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Limited Field Investigation Report for the 100-HR-1 Operable Unit

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EXECUTIVE SUMMARY

BACKGROUND

This Limited Field Investigation (LFI) report summarizes the data collection and analysis activities conducted during the 100-HR-1 Source Operable Unit LFI and the associated qualitative risk assessment (QRA) (WHC 1993a), and makes recommendations on the continued candidacy of high-priority sites for interim remedial measures (IRM). The results and recommendations presented in this report are generally independent of future land use scenarios. This report is unique in that it is based on Hanford-specific agreements discussed in the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement, Ecology et al. 1990), the *Hanford Site Past Practice Strategy* (HSPPS), the Hanford Site Baseline Risk Assessment Methodology (HSBRAM), and the *RCRA Facility Investigation/ Corrective Measures Study Work Plan for the 100-HR-1 Operable Unit, Hanford Site, Richland, Washington* (DOE-RL 1992a) and must be viewed in this context. The HSPPS, described and justified in *The Hanford Federal Facility Agreement and Consent Order Change Package* and dated May 16, 1991 (Ecology et al. 1991), emphasizes initiating and completing waste site cleanup through interim actions.

A LFI Report is required, in accordance with the HSPPS, when waste sites are to be considered for IRMs. The purpose of the report is to identify those sites that are recommended to remain as candidates for IRMs, provide a preliminary summary of site characterization studies, refine the conceptual model as needed, identify contaminant- and location-specific applicable or relevant and appropriate requirements (ARAR), and provide a qualitative assessment of the risks associated with the sites. This assessment includes consideration of whether contaminant concentrations pose an unacceptable risk that warrants action through IRMs. An IRM is defined by the HSPPS in broad terms and is not restricted to limited- or near-term actions. Interim remedial measures are intended to achieve remedies that are likely to lead to a final Record of Decision (ROD). The final decision to conduct an IRM will rely on many factors including risk, ARARs, future land use, point of compliance, time of compliance, a bias-for-action, and the threat to human health and the environment.

The unit managers assigned all known and suspected areas of contamination in the 100-HR-1 Operable Unit either a high- or low-priority, as listed in Table ES-1. The classification of sites was based on the collective knowledge of the three parties and information contained in existing work plans. The site classification decisions were made during joint meetings with the three parties and are documented by meeting minutes that are part of the administrative record. Sites classified as high-priority pose risk(s) through one or more pathways sufficient to recommend a streamlined action via an IRM. Low-priority sites do not pose risks sufficient to recommend streamlining.

The 100-HR-1 Source Operable Unit is one of three Source Operable Units associated with the 100-H Area at the Hanford Site. The 100-HR-1 and 100-HR-2 Source Operable Units address contaminant sources while the 100-HR-3 Groundwater Operable Unit addresses contamination present in the underlying groundwater. The 100-HR-1 Source Operable Unit

encompasses approximately 100 acres (40.5 hectares) and is located immediately adjacent to the Columbia River shoreline. The operable unit contains waste units associated with the original plant facilities constructed to support the H Reactor. The area also contains evaporation basins which received liquid process wastes and nonroutine deposits of chemical wastes from the 300 Area, where fuel elements for the N Reactor were produced. These solar evaporation basins received wastes from 1973 through 1985 and are therefore under the jurisdiction of Resource Conservation and Recovery Act (RCRA) interim status treatment, storage, and disposal (TSD) requirements. Currently there are no active facilities or operations within the 100-HR-1 Source Operable Unit.

The 100-HR-1 Source Operable Unit LFI was performed to provide additional data needed to support a decision on the appropriateness of continuing along the HSPPS IRM pathway. The LFI included data compilation, non-intrusive investigations, intrusive investigations at five high-priority sites, and data evaluation. It also summarized recent results of the 100 Area aggregate studies.

INVESTIGATION RESULTS

Intrusive vadose zone boreholes were drilled at five sites. Soil samples were collected from each borehole and submitted for laboratory analysis. Boreholes were surveyed for radiological contamination using downhole geophysical techniques to further delineate the locations and levels of contaminants. Materials removed from the boreholes were screened in the field for volatile organic compounds and radionuclides to assist in selection of sample intervals. Analytical data were validated. All data associated with the LFI were evaluated.

Five sites were investigated by vadose zone boreholes: 116-H-1, 116-H-2, 116-H-3, 116-H-7, and 116-H-9. Radiological contamination is the primary concern, as confirmed through this study. Metals contamination was found at the 116-H-1 process effluent disposal trench and the 116-H-7 process effluent retention basin. The maximum concentrations of metals in the 116-H-1 samples were: arsenic - 37.9 mg/kg, chromium - 29.6 mg/kg, and lead - 187 mg/kg. The maximum concentrations of metals in the 116-H-7 samples were: arsenic - 47 mg/kg and lead - 540 mg/kg. Concentrations of lead exceed the potential soil ARARs, which are Washington State Model Toxics Control Act (MTCA) cleanup regulation Method B concentrations. Semi-volatile organic compounds were detected in concentrations below the MTCA Method B guidelines. Volatile organic compounds, while detected, were generally low in concentration or likely laboratory contamination. Contaminant concentrations and locations determined through the intrusive investigation generally confirmed historical information such as documented in Dorian and Richards (1978) though the levels of contamination detected during the LFI were not consistent with the levels detected in the historical data. The remaining high-priority sites in the 100-HR-1 Source Operable Unit were evaluated using data from analogous sites in the 100 Areas or historical data. No 100-HR-1 sites showed contamination that would warrant an Expedited Response Action.

Three low-priority sites were also investigated as part of the LFI. The sites consisted of two septic tanks (1607-H-2 and 1607-H-4) and the electrical facilities within the 100 H Area. Heavy metal contaminants and man-made radionuclides were found at both septic tank sites, with the 1607-H-2 site having the higher concentrations. It is recommended that the 1607-H-2 septic tank site be reviewed for possible reclassification from a low-priority site to a high-priority site due to the high concentrations of contaminants detected. PCB sampling results from surface-soil samples taken at the electrical facilities showed small concentrations of PCBs in five of the eight samples taken. The sample locations were determined by visual inspection of the area and samples were only taken where transformer oils were suspected to have spilled.

QUALITATIVE RISK ASSESSMENT

A QRA was performed for the high priority sites. Conservative assumptions such as highest reported contaminant levels from either the LFI or historical data base were utilized. The QRA provides estimates of human health risks assuming either low-frequency or high-frequency use and includes considerations such as the attenuation of external dose provided by layers of clean gravel fill that overlie many sites. The QRA identifies the major human health risk to be external exposure from the radionuclides Co-60, Cs-137, Eu-152, and Eu-154. The QRA also provides environmental hazard quotient (EHQ) risk estimates for many of the 100-HR-1 high-priority sites.

IRM RECOMMENDATIONS

The 100-HR-1 high-priority sites were evaluated using the following criteria to identify sites recommended to continue as IRM candidates; a detailed discussion of the criteria is provided in Section 5.2 of this report:

- The QRA provides risk estimates for human health and the EHQ ratings. Sites with high or medium risks to human health for the low-frequency use scenario are recommended to continue as IRM candidates. High risk corresponds to an incremental cancer risk (ICR) greater than 1E-02. Medium risk corresponds to an ICR between 1E-04 and 1E-02. Low risk corresponds to an ICR between 1E-06 and 1E-04. Very low risk corresponds to an ICR of less than 1E-06. Sites with an EHQ rating greater than 1 are also recommended to continue as IRM candidates.

- If contaminants at the waste site exceed a chemical-specific ARAR, that site is recommended to continue as an IRM candidate. The Washington State MTCA Method B concentrations are potential ARARs for soil contamination, as discussed in Section 3-9 of this report and in the *100 Area Feasibility Study, Phases 1 and 2* (DOE-RL 1992c). Model Toxics Control Act Method B regulatory limits for soil contaminant concentrations are utilized because they are the standard method and are conservative.

- If LFI results indicate that a site is a current source of groundwater contamination then the site is recommended to continue as an IRM candidate.

- The conceptual model for the waste site includes sources of contamination, types of contaminants, affected media, known and potential routes of migration, known or potential human and environmental receptors, and the general understanding of the site structure/process. If the conceptual model of the site is found to be incomplete, collection of data needed to complete the model through limited field sampling is recommended. Sites with incomplete conceptual models are recommended to continue as IRM candidates.

- The potential for the contaminants at a site to be reduced by natural attenuation, e.g., radioactive decay by the year 2018, may be a consideration for sites where the excess risk is caused by external exposure from radionuclides with half lives of less than 30 years. This is not a consideration for sites where multiple exposure pathways drive the risk.

Table ES-2 presents the evaluation of the high-priority waste sites using the above criteria, and the previous site-specific IRM recommendations. The following sites are recommended to continue as IRM candidates:

- 116-H-1 process effluent disposal trench, 116-H-7 process effluent retention basin, 116-H-5 process effluent outfall structure, and the process effluent pipeline sludge and soil.

The 116-H-2 effluent disposal trench, 132-H-3 effluent pumping station, 132-H-2 exhaust air filter building, 132-H-1 reactor exhaust stack, and 116-H-4 pluto crib sites are recommended to be addressed as solid waste burial grounds.

The 116-H-9 confinement seal pit drainage crib, 116-H-3 dummy decontamination French drain, and 116-H-7 sludge burial trench sites are not recommended for IRMs, since risks, contamination, and impact to groundwater are all low. Action at these sites may be deferred until final remedy selection.

Table ES-1 100-HR-1 Operable Unit High-Priority Sites and Low-Priority Sites

HIGH-PRIORITY SITES	LOW-PRIORITY SITES
116-H-1 Process Effluent Disposal Trench[a]	1607-H-2 Septic System[a]
116-H-2 Effluent Disposal Trench[a]	1607-H-4 Septic System[a]
116-H-3 Dummy Decontamination French Drain[a]	Electrical Facilities[a]
116-H-7 Process Effluent Retention Basin[a]	
116-H-9 Confinement Seal Pit Drainage Crib[a]	
116-H-5 Process Effluent Outfall Structure[b]	
Process Effluent Pipelines (Sludge)[c]	
Process Effluent Pipelines (Soil)	
116-H-7 Sludge Burial Trench	
132-H-3 Effluent Pumping Station[b]	
132-H-2 Exhaust Air Filter Building	
132-H-1 Reactor Exhaust Stack	
116-H-4 Pluto Crib	
116-H-6 Solar Evaporation Basins[d]	

[a] = Soil sampling conducted as part of the Limited Field Investigation
[b] = Additional data used from analogous site
[c] = Remote sensing performed on section of process effluent pipeline
[d] = 116-H-6 Solar Evaporation Basins are to be considered under RCRA Interim Status and are not further addressed in this document

Source: DOE-RL, 1992a

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Table ES-2 IRM Recommendations for 100-HR-1 High-Priority Sites

Waste Site	Qualitative Risk Estimation		Conceptual Model	Exceeds ARAR	Probable Current Impact on Groundwater	Potential for Natural Attenuation by 2018	IRM Candidate yes/no
	Low-frequency scenario	EHQ > 1					
116-H-1 Process Effluent Disposal Trench	Medium	Yes	Adequate	Yes	Yes	No	Yes
116-H-2 Effluent Disposal Trench	Low	Yes	Incomplete*	No	No	No	Yes*
116-H-3 Dummy Decontamination French Drain	Low	No	Adequate	No	No	Yes	No
116-H-7 Process Effluent Retention Basin	High	Yes	Adequate	Yes	Yes	No	Yes
116-H-9 Confinement Seal Pit Drainage Crib	Low	No	Adequate	No	No	Yes	No
116-H-5 Process Effluent Outfall Structure	Medium	--	Adequate	No	No	No	Yes
Process Effluent Pipelines (Soil)	Very Low	No	Adequate	No	Yes	No	Yes
Process Effluent Pipelines (Sludge)	High	No	Adequate	No	Yes	No	Yes
116-H-7 Sludge Burial Trench	Very Low	--	Adequate	No	No	No	No
132-H-3 Effluent Pumping Station	Low	--	Adequate	Unknown	Unknown	Unknown	Yes
132-H-2 Exhaust Air Filter Building	Low	--	Adequate	Unknown	No	Unknown	Yes
132-H-1 Reactor Exhaust Stack	Low	--	Adequate	Unknown	No	Unknown	Yes
116-H-4 Pluto Crib	Low	--	Adequate	Unknown	No	Unknown	Yes

EHQ – Environmental Hazard Quotient calculated by the qualitative ecological risk assessment (WHC 1993a)
-- = Not rated by the qualitative ecological risk assessment
* = Data needed concerning nature and vertical extent of contamination, site remains an IRM candidate until data are available.
* = Conceptual model is considered incomplete due to discrepencies between the LFI data and the historical data. The LFI data indicates little or no contamination which contradicts with the historical data. Additional investigation may be necessary.
ARAR = Applicable or Relevant and Appropriate Regulation, specifically the Washington state Model Toxics Control Act Method B concentration values for soils (DOE-RL, 1992a)
Shaded areas indicate driving factors keeping site as IRM candidate.

