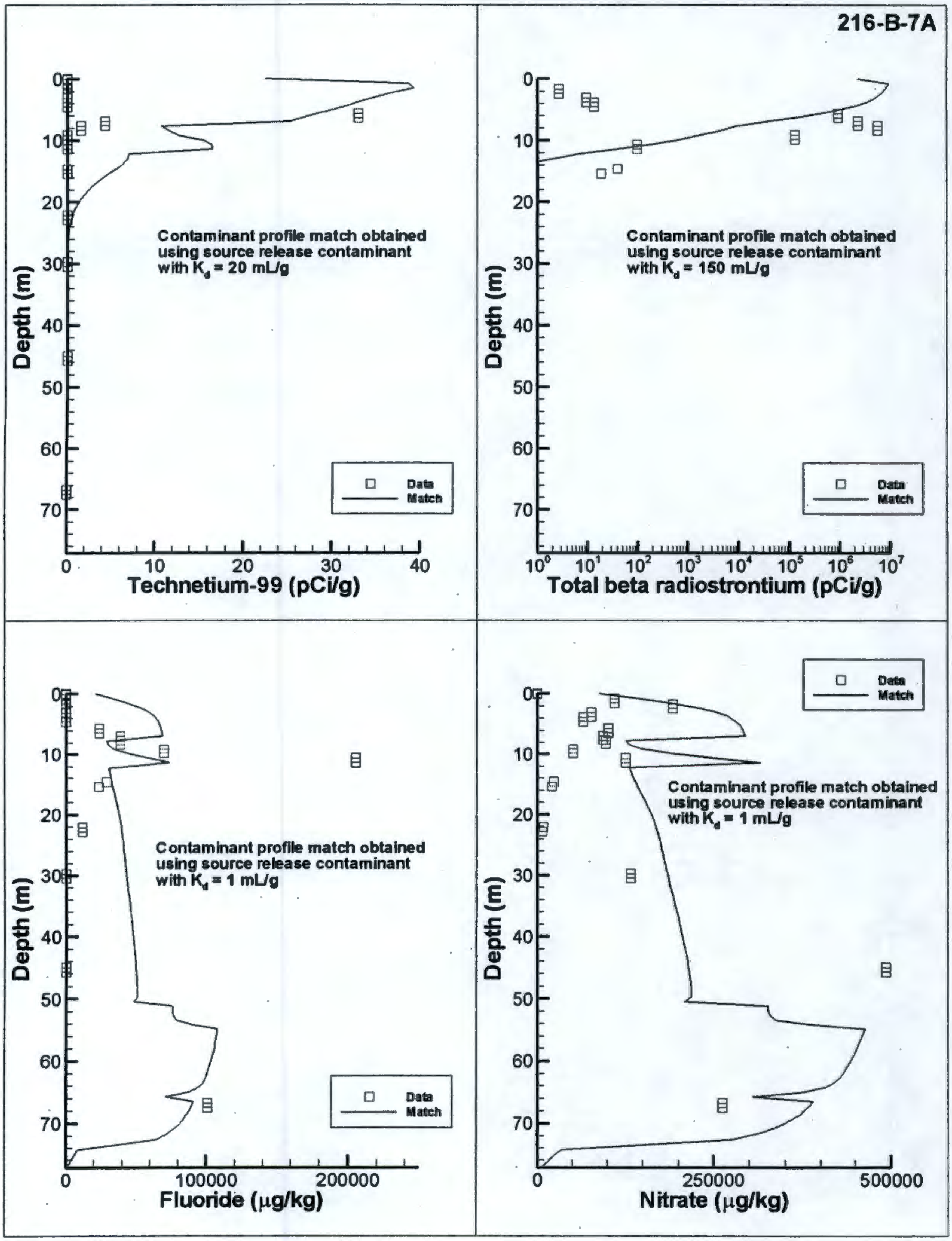

Figure C-11. 216-B-7A Crib Contaminant Profile Data and Matching Model Input for Tritium, Uranium-233/234, Uranium-235, and Uranium-238.