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ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COPC	contaminant(s) of potential concern
CPM	counts per minute
CRDL	contract required detection limit
CRQL	contract required quantitation limit
DCHM	Data Chem Laboratories
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQO	data quality objective(s)
EE/CA	environmental evaluation/corrective action
EHQ	Environmental Hazard Quotient
EPA	U.S. Environmental Protection Agency
ERA	expedited response action(s)
GPR	ground-penetrating radar
HEIS	Hanford Environmental Information System
HEPA	high efficiency particulate air
HQ	hazard quotient
HSBRAM	Hanford Site Baseline Risk Assessment Methodology
HSPPS	Hanford Site Past-Practice Strategy
ICR	incremental cancer risk
IRM	interim remedial measures
LFI	Limited Field Investigation
LOEL	lowest observable effect level
MTCA	Model Toxics Control Act
NCRP	National Council on Radiation Protection and Measurements
NPL	National Priorities List
OU	operable unit
OVM	organic vapor monitor
PCB	polychlorinated biphenyl
PEF	particulate emission factor
PNA	polynuclear aromatics
QAPjP	quality assurance project plan
QC	quality control
QRA	qualitative risk assessment
RCRA	Resource Conservation and Recovery Act
RFI/CMS	RCRA Facility Investigation/Corrective Measures Study
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
S^3	Maxwell Laboratories, S-Cubed Division
TAL	target analyte list

ACRONYMS (cont)

TCL	target compound list
TMA	Thermo Analytical, Inc.
TSD	treatment, storage, and disposal
UTL	upper threshold limit
VOC	volatile organic compound
WESTON	Weston Laboratory
WHC	Westinghouse Hanford Company

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1.0 INTRODUCTION

This Limited Field Investigation (LFI) report summarizes the data collection and analysis activities conducted during the 100-HR-1 Source Operable Unit LFI and the *Qualitative Risk Assessment of the 100-HR-1 Source Operable Unit* (WHC 1993a). An LFI report is required, in terms of the *Hanford Site Past-Practice Strategy* (HSPPS) (DOE-RL 1991a), when waste sites are to be considered for interim remedial measures (IRM). The purpose of the report is to identify those sites that are recommended to remain as candidates for IRMs, to provide a preliminary summary of site characterization studies, to refine the conceptual model as needed, to identify contaminant- and location-specific applicable or relevant and appropriate requirements (ARAR), and to provide a qualitative assessment of the risks associated with the sites. This assessment also considers whether contaminant concentrations pose an unacceptable risk that warrants action through interim remedial measures. These objectives are described fully in the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-HR-1 Operable Unit, Hanford Site, Richland, Washington* (DOE-RL 1992a).

The work plan (DOE-RL 1992a) divides the site characterization activities into 12 tasks. These are subjects of the LFI summary of characterization studies. Table 1-1 lists the 12 characterization activities and how each is addressed in the LFI report.

To limit the size of this report and to improve its readability, reliance is placed on the referral to other documents for specific details. This document is unique in that it is based on Hanford-specific agreements discussed in the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement, Ecology et al. 1990), the HSPPS, the Hanford Site Baseline Risk Assessment Methodology (HSBRAM), and the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-HR-1 Operable Unit, Hanford Site, Richland, Washington* (DOE-RL 1992a), and it should be viewed in this context. An IRM, for example, is defined in broad terms and is not restricted to limited or near-term actions. It allows for interim action with a final goal of achieving final action levels. Indeed, an IRM may not be necessary, if it is not likely to lead to a final Record of Decision (ROD). The qualitative risk assessment (QRA) is used only to assess risk for an IRM determination and is not intended to define current risk or baseline risk in a traditional sense. The final decision to conduct an IRM will rely on many factors, including the QRA, ARARs, future land use, point of compliance, time of compliance, a bias-for-action, and the threat to human health and the environment, including the threat to groundwater.

This LFI report is organized into five major sections, including the introductory section. Section 2.0 describes the LFI process, including field investigation, type of sampling, screening, geophysical logging, sample analysis, and data validation activities. Section 3.0 presents the results and conclusions of the investigation. Section 4.0 summarizes the QRA process, and Section 5.0 provides a summary of recommendations. The compiled analytical data for the sampling and analysis performed during the LFI process on the high- and low- priority sites are presented in Appendices A and B, respectively.

1.1 SITE BACKGROUND

The 100-HR-1 Source Operable Unit is situated within the 100 H Area of the U.S. Department of Energy's (DOE) Hanford Site, in the south-central portion of the state of Washington. The 100 H Area is located in Benton County along the south bank of the Columbia River in the north-central part of the Hanford Site, approximately 27 miles (mi) (43.4 kilometers [km]) north-northwest of Richland, Washington (DOE-RL 1992a).

Covering approximately 100 acres [40.5 hectares (ha)], the 100-HR-1 Source Operable Unit is located immediately adjacent to the Columbia River in the northeast portion of the 100 H Area. The operable unit lies primarily within the northeast quadrant of Section 18 of township 14N, range 27E, and is located between latitude 46° 42' 30" and 46° 43' 30" north and longitude 119° 29' 00" and 119° 28' 00" west. Site maps locate it within north/south Hanford Site plant coordinates N94,000 and N99,000 and east/west plant coordinates W37,000 and W41,000 (Figure 1-1) (DOE-RL 1992a).

The 100-HR-1 Source Operable Unit is one of three Source Operable Units associated with the 100 H Area at the Hanford Site. Two of these units, 100-HR-1 and 100-HR-2, are source operable units composed of waste units. The groundwater/surface-water operable unit is designated 100-HR-3 and includes the entire 100 H Area, the 100 D/DR Area, and the area in between. The 100 D/DR Area is located approximately 2 mi (3.5 km) southwest of the 100 H Area. The 100-HR-1 Source Operable Unit is bordered on the west and south by the 100-HR-2 Source Operable Unit, which is the solid and buried waste operable unit for the 100 H Area. The 100-HR-2 Source Operable Unit consists of solid waste burial grounds that contain radioactive solid wastes, radioactively contaminated equipment, and failed reactor components (DOE-RL 1992a).

Designated as a reactor effluent waste source, the 100-HR-1 Source Operable Unit contains most of the sites involved in plutonium production, including the reactor and its cooling system.

The 100 H Reactor complex was constructed after World War II to produce plutonium for use in military weapons (WHC 1988a). Fuel elements for the reactor were manufactured in the 300 Area, and the plutonium-enriched fuel produced by the reactor was processed in the 200 Area. The H Reactor operated from 1949 to 1965, when it was retired (WHC 1988a). A reactor decommissioning process is ongoing. (Because the reactor is being decommissioned separately, it is not within the scope of this LFI.)

The 100 H Area support facilities included offices, storage buildings for contaminated equipment, warehouses, a laboratory, a garage, maintenance shops, a paint shop and storage, a fallout shelter, a coal-fired electrical generation substation (including coal storage and fly-ash disposal facilities), solid waste burial grounds, a burn pit, a water treatment plant (including water intake and storage structures), a river pump house, a process effluent system, and a subsurface sanitary sewage disposal system (WHC 1988a;

General Electric 1963). A number of the aboveground facilities have undergone some degree of decommissioning or have been removed completely.

The cooling water treatment system included 16 settling basins, four of which were modified to store and treat liquid process wastes generated at the N Reactor fuel fabrication facilities. The resulting solar evaporation basins (116-H-6) received these wastes from 1973 through 1985 (WHC 1988a). Therefore, the solar evaporation basins are being handled under RCRA interim status guidelines (WHC 1988a) and will not be addressed further in this report. Currently there are no active facilities or operations within the 100-HR-1 Source Operable Unit.

The 100-HR-3 Groundwater Operable Unit is described in the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-HR-3 Operable Unit* (DOE-RL 1992b). The results of a recently completed LFI for the 100-HR-3 Operable Unit are presented in the *Limited Field Investigation Report for the 100-HR-3 Operable Unit,* (DOE-RL 1993d). The following groundwater information is from that LFI report.

Groundwater in the 100 H Area generally flows in a northeasterly direction towards the Columbia River. The groundwater table elevation (above mean sea level) at normal to low river stage ranges from 377 feet (ft) [114.9 meters (m)] in the southwest corner to approximately 374 ft (113.9 m) near the river. The groundwater gradient is approximately 0.0006. Typical groundwater flow velocities in the uppermost aquifer (Ringold Formation) range from 2 to 6 ft/day (0.3 to 2.0 m/day). The primary nonradioactive constituent contributing to health risk in the 100 H Area groundwater was chloroform (DOE-RL 1993d). The environmental risk assessment for aquatic organisms from nonradioactive contaminants indicated a low to moderate risk when maximum contaminant concentrations from near-river monitoring well samples are used (DOE-RL 1993d).

1.2 THE HANFORD SITE PAST-PRACTICE STRATEGY AND THE 100-HR-1 LFI

The signatories to the Tri-Party Agreement (Ecology et al. 1990) recognized the need for a new strategy of Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response Compensation and Liability Act (CERCLA) integration to provide greater uniformity in the applicability of requirements to the Hanford Site. Additionally, the signatories agreed that proceeding with the traditional CERCLA approach would likely require too much time and too large a portion of a limited budget to be spent before actual cleanup would occur. Another motivation for a new strategy was the need to coordinate past-practice investigations with RCRA closure activities, since some operable units contain RCRA treatment storage and disposal facilities. This new strategy, the HSPPS, is described and justified in *The Hanford Federal Facility Agreement and Consent Order Change Package*, dated May 16, 1991 (Ecology et al. 1991).

In response to the above concerns, the three parties have decided to manage and implement all past-practice investigations under one characterization and remediation

strategy, regardless of the regulatory agency lead (as defined in the Tri-Party Agreement). In order to enhance the efficiency of ongoing remedial investigation/ feasibility studies (RI/FS) and RCRA facility investigation/corrective measures study (RFI/CMS) activities at the 100 Area of the Hanford Site and to expedite the ultimate goal of cleanup, more emphasis will be placed on initiating and completing waste site cleanup through interim actions.

This strategy streamlines the past-practice remedial action process and provides new concepts for the following:

- Accelerating decision-making by maximizing the use of existing data consistent with data quality objectives (DQO)

- Undertaking expedited response actions (ERA) and/or IRMs, as appropriate, to either remove threats to human health and welfare and the environment, or to reduce risk by reducing toxicity, mobility, or volume of contaminants.

The HSPPS describes the concepts and framework for the RI/FS process in a manner that has a bias-for-action through optimizing the use of interim actions, culminating with decisions on final remedies on both an operable unit and 100 Area aggregate scale. The strategy focuses on reaching early decisions to initiate and complete cleanup projects, maximizing the use of existing data, coupled with focused short-time-frame investigations, where necessary. As more data become available on contamination problems and associated risks, the details of the longer term investigations and studies will be better defined.

Figure 1-2 is a decision flow chart that shows the HSPPS process. The strategy includes three paths for interim decision making and a final remedy-selection process for the operable unit that incorporates the three paths and integrates sites not addressed in those paths. An important element of this strategy is the application of the observational approach, in which characterization data are collected concurrently with cleanup.

As shown on Figure 1-2, the three paths for interim decision-making are as follows:

- ERA path, where an existing or near-term unacceptable health or environmental risk from a site is determined or suspected, and a rapid response is necessary to mitigate the problem.

- IRM path, where existing data are sufficient to formulate a conceptual model and perform a QRA. If a determination is made that a site continues to be a candidate for an IRM, the process will proceed to select an IRM remedy, and may include a focused feasibility study (FS), if needed, to select a remedy.

- LFI path, where an LFI can provide sufficient data to formulate a conceptual model and to perform a QRA. The data can be obtained in a less formal manner than that needed to support the operable unit ROD; however, regardless of the scope of the LFI, it is a part of the RI process and not a substitute for it.

The near-term past-practice strategy for the 100 Area provides for ERAs, IRMs, and LFIs for individual waste sites, grouped waste sites, and contaminated groundwater. The LFI is an integral part of the RI/FS process and functions as a focused RI for selection of IRMs. The information obtained from the LFIs and interim actions may be sufficient to perform the baseline risk assessment and to select the remedy for the operable unit. If the data are not sufficient, additional investigations and studies will be performed to the extent necessary to support the operable unit remedy selection. These investigations would be performed within the framework and process defined for RI/FS programs. Conversely, the sum of the IRMs may constitute the final cleanup, which would be formalized in a site ROD.

Implementation of the HSPPS at the 100-HR-1 Source Operable Unit began with the development of the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-HR-1 Operable Unit, Hanford Site, Richland, Washington* (DOE-RL 1992). Through the work plan, the three parties assigned all known and suspected areas of contamination either a high or low priority, as listed in Table 1-2. Sites classified as high priority pose a risk(s) through one or more pathways any of which are sufficient to warrant a streamlined action via the IRM pathway. Low-priority sites do not pose enough risk to justify streamlining. The three parties agreed that:

- None of the high-priority sites pose risks that would require an ERA

- Limited field sampling was sufficient for those high-priority sites where data are deemed insufficient to formulate the conceptual model and support the QRA

- Certain remediation activities would be more efficient to implement at the 100 Area aggregate or Hanford Site scale than the operable unit scale.

The LFI and QRA are part of the 100-HR-1 RFI/CMS, as described by the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-HR-1 Operable Unit, Hanford Site, Richland, Washington* (DOE-RL 1992a). The work plan includes the following topics that are directly applicable to the 100-HR-1 LFI:

- Operable unit site description (Section 2.1)

- Operable unit setting (Section 2.2)

- Known and suspected contamination (Section 3.1)

- Data quality objectives (Section 4.1.1)

- Data needs (Section 4.1.2)
- 100-HR-1 Source Operable Unit sampling and analysis approach (Section 4.2.2)
- Limited field investigations (Section 5.1.1)
- 100 Area aggregate studies and Hanford Site studies (Section 5.1.1).

The conceptual model for the 100-HR-1 Operable Unit, presented in Chapter 4 of the work plan (Section 4.1.2) (DOE-RL 1992a), was developed during the RFI scoping process. The conceptual model addresses the following:

- Structure and process of the waste sites
- Source of contaminants
- Type of contaminants
- Nature and extent of contamination
- Known and potential routes of migration
- Known and potential human and environmental receptors.

This conceptual model has been updated with data acquired through the LFI and is presented in Chapter 5 of this report.

The 100-HR-1 LFI began the investigative phase of the RI for a select number of high-priority sites. The LFI was performed to provide additional data needed to support the decision concerning selection, design, and implementation of IRMs. The LFI included data compilation, non-intrusive investigations, intrusive investigations, 100 Area aggregate studies, and data evaluation.

1.3 HISTORICAL DATA

An integral part of the RFI/CMS process for the 100-HR-1 Operable Unit has been the acquisition, evaluation, and utilization of records pertaining to the construction, operation, and decontamination/decommissioning of the reactor and related 100 H facilities. This information is categorized as historical information and includes operations records and reports, engineering drawings, photographs, interviews with former or retired operations personnel, and data from sampling and analysis of facilities and the local environment.

A primary reference for radiological characterization of the 100-HR-1 Operable Unit sources is a sampling study of the 100 Area performed during 1975-76 by Dorian and Richards (1978). In the 100-HR-1 Source Operable Unit area, Dorian and Richards (1978) collected samples from the retention basins, the effluent pipelines and surrounding soil, a liquid waste disposal trench, a retention basin sludge disposal trench, and the dummy decontamination drain. Samples of soil were collected from the surface and from the subsurface to a maximum of 25 ft (7.6 m) below grade. Samples were also

collected from retention basin sludge and concrete and from effluent line scale and sludge. The samples were analyzed for radionuclides. Inventories of radionuclides for the facilities and sites were calculated. Results from Dorian and Richards (1978) were a major resource used in the development of the 100-HR-1 conceptual model and LFI data needs. It should be noted, however, that only concentrations and inventories of selected radionuclides were reported in the 1975-76 study. In particular, Ni-63, which is generally present at activities on the same order of magnitude as Co-60, was reported for only some samples; Tc-99 was not evaluated; and daughter product radionuclides of Sr-90 and Cs-137, which have approximately the same activities as the parent nuclides, were not included in summaries of total activity.

1.4 100 AREA AGGREGATE STUDIES

The 100 Area aggregate studies and Hanford Site studies provide integrated analyses of selected issues on a scale larger than the operable unit, such as the Hanford Site background study. The 100-HR-3 work plan (DOE-RL 1992b) addresses activities common to the 100 Area such as a river impact study, a shoreline study, an ecological study, and a cultural resource study. These studies provide data to be used in the LFI and in the selection of final remedies. Results of the Hanford Site background study, the 100 Area ecological study, and cultural resource study that are applicable to the 100-HR-1 LFI are summarized below.

1.4.1 Hanford Site Background

Results of the characterization of the natural chemical composition of Hanford Site soils is presented in *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes* (DOE 1993a). The characterization included an analysis of physical properties and factors that might affect the natural soil chemical composition, as determined by regulatory protocols. Hanford Site soils have not been characterized to establish the natural concentrations of the following types of constituents: volatile organic compounds (VOC), semi-volatile organic compounds, pesticides and PCBs, and radionuclides.

Table 1-3 presents the 95th percentile of the data for a lognormal distribution and the 95 percent confidence limit of the 95th percentile of the data distribution for inorganic analyses of Hanford Site soils (DOE-RL 1993b). The 95 percent confidence limit of the 95th percentile of the data distribution, abbreviated as the 95% upper threshold limit (95% UTL), is identified by the Washington Administrative Code (WAC), Model Toxics Control Act (MTCA) (WAC 173-340-708 [lld]), as one way to define threshold levels. The 95% UTL values for inorganic constituents have been utilized in the 100-HR-1 QRA (WHC 1993a) to establish site potential contaminants of concern. An inorganic constituent at a site is considered a contaminant if the reported concentration exceeds the 95% UTL values. Because site-wide background levels for organic and radionuclide constituents have not been established (DOE-RL 1993b), all

detected concentrations of these constituents were considered in the QRA as potential contaminants of concern.

1.4.2 Ecological Analysis

Ecological surveys and sampling related to CERCLA have been conducted in the 100 Areas and in and along the Columbia River adjacent to the 100 Areas (Sackschewsky and Landeen 1992; Weiss and Mitchell 1992). Sampling included plants with either a past history of documented contaminant uptake or an important position in the food web, such as river algae, reed canary grass, tree leaves, and asparagus. In addition, samples were collected of caddisfly larvae (next step in the food chain from algae), burrow soil excavated by mammals and ants at waste sites, and pellets cast by raptors and coyote scat to determine possible contamination of the upper end of the food chain. The results of these sample analyses are being compiled and will be presented in separate documents. Other sampling results generated by site-wide surveillance and facility monitoring programs will also be used in the evaluation of ecological contamination.

Bird, mammal, and plant surveys were conducted and reported in Sackschewsky and Landeen (1992). Current contamination data have been compiled from other sources, along with ecological pathways and lists of all wildlife and plants at the site, including threatened and endangered species. This information has been published in Weiss and Mitchell (1992).

Detailed surveys of the 100 H Reactor area are discussed in Appendix D-2, Ecological Investigations, of the 100-HR-3 Groundwater Operable Unit work plan (DOE-RL 1992b).

1.4.3 Cultural Resources Review

In compliance with Section 106 of the National Historic Preservation Act, and at the request of Westinghouse Hanford Company, the Hanford Cultural Resources Laboratory conducted an archaeological survey during Fiscal Year 1991 of the 100 Area reactor compounds on the Hanford Site. This survey was conducted as part of a comprehensive cultural resources review of the 100 Area operable units in support of CERCLA characterization activities. The work included a literature and records review and pedestrian survey of the project area, following procedures established in the Hanford Cultural Resources Management Plan.

The following paragraphs briefly discuss the topographic, geomorphic, and vegetation characteristics of the 100 Area reactor compounds:

The 100 Area operable units, which cover a total area of 1,834 ha (18.3 km^2) are topographically and environmentally similar. Each is situated along the Columbia River bank, with the reactor located on a high gravel terrace left by the recession of glacial

floodwaters at the end of the Pleistocene. Epoch shoreline areas grade from steep banks with narrow cobble beaches to broad, stepped, well-defined floodplain terraces with gently sloping beaches. The floodplain terraces consist of sand deposited during the Holocene epoch and occur on at least two levels, one dating to the early or middle Holocene and another representing the later Holocene. Inland areas are broad flats broken only by stabilized dunes. The area from west of the 100 N Area to the western edge of the 100 D Area differs from this general pattern. The large, rounded gravel mounds in that vicinity are chaotic ripple marks produced by the rush of catastrophic Pleistocene floodwaters.

Vegetation on all sites is dominated by cheatgrass (*Bromus tectorum*), with scattered big sagebrush (*Artemisia tridentata*), tumble mustard (*Sysimbrium spp.*), Russian thistle (*Salsola kali*), rabbit brush (*Chrysothamnus spp.*), and needle and thread grass (*Stipa comata*). Small groves of deciduous trees and shrubs, usually black locust (*Robina pseudo-acacia*), willow (*Salix spp.*), and mulberry (*Morus spp.*) grow along the river bank at the site of early twentieth-century homesteads.

Detailed archeological surveys of the 100 H Reactor area are discussed in Appendix D-3, Cultural Resources Investigations, of the 100-HR-3 Groundwater Operable Unit work plan (DOE-RL 1992b).

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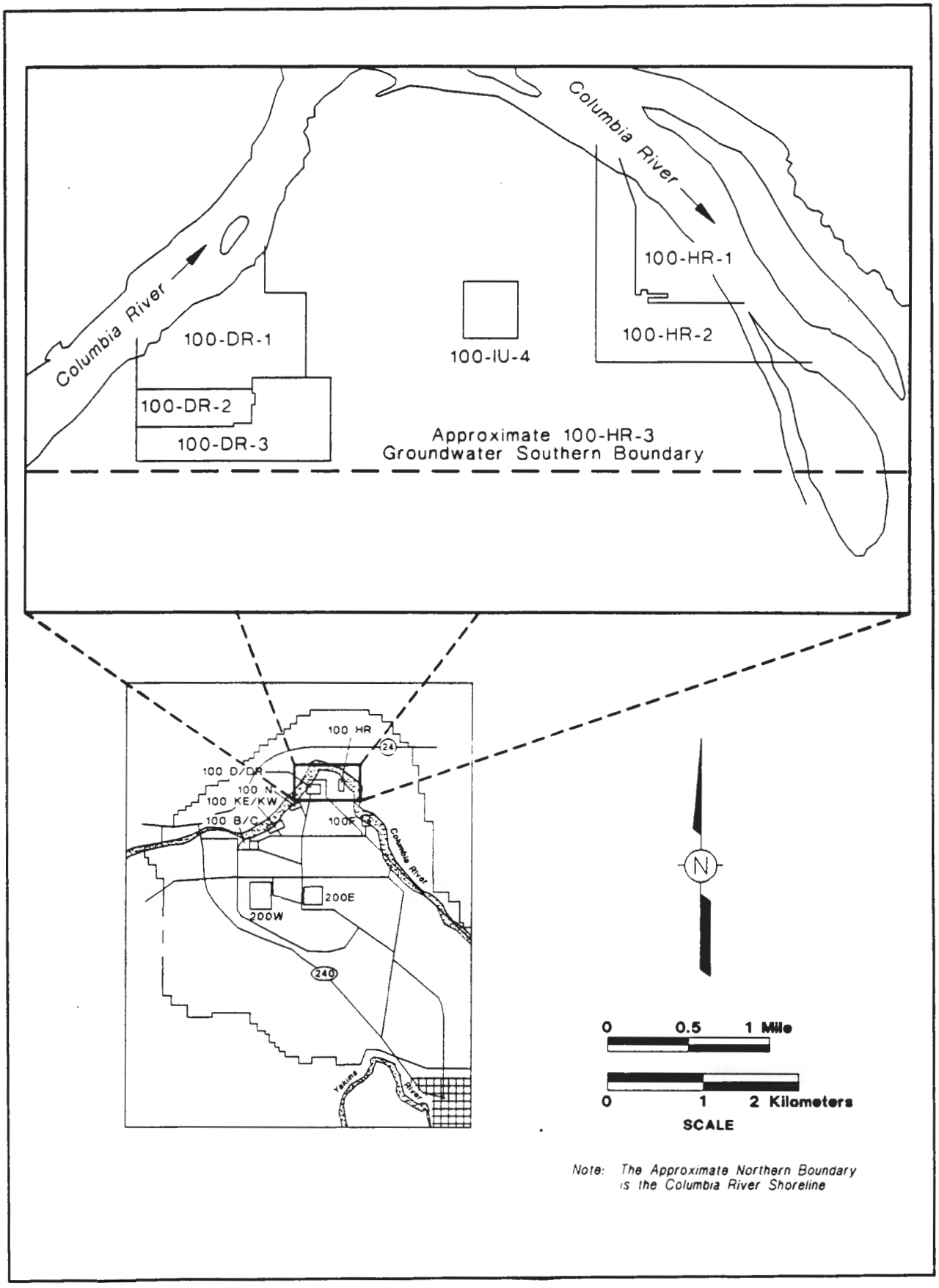
Figure 1-1 Map of the 100 D/DR and 100 H Areas Showing the Source and Groundwater Operable Units