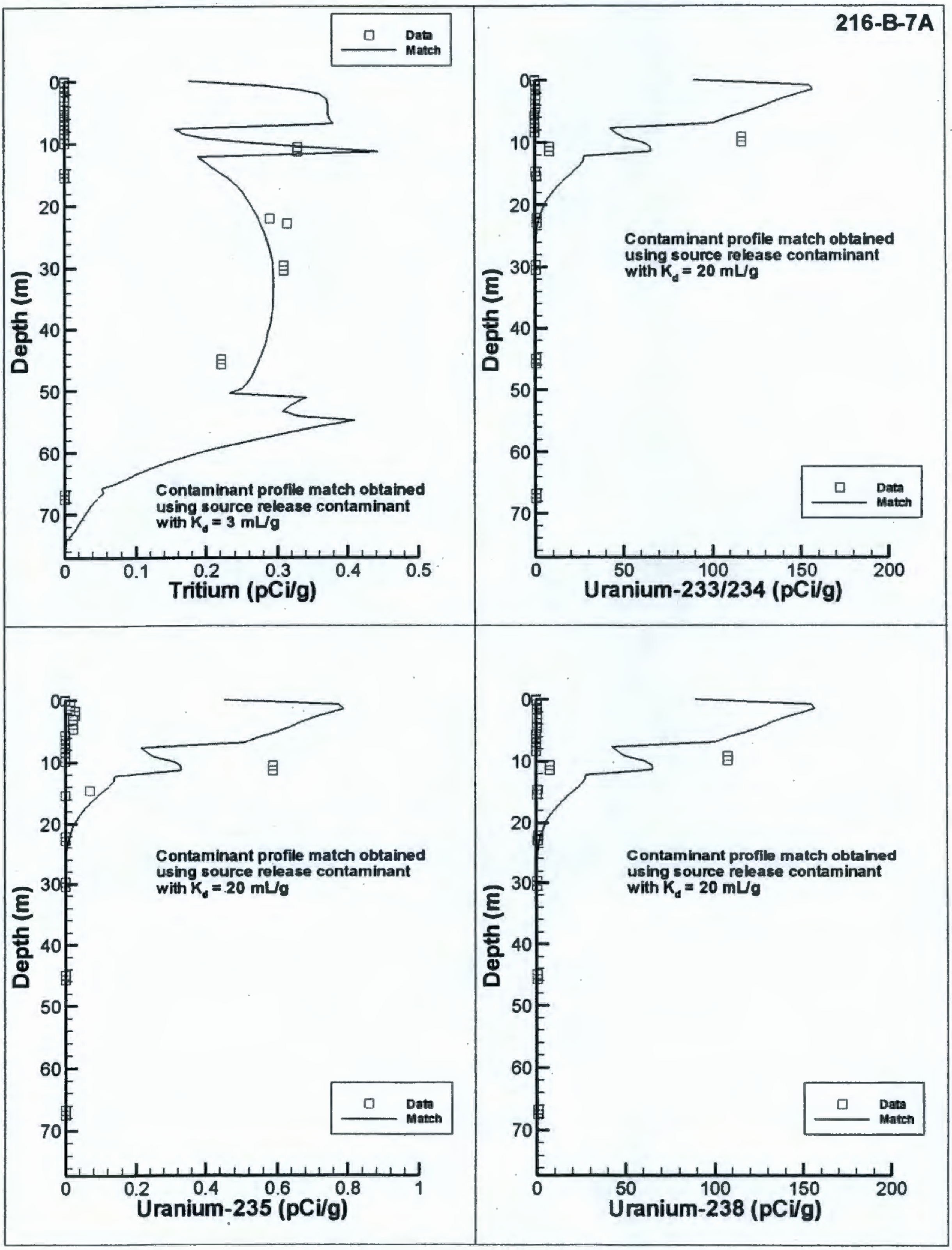

Figure C-12. 216-B-7A Crib Contaminant Profile Data and Matching Model Input for Americium-241, Europium-154, and Potassium-40.