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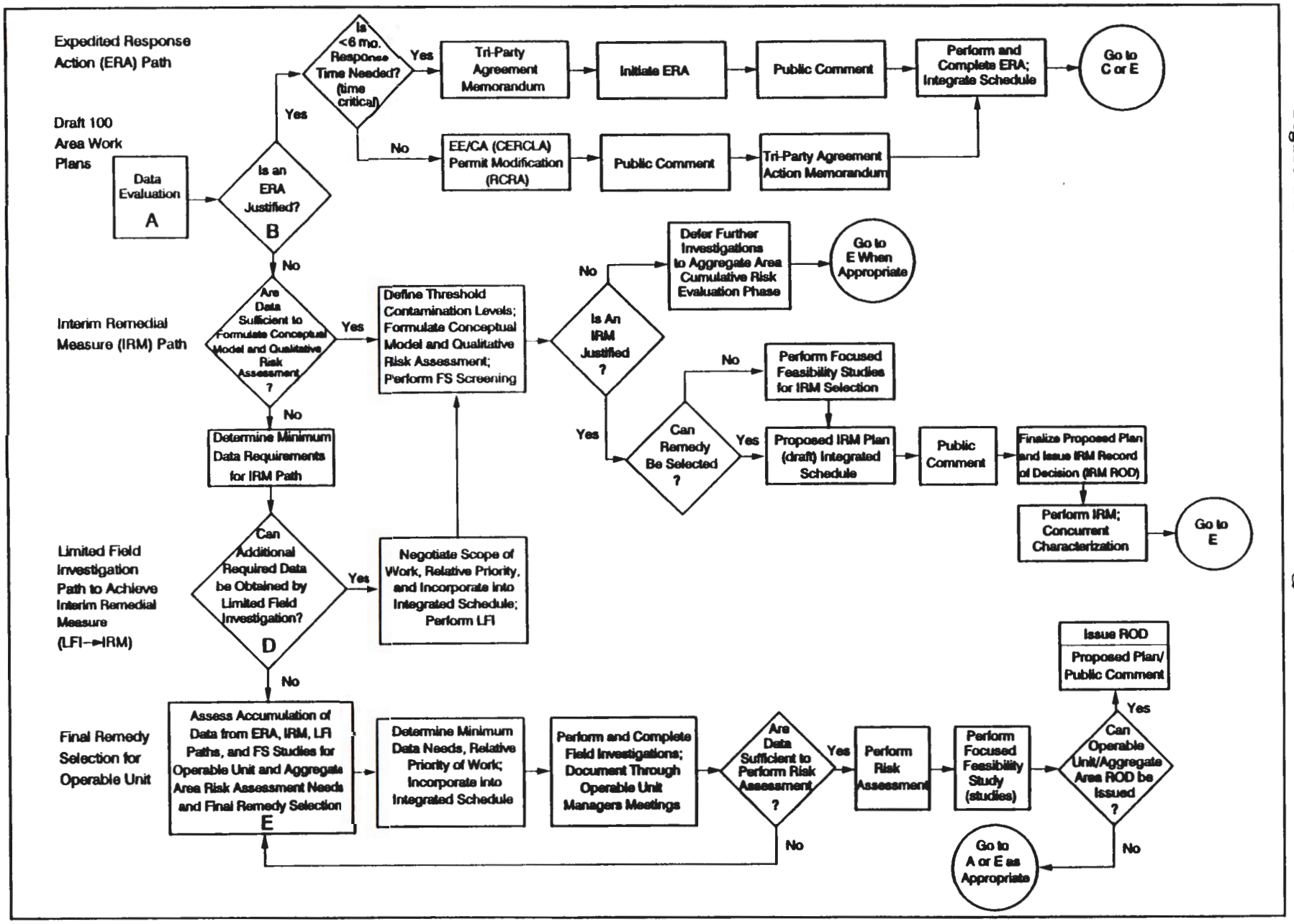

Figure 1-2 Hanford Site Past-Practice Strategy Decision Flow Chart

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Table 1-1 100-HR-1 Operable Unit Characterization Activities (page 1 of 2)

TASK	TITLE	WHERE ADDRESSED
1	Project Management	Accomplished throughout project
2	Source Investigation	See subtasks below
2a	Source Data Compilation and Review	Background information is incorporated into the work plan, QRA and LFI reports as appropriate.
2b	Surveying	Coordinates and locations of sampling sites are documented in the LFI report (Chapters 2 and 3).
2c	Field Activities	Field activities including site walkover, surface radiation survey, and source sampling are in the LFI report.
2d	Source Sample Laboratory Analysis and Data Validation	Analytical results and data validation are documented in data validation reports referenced in Chapter 2 of LFI report
2e	Source Data Evaluation	The data was evaluated for use in the QRA and also evaluated in the LFI report.
3	Geologic Investigation	Coordinated through the 100-HR-3 operable unit tasks.
4	Surface Water and Sediments Investigation	Not applicable to 100-HR-1
5	Vadose Zone Investigation	See subtasks below
5a	Data Compilation	See subtask 2a
5b	Borehole Soil Sampling and Logging	Results of the borehole investigations are presented in the LFI report (Chapter 3). Borehole logs are displayed in the figures in LFI report (Chapter 3).
5c	Soil Sample Analysis	The analysis and validation are documented in the data validation reports referenced in LFI report (Chapter 2).
5d	Geophysical Logging	The results of the geophysical logging are reported in the LFI report (Chapter 3).
5e	Data Evaluation	The data was evaluated for use in the QRA and also evaluated in the LFI report.

Table 1-1 100-HR-1 Operable Unit Characterization Activities (page 2 of 2)

TASK	TITLE	WHERE ADDRESSED
6	Groundwater Investigation	Performed as part of the 100-HR-3 operable unit activities.
7	Air Investigation	Routine health and safety monitoring was performed during the field activities.
8	Ecological Investigation	A discussion of the ecological investigation is included in the LFI report (Section 1.4.2).
9	Other Tasks	See subtask below
9a	Cultural Resource Investigation	A discussion of the cultural resource investigation is included in the LFI report (Section 1.4.3).
10	Data Evaluation	Evaluation and interpretation of the data is accomplished in the QRA and LFI reports. The evaluation of the data for other purposes such as Large Scale Remediation, FS activities and treatability testing is ongoing.
11	Risk Assessment	The data generated during the LFI was used in the QRA and will be used in the baseline risk assessment in the future.
11a	Human Health Evaluation	In the QRA and summarized in the LFI report (Chapter 4)
11b	Ecological Evaluation	In the QRA and summarized in the LFI report (Chapter 4)
12	Verification of Contaminant- and Location-Specific ARARs.	ARARs will be addressed in the FS report and FFS report. ARARs are also discussed in LFI report (Chapter 3).

ARAR - Applicable or Relevant and Appropriate Requirements
FS - Feasibility Study
FFS - Focused Feasibility Study
LFI - Limited Field Investigation
QRA - Qualitative Risk Assessment

Table 1-2 100-HR-1 Operable Unit High-Priority Sites and Low-Priority Sites

HIGH-PRIORITY SITES	LOW-PRIORITY SITES
116-H-1 Process Effluent Disposal Trench[a]	1607-H-2 Septic System[a]
116-H-2 Effluent Disposal Trench[a]	1607-H-4 Septic System[a]
116-H-3 Dummy Decontamination French Drain[a]	Electrical Facilities[a]
116-H-7 Process Effluent Retention Basin[a]	
116-H-9 Confinement Seal Pit Drainage Crib[a]	
116-H-5 Process Effluent Outfall Structure[b]	
Process Effluent Pipelines (Sludge)[c]	
Process Effluent Pipelines (Soil)	
116-H-7 Sludge Burial Trench	
132-H-3 Effluent Pumping Station[b]	
132-H-2 Exhaust Air Filter Building	
132-H-1 Reactor Exhaust Stack	
116-H-4 Pluto Crib	
116-H-6 Solar Evaporation Basins[d]	

[a] = Soil sampling conducted as part of the Limited Field Investigation
[b] = Additional data used from analogous site
[c] = Remote sensing performed on section of process effluent pipeline
[d] = 116-H-6 Solar Evaporation Basins are to be considered under RCRA Interim Status and are not further addressed in this document

Source: DOE-RL 1992a

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Table 1-3 Summary Statistics and Upper Threshold Limits (UTL) for Inorganic Analytes*

Analyte	95% Distribution[a] (mg/kg)	95% UTL[b] (mg/kg)
Aluminum	13,800	15,600
Antimony	NR	15.7[c]
Arsenic	7.59	8.92
Barium	153	171
Beryllium	1.62	1.77
Cadmium	NR	0.66[c]
Calcium	20,410	23,920
Chromium	23.4	27.9
Cobalt	17.9	19.6
Copper	25.3	28.2
Iron	36,000	39,160
Lead	12.46	14.75
Magnesium	7,970	8,760
Manganese	562	612
Mercury	0.614	1.25
Nickel	22.4	25.3
Potassium	2,660	3,120
Selenium	NR	5[c]
Silver	1.4	2.7
Sodium	963	1,290
Thallium	NR	3.7[c]
Vanadium	98.2	111
Zinc	73.3	79
Molybdenum	NR	1.4[c]
Titanium	3,020	3,570
Zirconium	47.3	57.3
Lithium	35	37.1
Ammonia	15.3	28.2
Alkalinity	13,400	23,300
Silicon	108	192
Fluoride	6.4	12
Chloride	303	763
Nitrite	NR	21[c]
Nitrate	96.4	199
Ortho-phosphate	3.7	16
Sulfate	580	1,320

*Source: DOE-RL, 1993b.
NR = Not reported.
[a]95th percentile of the data for a lognormal distribution.
[b]95 percent confidence limit of the 95th percentile of the data distribution.
[c]Limit of detection.

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2.0 INVESTIGATIVE APPROACH

The 100-HR-1 LFI process consisted of intrusive investigations, sampling and subsequent analysis, evaluation of data collected from analogous sites by LFIs at other 100 Area operable units, evaluation of historical data, and a QRA. The 100-HR-1 Source Operable Unit LFI included all the high-priority sites identified in the work plan (DOE-RL 1992a) and several low-priority sites. Intrusive sampling activities, in the form of drilling vadose zone boreholes, took place at the following high-priority sites:

- 116-H-1 process effluent disposal trench
- 116-H-2 effluent disposal trench
- 116-H-3 dummy decontamination French drain
- 116-H-7 process effluent retention basin
- 116-H-9 reactor confinement seal pit drainage crib

Analogous data from intrusive LFI investigations in the 100-DR-1 Source Operable Unit were applied to the LFI evaluation of the 116-H-5 outfall structure and to the 132-H-3 effluent pumping station. Non-intrusive investigations of the other 100-HR-1 high priority sites (116-H-7 sludge burial trench, 132-H-2 exhaust air filter building, 132-H-1 reactor exhaust stack, 116-H-4 pluto crib) relied on historical data such as that from past sampling and analysis (Dorian and Richards 1978) and process knowledge.

Sampling activities also took place at the following low-priority sites:

- 1607-H-2 septic tank
- 1607-H-4 septic tank
- Two inactive electrical facility sites

An investigation of a section of the process effluent pipeline using remote sensing equipment was also performed. Additionally, ground-penetrating radar (GPR) and radiological surveys were performed during a surface-area walkover of the 100-HR-1 Source Operable Unit. This chapter discusses the investigation techniques used at the high- and low-priority sites within the 100-HR-1 Source Operable Unit.

2.1 FIELD INVESTIGATION

Intrusive investigations of the 100-HR-1 Source Operable Unit LFI were performed using vadose borehole drilling through selected high-priority waste disposal sites. A test pit was constructed at the low-priority 1607-H-4 septic tank, and liquid and sludge sampling was performed at the low-priority 1607-H-2 septic tank. Surface soil sampling was performed at selected low-priority 100 Area electrical facilities where visible surface soil contamination by PCB was suspected.

The investigative methods are proven methods that allow appropriate sample extraction. Once the desired samples are taken, they are shipped off site for laboratory analysis and the results are then the analyses returned for validation and evaluation. (All samples shipped to off-site laboratories received a preshipping radiological characterization for total activity at the 222-S Laboratory on the Hanford Site.) The following sections describe the LFI process in detail.

2.1.1 Vadose Zone Boreholes

Five boreholes were advanced using cable tool drilling methods and sampled using split-spoon samplers (see Figure 2-1 for sampling locations). Cable tool equipment was used for this task due to the presence of gravel, cobbles, and boulders. Detailed procedures for drilling and sampling are described in the "Environmental Investigations and Site Characterization Manual, Resource Protection Well and Test Borehole Drilling" (EII) 6.7, (WHC 1991a).

The depth of each borehole was based on expected waste depth and field screening results for radionuclides and VOCs. Use of the field screening instruments is discussed in Section 2.4.

2.1.2 Low-Priority Sites

2.1.2.1 1607-H-2 Septic Tank. Five liquid samples and two sludge samples were taken from the 1607-H-2 septic tank for chemical and radionuclide analysis (see Figure 2-1 for tank location).

2.1.2.2 1607-H-4 Septic Tank. The liquid and sludge wastes at the 1607-H-4 septic tank could not be sampled directly, because the septic tank had been backfilled with a mixture of soil and large rocks. The size of both the fill material and the tank prevented installation of a borehole in the septic tank. As an alternative sampling method, a test pit was constructed in the tile/leach field consisting of two trenches in an "L" shape in the leach field immediately downstream from the septic tank. The first trench was excavated across the two drain legs of the leach field. The second trench was excavated along one of the two drain legs so that samples could be obtained from around the tiles. The trenches were excavated to a depth of approximately 4 feet (ft) (1.2 meters [m]) (see Figure 2-1 for tank location). Four soil samples were taken for chemical and radionuclide analysis during the test pit excavation.

2.1.2.3 Electrical Facilities. Surface-soil sampling was conducted at two inactive electrical facility sites within the 100-HR-1 Source Operable Unit, in an effort to determine if PCB contamination of the soil had occurred (see Figure 2-1 for electrical facility sampling locations). A total of eight surface soil samples were analyzed for PCB contamination during the investigation.

2.1.2.4 Surface-Area Walkover. Surface-area walkover surveys were conducted within the 100-HR-1 Source Operable Unit. These walkovers included a GPR survey of specific areas to help locate some of the high-priority sites and a radiological survey of the entire operable unit to identify areas of high radioactive surface contamination.

2.2 PHYSICAL PROPERTIES SAMPLING

Three physical properties samples were taken in support of "EPA Physical Sampling Criteria for the 100 Areas", Attachment 1 of the 100-HR-1 Operable Unit Work Plan (DOE-RL 1992a). The physical property samples were analyzed for the following parameters using American Society for Testing and Materials (ASTM) methods. Bulk density and K_{unsat} were calculated.

- bulk density
- particle size distribution (ASTM D422-63)
- moisture content (ASTM D2216)
- moisture retention (ASTM D2325-68, D3152-72)
- saturated hydraulic conductivity (K_{sat}) (ASTM D2434-68)
- unsaturated hydraulic conductivity (K_{unsat}) at 10% moisture content after full saturation.

2.3 GEOPHYSICAL DATA

2.3.1 Vadose Zone Boreholes

2.3.1.1 Borehole Logging. Logging with a high-resolution, high-purity germanium, passive, spectral gamma-ray system was performed on four vadose boreholes within the 100-HR-1 Source Operable Unit per EII 11.1, Geophysical Logging (WHC 1991a). The objective of the borehole surveys was to identify the presence of man-made gamma-emitting radionuclides and to support the analytical results from soil sampling of the boreholes. The complete results of the borehole logging can be found in *Spectral Gamma-Ray Log Report for the 100 Area Borehole Surveys* (WHC 1993b).

2.3.1.2 Ground-Penetrating Radar. GPR surveys were conducted at several of the high-priority sites within the 100-HR-1 Source Operable Unit. The purpose of the GPR surveys was to assist in determining the location and lateral extent of the waste sites. The surveys were conducted in accordance with EII 11.2, Geophysical Survey Work, Rev. 1 (WHC 1991a). The complete results of the GPR surveys are presented in *100-HR-1 Geophysical Surveys* (Mitchell and Kunk 1991).

2.3.2 Low-Priority Sites

Surface Radiological Survey. A radiological survey was conducted over the entire surface of the 100-HR-1 Source Operable Unit to measure gross gamma radiation levels of the surface soil (Beckstrom and Wade 1991). The purpose of the survey was to identify areas of radioactive surface contamination. The survey was conducted in accordance with the following procedures contained within the Health Physics Procedures Manual (WHC 1991b):

- Section 1.05, Ultrasonic Ranging and Data System: Connecting the Equipment, Rev. 0
- Section 1.06, Ultrasonic Ranging and Data System: Equipment Setup, Rev. 0
- Section 1.07, Ultrasonic Ranging and Data System: System Calibration, Rev. 0
- Section 1.08, Ultrasonic Ranging and Data System: Performing the Survey, Rev. 0.

Initially, a background level survey was performed off site to characterize background conditions. The entire operable unit surface was then surveyed. The operable unit was broken up into 200 by 200 ft (61 by 61 m) grid blocks. Each grid block was traversed on approximately 25 ft (7.6 m) transects (generally in the north-south direction). Closer transect spacing was implemented when significantly higher than background readings were encountered.

2.4 SOIL SCREENING

2.4.1 Vadose Zone Boreholes

All soil samples and cuttings from the five vadose boreholes were field screened for evidence of VOCs and radionuclides. If any of the field screening action levels were exceeded, soil sampling was to be initiated as specified in the applicable description of work (and summarized in Section 2.5.1 below). VOCs were screened using an organic vapor monitor (OVM) that was used, maintained, and calibrated consistent with EII 3.2, Health and Safety Monitoring Instruments, and EII 3.4, Field Screening (WHC 1991a). Radionuclides were screened by the field geologist using a Geiger-Mueller instrument, and all sample screening data were recorded on the borehole logs per EII 9.1, Geologic Logging (WHC 1991a).

The action level for radionuclide screening was set at twice the background level. The action level for VOCs was set at 10 parts per million (ppm) above background. The background levels were determined at the start of each shift, from ambient air, at a

chosen background site located near the Columbia River, generally north of the sampling location.

Total chromium screening was performed on samples from the bottom of each vadose borehole using a portable chromium test kit. Because the test method is currently under development, the screening was performed for informational purposes only; therefore, an action level was not set and the results were not used to make decisions in the field nor are they reported in this report.

The capabilities and the limitations of these field screening methods should be noted. The VOC field screening method provides an estimate of the vapor concentration resulting from subsurface contamination of VOCs. The detected concentration should be interpreted only in a semi-quantitative manner with more emphasis on relative values than on absolute values. Similarly, the Geiger-Mueller instrument generally detects gamma radiation only and will not detect alpha or low energy beta emissions. Again, the detected counts per minute should be interpreted as relative values rather than absolute values. As stated previously, the chromium screening kit is under development and results should be used for informational purposes only.

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2.4.2 Low-Priority Sites

2.4.2.1 1607-H-2 and 1607-H-4 Septic Tanks. Liquid, sludge, and soil samples were field screened for VOCs and radionuclides. VOCs were screened using an OVM, per EII 3.2, Health and Safety Monitoring Instruments (WHC 1991a). Radionuclide screening was performed using a Geiger-Mueller instrument with a P-11 probe. The action level for radionuclide screening was set at twice the background level. The action level for VOCs was set at 5 ppm above background. The background level was determined by the field team leader at a point 3 ft (1 m) above the sampling site before any disturbance of the area (e.g., opening the tank or excavation).

2.4.2.2 Electrical Facilities. Surface-soil samples taken at potential PCB contamination sites were screened for radioactivity.

2.5 SOIL SAMPLING

2.5.1 Vadose Zone Boreholes

Soil sampling intervals in the vadose boreholes were selected on the basis of field screening results and the predicted waste site target depths. Soil removed from the vadose borehole was screened continuously for VOCs and radioactivity. The borehole was deepened until either sediment was encountered that exceeded the field screening action level, or the maximum expected waste site target depth was reached. Once action levels were exceeded, sampling then continued at 5 ft (1.5m) intervals until either two consecutive sample intervals did not exceed the action level, or the borehole had reached

a depth 5 ft (1.5m) below the water table. If sediment did not exceed the action levels and the maximum expected waste site target depth had been reached, sampling continued at 5 ft (1.5m) intervals until two consecutive samples did not exceed the action levels.

Analytical samples were collected using 5-inch (12.7-centimeter [cm]) outside-diameter split-spoon samplers, per EII 5.2, Soil and Sediment Sampling (WHC 1991a). Geologic soil samples that passed the screening criteria in Section 2.4.1 were collected at 5-foot (1.5-m) intervals and were archived, per EII 5.7A, Hanford Geotechnical Sample Library Control (WHC 1991a).

The boreholes and their associated expected waste depths and estimated depth to groundwater, based upon process knowledge and historical data, are shown in Table 2-1.

2.5.2 Low-Priority Sites

2.5.2.1 1607-H-2 Septic Tank. Five water and two sludge samples were collected from the intact 1607-H-2 septic tank. Because the sampling was performed before there was a requirement for a description of work, the sampling technique was not documented.

2.5.2.2 1607-H-4 Septic Tank. Four analytical samples were collected directly from the backhoe bucket using hand tools and standard soil sampling techniques, per EII 5.2, Soil and Sediment Sampling (WHC 1991a). The bucket of the backhoe was cleaned of visible dirt before sampling and between sample locations. A bucket of soil was removed from the desired sampling interval and brought to the side of the test pit. Samples were collected from soil in the middle of the bucket, away from the bucket sides.

2.5.2.3 Electrical Facilities. Surface-soil samples were collected in accordance with EII 5.2, Soil and Sediment Sampling (WHC 1991a). Eight samples were taken from two locations in the 100-HR-1 Source Operable Unit. Sampling sites were selected based on signs of spills identified during visual inspections or at uncleared abandoned electrical facility sites.

2.6 SAMPLE ANALYSIS

All samples collected for chemical analysis were analyzed for the full suite of radionuclides and CERCLA Contract Laboratory Program (CLP) target compound list (TCL) and target analyte list (TAL) constituents. The CLP TCL constituents are VOCs, semi-volatile organic compounds, pesticides, and PCBs. The CLP TAL constituents include metals and cyanide. Chemical analysis was conducted using CLP methods. Appendices A and B present a summary of the analytical data set. Table 2-2 presents the location, depth, and assigned laboratory for each sample taken as part of the vadose zone borehole investigation. Figure 2-1 shows relative borehole locations. Tables 2-3

and 2-4 present the location and assigned laboratory for the samples taken at the low-priority sites.

Samples from electrical facilities were analyzed for PCBs following CLP protocols using EPA SW-846 Method 8080 (EPA 1986).

Analytical methods, routine analytical detection and quantitation limits, and precision and accuracy specified for the methods are listed in Table QAPjP-1 of the Quality Assurance Project Plan in the 100-HR-1 Operable Unit Work Plan (DOE-RL 1992a).

2.7 DATA VALIDATION

Data validation was performed by a qualified independent participant contractor. The validation responsibilities are defined in associated statements of work. All data validation was performed in compliance with Westinghouse Hanford *Sample Management and Administration Manual* WHC-CM-5-3 (WHC 1990), Section 2.2 for organics analyses, Section 2.1 for inorganics analyses, and Sections 2.3 and 2.4 for radionuclide analyses. All data packages were assessed. Most of the chemical and radionuclide data were validated (data from sample number B05WV5 were not validated). The physical property data were not validated. The following reports present the data validation process:

- *Data Validation Report for the 100-HR-1 Operable Unit Vadose Boreholes*, (WHC 1992a)
- *Data Validation Report for the 100-HR-1 Operable Unit H-2 Septic Samples*, (WHC 1992b)
- *Data Validation Report for the 100-HR-1 Operable Unit H-4 Septic Samples*, (WHC 1992c)
- *Data Validation Report for the 100-HR-1 Operable Unit Electrical Facilities*, (WHC 1992d).

In addition to the data validation identified above, the LFI data were evaluated for use in the LFI and QRA. The first step in the data evaluation process was to develop a detailed inventory of all samples collected for the LFI. This information was gathered from the project sample list, borehole logs, sample tracking sheets, and sample location maps. Multiple information sources were reviewed, as no one source contained all required information.

The second step was to compile and review the analytical data. This was done to verify that validation results are incorporated into the analytical database and that data qualifiers are listed. Rejected data were assigned the qualifier "R." Data rejected for major quality deficiencies (e.g. technical concerns) were not used; however, data rejected

for administrative reasons (missing documentation) were used. Data sources were Hanford Environmental Information System (HEIS), CLP analysis data disks, validated analytical reports, i.e., "form 1" sheets, and CLP data packages.

The third step was to review trip, equipment, and field blank data to determine if sample data detections were due to sources other than media contamination. This review was conducted using the EPA's "five or ten times rule." The ten times rule applies to common laboratory contaminants, e.g., methylene chloride, acetone, toluene, 2-butanone, and common phthalate esters. Detected concentrations of common lab contaminants had to be greater than 10 times their corresponding blank value to be considered valid. Detected concentrations of other contaminants had to be greater than five times their corresponding blank value to be considered valid (EPA 1986).

One result of the data evaluation and validation process is the assignment of data qualifier letter codes to individual analytical results. The following qualifier letter codes were applied to data from the LFI investigation:

- "U" indicates that the analyte was analyzed for and not detected. The numerical value reported is the contract required detection limit (CRDL) or the contract required quantitation limit (CRQL). CRDLs apply to EPA CLP protocol analyses of inorganic constituents and to detection limits established by WHC for radionuclide analyses. CRQLs apply to EPA CLP protocol analyses of organic constituents. Sample quantitation limits and sample detection limits may be lower or higher than CRQLs or CRDLs, depending on instrumentation, matrix, and concentration factors.

- "J" indicates that the analyte was analyzed for and detected. The concentration reported is an estimate due to identified quality control (QC) deficiencies. For example, if the amount present is less than either the CRDL or CRQL, the concentration reported is considered an estimated value.

- "UJ" indicates the analyte was analyzed for and not detected and the detection or quantitation limit for the sample can only be estimated due to identified QC deficiencies.

- "JN" indicates the analyte was analyzed for and that there is presumptive evidence for the presence of the analyte. The concentration reported is considered an estimate usable only for information purposes.