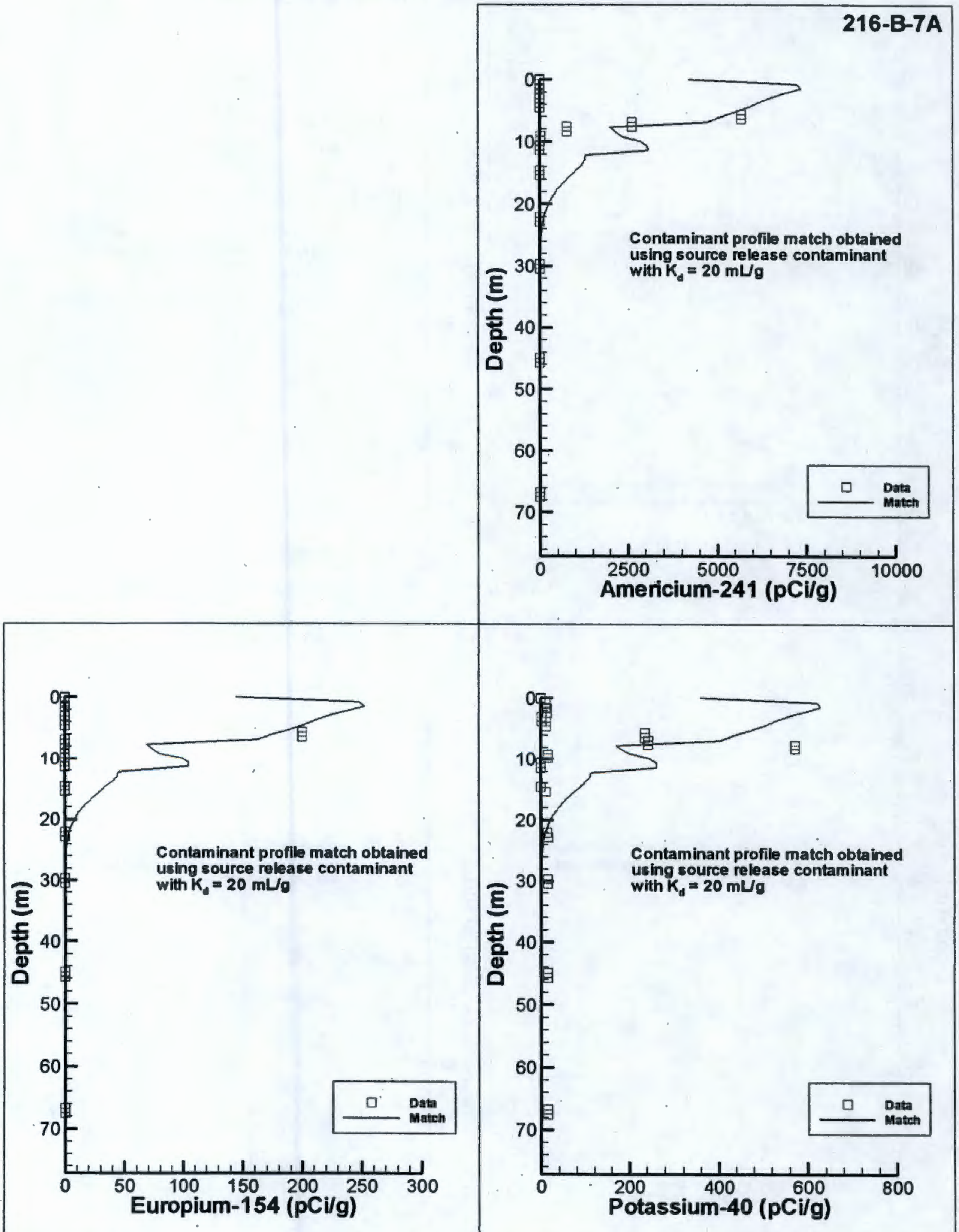

Figure C-13. 216-B-38 Trench Contaminant Profile Data and Matching Model Input for Technetium-99, Tritium, Uranium-233/234, and Uranium-238.