- "E" indicates the analyte was analyzed for and detected at a concentration outside the calibration range of the instrument. The reported concentration is an estimate possibly containing significant error.

- "R" indicates that the data were rejected during validation because of quality assurance problems.

- "B" indicates that the analyte was detected in the sample and in the blank associated with the sample.

Data marked with "J" or "R" qualifiers were used for the LFI and QRA as indications of contamination present, as were data that had no qualifiers attached. Data that were marked with "U" or "UJ" qualifiers were not used indicating no contamination present above detection limits. Data that were marked with "B" qualifiers were evaluated using the EPA five and ten times rule to assess if they were usable.

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Figure 2-1 100-HR-1 Sampling Locations

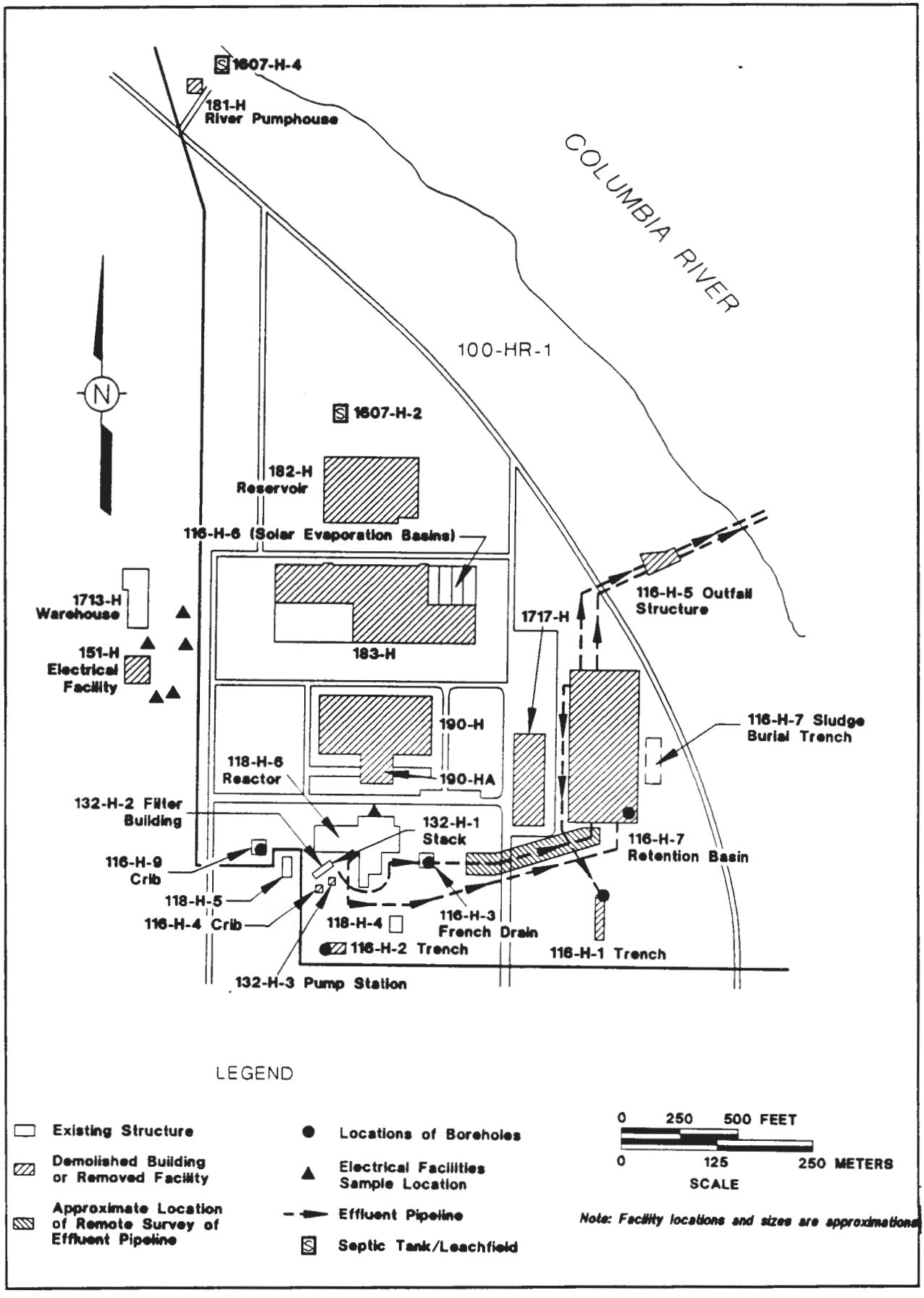

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Table 2-1 Borehole Expected Waste Depths[a]

Borehole Number	Expected Waste Depth (below ground surface)		Estimated Depth to Groundwater	
	(ft)	(m)	(ft)	(m)
116-H-1	10	3	55	16.8
116-H-2	10	3	35	10.7
116-H-3	15	4.6	35	10.7
116-H-7	10	3	55	16.8
116-H-9	10	3	35	10.7

[a]WHC, 1991c.

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Table 2-2 Vadose Zone Boreholes - Sample Collection Information

Location[a]	Sample Number	Depth (ft)	Sample Type	Laboratory[b]	Date Sampled	Comments
116-H-1 (N95,039.4; W38,608.8)	B05WV5	10.0 - 12.0	Soil	TMA	3/9/92	
	B05WV6	13.6 - 15.6	Soil	TMA	3/9/92	
	B05WV7	13.6 - 15.6	Soil	WESTON	3/9/92	Split with B05WV6
	B05WV8	15.0 - 17.0	Soil	TMA	3/9/92	
	B05WV9	16.5 - 17.8	Soil	TMA	3/10/92	
	B05WW0	19.3 - 20.8	Soil	TMA	3/11/92	
	B05WW4	24.0 - 25.1	Soil	TMA	3/11/92	
116-H-2 (N94,866.9; W39,714.3)	B05WW5	9.9 - 12.1	Soil	TMA	3/13/92	
	B05WW6	14.9 - 17.2	Soil	TMA	3/16/92	
	B05WW7	14.9 - 17.2	Soil	TMA	3/16/92	Duplicate with B05WW6
116-H-3 (N95,129.6; W39,372.4)	B05WP1	14.5 - 16.3	Soil	TMA	3/4/92	
	B05WP5	19.6 - 21.7	Soil	TMA	3/5/92	
116-H-7 (N95,429.8; W38,515.3)	B05WT8	1.0 - 3.0	Soil	TMA	2/27/92	
	B05WT9	8.0 - 10.0	Soil	TMA	2/28/92	
	B05WV2	9.8 - 12.4	Soil	TMA	3/2/92	
	B05WV3	14.8 - 16.4	Soil	TMA	3/2/92	
	B05WV4	19.2 - 20.8	Soil	TMA	3/2/92	
116-H-9 (N95,055.9; W40,107.2)	B05WN8	3.1 - 5.3	Soil	TMA	2/26/92	
	B05WN9	17.6 - 20.1	Soil	TMA	2/27/92	
	B05WP0	21.7 - 24.2	Soil	TMA	2/27/92	

[a]Hanford site coordinates of borehole in parentheses.
[b]TMA = Thermo Analytical Laboratories, Richmond, California.
WESTON = Weston Laboratory, Lionville, Pennsylvania.

Table 2-3 Septic Tanks - Sample Collection Information

Location	Sample Number	Sample Type	Laboratory[a]	Date Sampled	Comments
1607-H-2	B00ZM6	Sludge	TMA	6/25/91	
	B00ZM7	Sludge	TMA	6/25/91	
	B01605	Liquid	TMA	6/25/91	
	B01606	Liquid	TMA	6/25/91	
	B01607	Liquid	TMA	6/25/91	
	B01608	Liquid	TMA	6/25/91	
	B01609	Liquid	TMA	6/25/91	
1607-H-4	B07206	Soil	TMA	8/3/92	
	B07207	Soil	WESTON	8/3/92	Split with B07206
	B07208	Soil	TMA	8/3/92	Duplicate with B07206
	B07209	Soil	TMA	8/3/92	Trip Blank
	B07210	Soil	WESTON	8/3/92	Trip Blank
	B07211	Soil	TMA	8/3/92	

[a]TMA = Thermo Analytical Laboratories, Richmond, California.
WESTON = Weston Laboratory, Lionville, Pennsylvania.

Table 2-4 Electrical Facilities - PCB Sample Collection Information

Location	Sample Number	Sample Type	Laboratory[a]	Date Sampled	Comments
105-H, 152 JIH	B018S5	Soil	DCHM	12/09/91	
151-H, S-EAST-MAIN	B018S6	Soil	DCHM	12/09/91	
151-H, SOUTH	B018S7	Soil	DCHM	12/09/91	
151-H, S-WEST-COR	B018S8	Soil	S^3	12/09/91	
151-H, S-WEST-COR	B018S9	Soil	DCHM	12/09/91	Duplicate of B018S8
151-H, WEST	B018T0	Soil	DCHM	12/09/91	
151-H, N-EAST-MAIN	B018T1	Soil	DCHM	12/09/91	
151-H, N-EAST-MAIN	B018T2	Soil	DCHM	12/09/91	Split with B018T1

[a] DCHM = Data Chem Laboratories.
S^3 = Maxwell Laboratories, S-Cubed Division.

3.0 INVESTIGATION RESULTS AND CONCLUSIONS

This chapter presents results and conclusions from background sampling and the LFI results for each of the sites investigated. Section 3.1 discusses the background sampling. Sections 3.2 through 3.6 presents the results of the intrusive investigation at five high-priority sites. Section 3.7 presents the results of non-intrusive investigations at the rest of the high-priority sites. Section 3.8 presents the results of the investigations at the low-priority sites. Section 3.9 provides a summary of potentiall ARARs for the 100-HR-1 Operable Unit.

The following types of data are presented in discussions of the sites:

- Site location, size, characteristics, history, and expected contaminants
- Geologic data obtained during the investigation
- Analytical results from off-site laboratories including analyses of inorganic contaminants (metals), VOCs, semi-volatile organic compounds, pesticides, PCBs, and on-site laboratory analyses of physical properties.
- Radionuclide analytical results from off-site laboratories
- Field screening data collected using hand-held instruments during sampling
- Borehole spectral gamma geophysical logging results
- Analysis of data collected at sites that are analogous to 100-HR-1 sites by other 100 Area Source Operable Unit LFIs
- Results of the comparison of data collected during the 1992 LFI and historical data from previous investigations at the site.
- Concentrations of Sr-90 and Tc-99 and gross alpha levels in groundwater from monitoring wells near the high-priority sites are reviewed to assess the potential impact on groundwater in the groundwater uppermost unconfined aquifer. These data were obtained during the 100-HR-3 Operable Unit LFI.

Conclusions reached about each site are also presented in this chapter.

3.1 BACKGROUND SAMPLING

3.1.1 General Hanford Sitewide Background Data

The natural soil composition at the Hanford Site has been reported in previous studies (DOE-RL 1993a). The characterization effort involved the determination of the types and concentrations of nonradioactive analytes that exist naturally in the soils on the Hanford Site. The Hanford sitewide approach to chemical background levels of soils is based on the premise that all waste sites are part of a common sequence of vadose zone sediments, and the basic characteristics that control the chemical composition of the sediments are similar throughout the Hanford Site. The range of natural soil compositions was used to establish a single set of soil background data to identify inorganic contaminants of potential concern, a necessary step in the environmental restoration process.

Based on the data presented in the Hanford Site background report (DOE-RL 1993a), a table of the 95 percent UTL, based on a lognormal distribution, for inorganic analytes was generated (Table 3-1). This table is used as a screening tool to identify potential contaminants of concern in both the QRA (WHC 1993a) and this LFI report.

Hanford sitewide background levels for organic and radionuclide analytes are not included in the Hanford Site background report (DOE-RL 1993a). Any detection of organic compound above the contract required quantitation limits is considered a contaminant of potential concern.

3.1.2 Local Background Data

No specific background data exists for the 100-HR-1 Source Operable Unit. Local background sampling of ambient air concentrations was performed during the drilling of the five vadose zone boreholes in order to determine the background levels for radioactivity and VOCs during field screening. The background levels for radioactivity taken in the field ranged from 50 to 75 counts per minute (CPM) using a Geiger-Mueller beta-gamma detector. The VOC background levels indicated concentrations at less than detectable limits. These background levels were taken daily at a background site located generally north of the operable unit, near the river, and outside of the 100-HR-1 Source Operable Unit site.

3.2 116-H-1 PROCESS EFFLUENT DISPOSAL TRENCH

The 116-H-1 process effluent disposal trench was located directly south of the 116-H-7 retention basin, in the southeast corner of the 100-HR-1 Source Operable Unit (Figure 2-1). It was approximately 300 ft (91 m) long, 100 ft (30 m) wide, and 15 ft (4.6 m) deep (DOE-RL 1991b). From 1952 to 1954, the trench served as an emergency disposal crib for process effluent contaminated by fuel element ruptures. Radionuclide

contaminants in this effluent included fission products such as Sr-90, Tc-99, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, and transuranics such as Pu-238, Pu-239, Pu-240, and Am-241. When ruptures occurred, process effluent was diverted from the 116-H-7 retention basin to this facility to prevent direct discharge of the highly contaminated waste stream to the Columbia River. After 1954, the trench was no longer used for process effluent. In 1965, when the 100 H Area was deactivated, sludge taken from the 116-H-7 retention basin was disposed of in the trench. Currently, the site is covered with clean gravel.