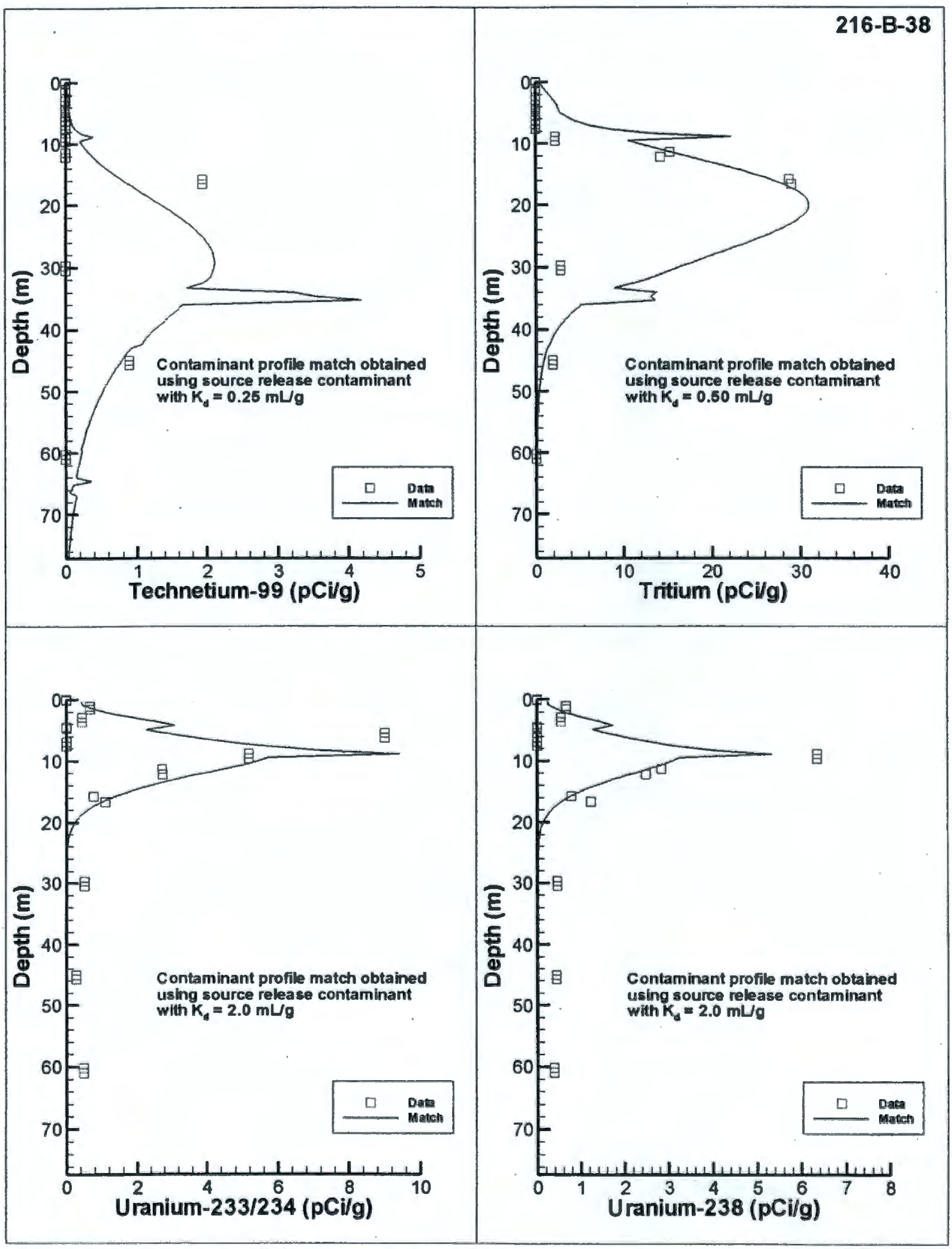

Figure C-14. 216-B-38 Trench Contaminant Profile Data and Matching Model Input for Fluoride, Nitrate, Nitrite, and Potassium-40.