In addition to radionuclide contamination from the 116-H-7 retention basin sludge, approximately 200 pounds (lb) (90 kilograms [kg]) of sodium dichromate were disposed of (mixed with effluent water) in the 116-H-1 trench over its lifetime.

3.2.1 Geology

This site is characterized by sandy gravel fill to a depth of 13.6 ft (4.1 m) below ground surface (bgs). Below the fill is gravel and sand from 13.6 to 25.7 ft (4.1 to 7.8 m) bgs, the total depth of the borehole. The contact between the fill material and the native soil is characterized by a change in soil color and particle size distribution (Figure 3-1).

3.2.2 Soil Samples

3.2.2.1 Chemical Analysis. Laboratory analysis results of soil samples taken between 10 and 17.8 ft bgs indicated three inorganic contaminants above the 95 percent UTL level. These contaminants were arsenic, found between 10 and 15.6 ft (3.0 and 4.8 m) bgs; chromium, found between 16.5 and 17.8 ft (5.0 and 5.4 m) bgs; and lead, found between 10 and 17.8 ft (3.0 and 5.4m) bgs. Samples taken above 10 ft (3.0 m) and below 17.8 ft (5.4 m) did not contain elevated levels of inorganic analytes. Table 3-2 shows the contaminant levels at the various depths.

The VOC and semi-volatile organic contaminants detected in the samples taken from the 116-H-1 vadose zone borehole are presented in Tables 3-3 and 3-4. The VOCs presented in Table 3-3 are typical of laboratory contaminants. None of these typical laboratory contaminants were detected in the laboratory blank or the split sample associated with the sample taken between 13.6 and 15.6 feet. The analytical data for the sample taken between 10.0 and 12.0 feet was not validated, and no laboratory blanks are associated with it. Other sets of samples analyzed at the same laboratory during the same time period did have these analytes detected in their associated laboratory blanks. It is probable that these detections of acetone, methylene chloride, and toluene are laboratory anomalies.

Eleven semivolatile polynuclear aromatics (PNA) were detected (Table 3-4). The source of these PNA contaminants is unclear, since the contaminants are not generally associated with the processes that generate the wastes disposed of in the 116-H-1 trench. However, the PNAs may be associated with coal tars (sometimes used to coat pipes to

control corrosion) or creosote (commonly used as a wood preservative) (Ekambaram et al. 1988).

No pesticides were detected in the soil samples taken from the 116-H-1 vadose zone borehole.

The complete results of the chemical analyses for the samples taken from the 116-H-1 borehole are presented in Table A-1, Appendix A.

3.2.2.2 Radionuclide Analysis. The results of the radionuclide analysis of the soil samples taken from the 116-H-1 vadose zone borehole are presented in Table 3-5. The highest concentrations of radionuclide contamination are generally found in samples taken from between 10 and 17.8 ft (3.0 and 5.4 m) bgs and include Co-60, Sr-90, Tc-99, Cs-137, Eu-152, and Eu-154. The complete results of the radionuclide analyses for the samples taken from the 116-H-1 borehole are presented in Table A-6, Appendix A.

3.2.2.3 Field Screening. Continuous field screening for VOCs and radionuclides was performed at each of the five vadose zone boreholes by the field geologist. VOC screening was performed using an OVM, while radionuclide screening was performed with a Geiger-Mueller instrument. No VOC concentrations above the action level (10 ppm above background) were detected during the drilling and sampling of the 116-H-1 borehole. Radionuclide screening found activity above the action level (twice the background level of 50 CPM) from 13.6 ft to 18.9 ft (4.1 to 5.8 m) bgs. The field screening values are shown in Figure 3-1 and range from 85 CPM to 1500 CPM, with the peak being at a depth of 16.5 ft (5.0 m).

3.2.2.4 Geophysical Borehole Logging. Geophysical logging using a spectral gamma-ray system was performed on the vadose zone boreholes included in this LFI. The results of the logging on the 116-H-1 borehole indicated the presence of Co-60 from 9 to 17 ft (2.7 to 5.2 m) bgs. The maximum Co-60 decay activity detected was 30 picocuries per gram (pCi/g) at a depth of 15 ft. Cesium-137 was detected from the surface to a depth of 18 ft (5.5 m). The maximum Cs-137 decay activity detected was 100 pCi/g at 15 ft (4.8 m) bgs. Europium-152 was encountered in the borehole survey from the surface to the maximum survey depth of 21 ft (6.4 m) bgs. The maximum Eu-152 decay activity was over 200 pCi/g between 14 and 16 ft (4.3 and 4.9 m) bgs. Europium-154 was detected from 10 to 17 ft (3.0 to 5.2 m) bgs, with a peak activity of 60 pCi/g at 15 ft (4.8 m) bgs.

3.2.3 Physical Properties Sample

Three samples were taken in conjunction with the 116-H-1 borehole investigation for physical properties analysis. The samples were analyzed as described in Section 2.2

3.2.3.1 Sampling Data. Split tube samples were collected from borehole 116-H-1 at 12.7 - 13.7 ft, 20.5 - 21.5 ft, and 24.5 - 25.5 ft bgs. The first sample was taken from material described by the field geologist as sandy gravel fill. The second sample was taken in a sandy gravel material below the fill. The third sample was taken at the

bottom of the hole in gravelly sand. All three samples were collected in the vadose zone and all samples were described as dry.

3.2.3.2 Discussion of Physical Properties. Laboratory sieve analyses showed that the sediment grain size in the 12.7 to 13.7 ft interval consisted of 59% gravel, 24% sand, and 17% silt and clay. The sediment grain size in the 20.5 to 21.5 ft interval consisted of 47% gravel, 42% sand, and 11% silt and clay. The sediment grain size in the 24.5 to 25.5 ft interval consisted of 42% gravel, 43% sand, and 15% silt and clay. The specific gravity (sG) was determined for both the coarse and fine fraction of the samples. The average sG for the three sample intervals was 2.73. The bulk density for each sample was 1.89 g/cc, 2.20 g/cc, and 2.02 g/cc in order of increasing depth of sample.

The moisture content of the samples was 4.28%, 1.34%, and 2.80% in order of increasing depth of the sample location.

The saturated hydraulic conductivity varied from 2.0 E-04 to 4.1 E-04 cm/s; these values are quite low for sandy gravels. The low hydraulic conductivity could be the result of the high silt and clay content reported by the grain size analysis.

The porosity of the soil samples ranged from a low of 20.63% for the 20.5 - 21.5 ft sample to a high of 30.73% for the 12.7 - 13.7 ft sample with the 24.5 - 25.5 ft sample having a porosity of 25.60%.

3.2.4 Conclusions

The 116-H-1 process effluent disposal trench area is contaminated with both inorganic (arsenic, chromium, and lead) and semivolatile organic chemical contaminants (PNAs) as well as man-made radionuclides. Based on both the LFI data and the historical data (Dorian and Richards 1978), the contamination appears to be limited to a depth of 23 ft (7.0 m) bgs. The levels of radionuclide contamination detected as a result of the LFI are approximately an order of magnitude less than the levels that were previously reported by Dorian and Richards (1978) (Table 3-5). Figure 3-1 compares the various types of LFI data that were collected for the 116-H-1 disposal trench and the historical data. Since the historical data are limited to radionuclide analysis only, a direct comparison of LFI inorganic or organic contaminant data is not possible.

Three sites analogous to the 116-H-1 site are located in other 100 Area source operable units have been examined thus far by LFIs. These are 116-DR-1, 116-DR-2, and 116-B-1. To assess the concept that these sites are analogous, a comparison of radionuclide and chemical analytical results from the LFI samples was performed. The analytical data are compiled in the LFI reports for each operable unit (DOE-RL 1993c and DOE-RL 1993e) The radionuclide contaminants present in samples from the four sites are similar. Chromium is a contaminant, i.e., present in concentrations greater than the 95% UTL, in three of the four sites. Chromium is not a contaminant at the 116-DR-2 site, but cadmium and silver are. At site 116-DR-1, chromium and silver are contaminants. Lead was not found to be a contaminant at any of the other sites.

Volatile organic compounds were found at all four sites. The compounds detected are toluene, acetone, and methylene chloride. Semi-volatile compounds were detected in three of the four sites, but there was little consistency of compounds between the sites. No PCBs or pesticides were found at the four sites.

3.2.5 Groundwater Assessment

Monitoring wells H4-13 and H4-45, constructed and sampled as part of the 100-HR-3 Groundwater Operable Unit LFI (DOE-RL 1993d) have elevated levels of Sr-90 relative to upgradient wells (33 and 13 pCi/liter respectively). These two wells are located northeast (side gradient) of the 116-H-1 process effluent disposal trench. The 116-H-1 site had elevated levels of Sr-90 detected in the soil. There is no clear indication that the site is having a current impact to the groundwater.

3.3 116-H-2 EFFLUENT DISPOSAL TRENCH

The 116-H-2 trench is situated outside the H Reactor building security fence in the far southwestern corner of the 100-HR-1 Source Operable Unit, directly south of the H Reactor building (Figure 2-1). The trench measures 275 ft (84 m) long, 100 ft (30 m) wide, and 6 ft (1.8 m) deep. Decontamination wastes generated during reactor shutdown and standby periods were disposed of in this unit. The wastes were collected in the 132-H-3 effluent pumping station sumps and pumped to the 116-H-2 disposal trench. The trench was used from 1953 until its retirement in 1965, at which time it was covered to grade with soil (Stenner et al. 1988). Approximately 1,300 lb (600 kg) of sodium dichromate were disposed of in this trench.

3.3.1 Geology

This site is characterized by gravelly sand fill (approximately 20 percent gravel) to a depth of 12.2 ft (3.7 m) bgs. From 12.2 to 18.2 ft (3.7 to 5.5 m) bgs (the total depth of the borehole) the material is sandy gravel, with up to 60 percent gravel (Figure 3-2). All the material encountered during drilling is probably fill material.

3.3.2 Soil Samples

3.3.2.1 Chemical Analysis. The laboratory analysis of samples taken from the 116-H-2 borehole did not indicate any inorganic contaminant concentrations above the 95 percent UTL. There were no VOC, semivolatile organic, or pesticide contaminant detections. The complete results of the chemical analyses for the samples taken from the 116-H-2 borehole are presented in Table A-2, Appendix A.

3.3.2.2 Radionuclide Analysis. In the soil samples taken from the borehole, four radionuclides were detected; U-238, Ra-226, Th-228, and Th-232. The concentrations of

radionuclide analyses for the samples taken from the 116-H-2 borehole are presented in Table A-7, Appendix A.

3.3.2.3 Field Screening. During continuous field screening of the 116-H-2 borehole, no VOC concentrations above the action level (10 ppm above background) were detected, nor was radionuclide activity above the background level of 50 CPM detected.

3.3.2.4 Geophysical Borehole Logging. Logging with a spectral gamma-ray system was performed on the 116-H-2 borehole. No man-made radionuclides (Co-60, Cs-137, Eu-152, and Eu-154) were detected in the borehole.

3.3.3 Conclusions

The 116-H-2 effluent disposal trench does not contain any inorganic contaminants above the 95 percent UTL, nor organic or pesticide contaminants. Small amounts of radionuclides (naturally occurring isotopes) were detected. However, Dorian and Richards (1978) reported radionuclide contamination (including H-3, Co-60, Sr-90, Cs-137, Eu-152, Eu-154, Eu-155) of up to 77 pCi/g at depths of 1 to 10 ft (0.3 to 3.0 m) bgs at this site. This historical data is inconsistent with the LFI data reported here. Figure 3-2 presents a comparison of the various types of LFI data that were collected for the 116-H-2 disposal trench.

The vadose zone borehole was drilled in the southwest corner of the 116-H-2 site. This location was chosen based on discussions at meetings with regulators that considered lateral extent of the site, access, etc. It is possible that a second borehole, located near the center of the trench, would detect contamination at similar levels to that detected by Dorian and Richards (1978).

Sample analysis does not indicate the presence of sodium dichromate in the soil column. The contaminant may have been flushed through the soil to the groundwater. Or, as discussed above, the lack of detection may be associated with the borehole location.

There are no directly analogous sites to the 116-H-2 effluent disposal trench.

No specific conclusions can be drawn concerning the level of contamination at this site due to the inconsistency between the results of the field data and the historical data. The historical data was used in the development of the QRA to be conservative. The inconsistencies between the field and historical data do not assist in generating an accurate conceptual model of the site.