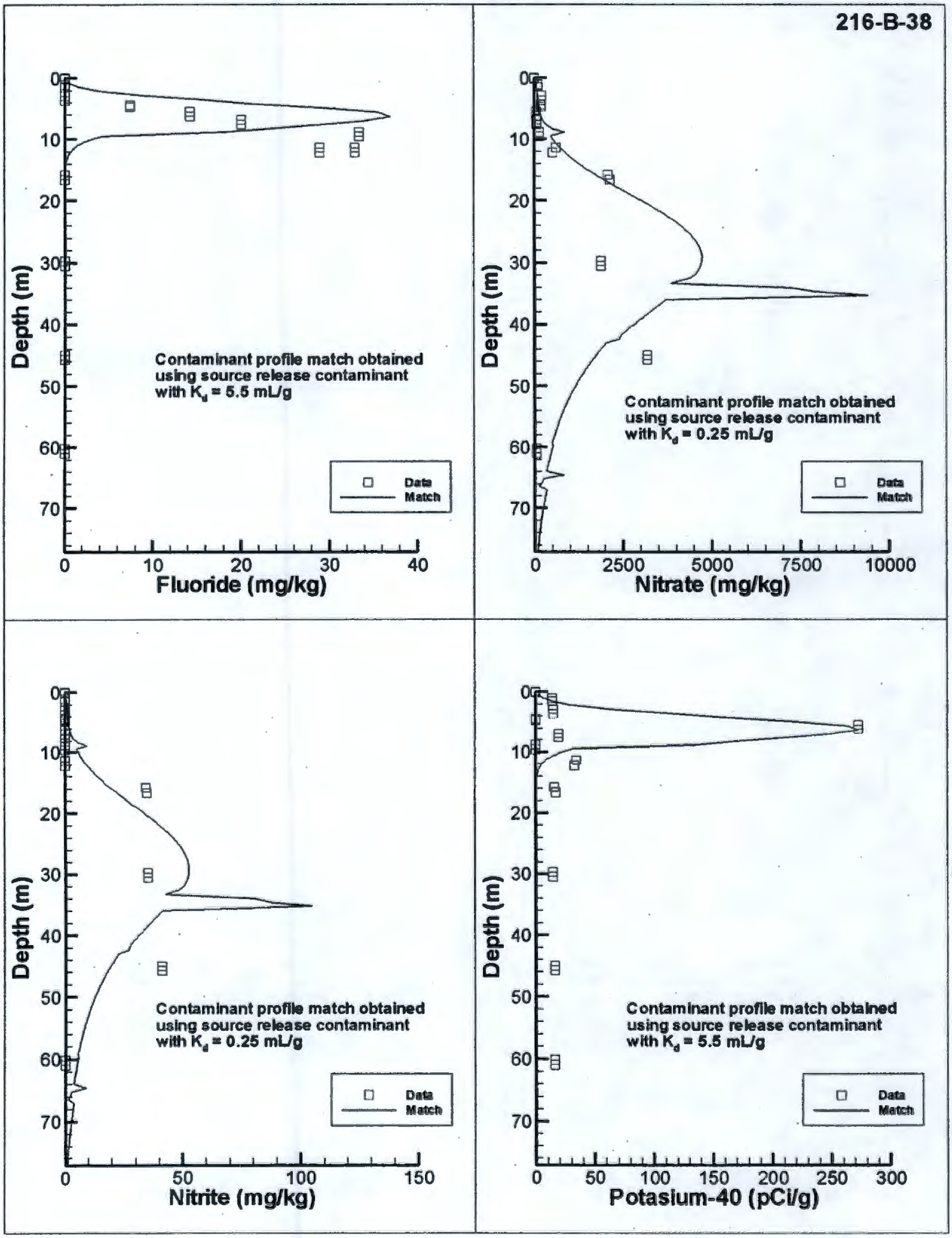

Figure C-15. 216-B-38 Trench Contaminant Profile Data and Matching Model Input for Total Beta Radiostrontium, Cesium-137, Americium-241, and Plutonium-238.