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3.3.4 Groundwater Assessment

Results from sampling at monitoring well H4-46, located down gradient from the 116-H-2 site, did not indicate any Sr-90, Tc-99, or gross alpha contamination. The 116-H-2 site does not appear to be having an impact on the groundwater.

3.4 116-H-3 DUMMY DECONTAMINATION FRENCH DRAIN

The 116-H-3 dummy decontamination French drain is a vertical leaching drain located within the H Reactor building security fence, directly east of the reactor building (Figure 2-1). The drain is 3 ft (0.9 m) in diameter, approximately 15 ft (4.6 m) deep and is made of vitreous tile conduit. From 1950 to 1965, wastes generated during decontamination of fuel-element spacers were transferred to this drain for disposal. Approximately 4,400 lb (2,000 kg) each of sodium dichromate, sodium oxalate, and sodium sulfamate were disposed of in the 116-H-3 drain (WHC 1993a). The drain is presently covered to grade with soil.

3.4.1 Geology

This site is characterized by sandy gravel fill to a depth of approximately 21.7 ft (6.6 m) bgs, the total depth of the borehole. A minor change in soil color occurs between 6 and 10 ft (1.8 and 3.0 m) bgs, but there is not enough change in other soil properties to determine if there is a fill/native soil contact represented here (Figure 3-3). All the material encountered in the borehole may be fill material.

3.4.2 Soil Samples

3.4.2.1 Chemical Analysis. The laboratory analysis of samples taken from the 116-H-3 vadose zone borehole (located near the southeast corner of the 116-H-3 site) showed no inorganic contaminant levels above the 95 percent UTL. There were no VOC, semivolatile organic, or pesticide contaminants detected. The complete results of the chemical analyses for the samples taken from the 116-H-3 borehole are presented in Table A-3, Appendix A.

3.4.2.2 Radionuclide Analysis. Seven radionuclides were detected in the soil samples from the 116-H-3 borehole (see Table 3-7). The radionuclides detected were Co-60, Eu-152, Ra-226, Th-228, Th-232, U-233/234, and U-238. All were detected at levels of < 1 pCi/g. The complete results of the radionuclide analyses for the samples taken from the 116-H-3 borehole are presented in Table A-8, Appendix A.

3.4.2.3 Field Screening. No levels of VOCs above the action level (10 ppm above background) were detected during continuous field screening of the 116-H-3 borehole. There also was no radionuclide activity detected above the background level of 75 CPM.

3.4.2.4 Geophysical Borehole Logging. Logging was performed on the 116-H-3 borehole using a spectral gamma-ray system. Small amounts of man-made radionuclides (Co-60,

Eu-152, and Eu-154) were detected in the borehole. Cobalt-60 was encountered in two intervals in the survey; from the surface to 1 ft (0.3 m) and from 12 ft (3.7 m) to the maximum survey depth of 18 ft (5.5 m) bgs. The activity detected was less than 1 pCi/g. Similarly, Eu-152 was detected at activity levels of less than 5 pCi/g in two intervals—from the surface to 1 ft (0.3 m) and from 11 to 18 ft (3.6 to 5.5 m) bgs. Europium-154 was detected between 12 and 16 ft (3.7 and 4.9 m) bgs. The detected activity was not continuous and was less than 1 pCi/g. Cesium-137 was not detected in the borehole.

3.4.3 Conclusions

There is no indication of inorganic or organic contamination at the 116-H-3 dummy decontamination French drain. There is, however, some indication of radionuclide contamination both near the surface and at depth at the site. One soil sample, the spectral gamma-ray borehole logging, and the historical data from Dorian and Richards (1978) indicate the presence of relatively small amounts of radionuclide contamination between approximately 12 and 18 ft (3.7 and 5.5 m) bgs. The gamma-ray logs indicate traces of radionuclide contamination (Co-60 and Eu-152) near the surface. Figure 3-3 presents a comparison of the various types of LFI data that were collected for the 116-H-3 drain and detections of contaminants from the historical data.

Sample analysis does not indicate the presence of the sodium dichromate in the soil column. The contaminant may have been flushed through the soil to the groundwater.

No sampling was performed at the analogous 116-B-4 dummy decontamination French drain site as part of an LFI making comparison of data at the two sites impossible.

3.4.4 Groundwater Assessment

Based on limited results from sampling at monitoring well H4-47, located down gradient from the 116-H-3 site, the site does not appear to be having an impact to the groundwater.

3.5 116-H-7 PROCESS EFFLUENT RETENTION BASIN

The 116-H-7 process effluent retention basin is located in the southeast corner of the 100-HR-1 Source Operable Unit and is now enclosed within a chain-link security fence (Figure 2-1). This double-celled basin received process effluent (primarily cooling water effluent) from the H Reactor. The basin was 600 ft (183 m) long, 273 ft (83.2 m) wide, and 20 ft (6 m) deep (extending approximately 14 ft above the ground surface) with a capacity of approximately 25,000,000 gal (95,000,000 liters [L]) (Stenner et al. 1988). It was designed to retain cooling water effluent to allow for radioactive decay and thermal cooling. The effluent was then discharged directly to the Columbia River. Decontamination wastes from the H Reactor building drains were also pumped to this basin by the 132-H-3 pumping station (DOE-RL 1992a).

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Prior to changing to parallel operation of both basins in 1954, the reactor effluent was normally routed to just one of the two concrete-lined cells of the basin. In the event of a fuel-element cladding rupture, cooling water would come in direct contact with the fuel element. When this occurred, the water from the side of the basin that had received the contaminated effluent would be drained to the 116-H-1 trench (Section 3.2) for soil column disposal (Dorian and Richards 1978).

The basin was active from 1949 to 1965. Sludge and waste from this basin were removed in 1953 and again in 1965. The material removed in 1953 was placed in an adjacent trench (116-H-7 disposal trench). Some of the sludge removed in 1965 was placed in the 116-H-1 trench. The standing walls of the retention basin were demolished into the basin, and the basin has been backfilled with soil. The present depth to the bottom of the basin is approximately 6 ft.

3.5.1 Geology

This site is characterized by sandy gravel fill to a depth of 5.8 ft (1.8 m) bgs. From 5.8 to 8 ft (1.8 to 2.4 m) bgs, the concrete bottom of the retention basin is encountered. Approximately 6 ft (1.8 m) of sandy gravel fill is found under the concrete floor of the basin to a total depth of 13.8 ft (4.0 m). Sandy gravel, with intermittent silt layers, makes up the native soil found between 13.8 and 20.8 ft (4.2 and 6.3 m) bgs, the total depth of the borehole (Figure 3-4).

3.5.2 Soil Samples

3.5.2.1 Chemical Analysis. Laboratory analysis results of a soil sample taken near the surface (1.0 to 3.0 ft [0.3 to 0.9 m] bgs) indicated elevated levels (above the 95 percent UTL) of arsenic and lead. Table 3-8 shows the contamination levels that were found. Samples taken below 3.0 ft (0.9 m) did not contain elevated levels of inorganic analytes.

The only VOC contaminant found in the 116-H-7 vadose zone borehole was toluene (Table 3-9). Toluene is a typical laboratory contaminant and the detection is probably a false positive detection. No semivolatile organic or pesticide compounds were detected in the soil samples taken from the borehole. The complete results of the chemical analyses for the samples taken from the 116-H-7 borehole are presented in Table A-4, Appendix A.

3.5.2.2 Radionuclide Analysis. The results of the radionuclide analysis of soil samples taken from the 116-H-7 vadose zone borehole are presented in Table 3-10. Twelve radionuclides, consisting of Co-60, Sr-90, Cs-137, Eu-152, Eu-154, Ra-226, Th-228, Th-232, U-235, U-238, Pu-239/240, and Am-241 were detected. The majority of the radionuclide contaminants were detected within the 8.0 and 16.4 ft interval. The complete results of the radionuclide analyses for the samples taken from borehole 116-H-7 are presented in Table A-9, Appendix A.

3.5.2.3 Field Screening. Continuous OVM field screening of the 116-H-7 borehole for VOCs resulted in no readings above the action level of 10 ppm above background.

Radionuclide screening showed activities ranging from 200 to 1,100 CPM between the depths of 5.8 and 14.8 ft (1.8 and 4.5 m). The peak of 1,100 CPM occurred at a depth of 13.8 ft (4.0 m) bgs. The radionuclide activity screening data is displayed in Figure 3-4.

3.5.2.4 Geophysical Borehole Logging. A spectral gamma-ray log was not performed on the 116-H-7 borehole because the logging equipment could not be brought into the contaminated retention basin.

3.5.3 Conclusions

The 116-H-7 process effluent retention basin area contains radionuclide contamination at depth and small amounts of heavy metal contamination (arsenic and lead) near the surface. The radionuclide contamination, based on the LFI data, extends from approximately 5 to 17 ft (1.5 to 5.2 m) bgs. This is also supported by the historical data (Dorian and Richards 1978), which indicates that radionuclide contamination extended to over 20 ft (6.1 m) bgs. Figure 3-4 presents a comparison of the various types of LFI data that were collected for the 116-H-7 retention basin and detections of contaminants from the historical data.

The 116-H-7 retention basins were considered analogous to the 116-D-7, 116-DR-9, and 116-C-5 retention basin sites. The 116-D-7, 116-DR-9, and 116-C-5 sites were sampled during the 100-DR-1 and 100-BC-1 LFIs (DOE-RL 1993c and DOE-RL 1993e). To assess the concept that this site is analogous, a comparison of the radionuclide and chemical analytical results from the 100-DR-1 and 100-BC-1 LFI samples, and the 100-HR-1 data, was made. The radionuclide contaminants found beneath the 116-D-7 and 116-H-7 sites are similar; both sites contain Co-60, Sr-90,
Cs-137, Eu-152, Eu-154, Ra-226, Th-228, Th-232, U-235, U-238, Pu-239/240, and Am-241
There are many radionuclide contaminants found in the 116-DR-9 site that are absent at 116-D-7 and 116-H-7. These are Be-7, Na-22, Mn-54, Co-58, Fe-59, Zn-65, Zr-99, Tc-99, Ru-103, Ru-106, Cs-134, Ba-140, Ce-141, and Ce-144. Comparisons of metallic contaminants in samples from the three sites revealed no similarities other than the presence of lead. The 116-D-7 site has a similar assemblage of organic contaminants to the 116-H-7 site. The 116-DR-9 site was the only site of the four that containe VOCs, semi-volatile compounds, and/or pesticides. Because the additional radionuclides at site 116-DR-9 have not been detected in 116-H-7 samples, the 116-D-7 and 116-C-5 sites are better analogous than the 116-DR-9 site for the 116-H-7 vadose zone radionuclide contamination. This is also the case for organic contaminants and pesticides. The sites are not truly analogous.

3.5.4 Groundwater Assessment

Monitoring well H4-11, constructed and sampled as part of the 100-HR-3 Groundwater Operable Unit LFI (DOE-RL 1993d), is located downgradient from the 116-H-7 retention basin and has elevated gross alpha levels (4.3 pCi/liter), as well as elevated levels of Tc-99 (36 pCi/liter), Sr-90 (26 pCi/liter), and chromium (90 μg/liter) relative to upgradient wells. Monitoring well H4-13, also located downgradient of the 116-H-7 retention basin and south of H4-11 has elevated levels of Sr-90 only (33 pCi/liter).

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Monitoring well data indicate that there is a current impact to the groundwater though the 116-H-7 sludge burial trench and the process effluent pipelines may also be contributing contaminants.

3.6 116-H-9 REACTOR CONFINEMENT SEAL PIT DRAINAGE CRIB

The 116-H-9 reactor confinement seal pit drainage crib is approximately 10 by 10 by 10 ft deep (3 by 3 by 3 m) and is located to the west of the H Reactor building (Figure 2-1). From 1960 to 1965, the crib received drainage from the 132-H-2 reactor exhaust air filter building seal pits. The radioactive effluent that drained to this crib contained radionuclides with short half-lives, and the crib was released from radiological controls prior to 1967. The crib received approximately 79,500 gal (300,000 L) of waste. Currently the site is filled with gravel and covered to grade with clean fill (WHC 1993a).

3.6.1 Geology

This site is characterized by sandy gravel fill to a depth of 10 ft (3.0 m) bgs. Remnants of a black plastic liner were found at a depth of 10 ft (3.0 m). Below the plastic, from 10 to 18.5 ft (3.0 to 5.6 m) bgs, is quarried, crushed basalt fill ranging from 1 to 4 inches (2.5 to 10 cm) in diameter. Sandy gravel material is present from 18.5 to 24.2 ft (5.6 to 7.4 m) bgs, the total depth of the borehole.

3.6.2 Soil Samples

3.6.2.1 Chemical Analysis. The laboratory analysis results from samples taken from the 116-H-9 vadose zone borehole did not indicate any inorganic levels above the 95 percent UTL. There were no VOC, semivolatile organic, or pesticide contaminants detected. The complete results of the chemical analyses for the samples taken from borehole 116-H-9 are presented in Table A-5, Appendix A.

3.6.2.2 Radionuclide Analysis. Six radionuclides were detected at levels <2 pCi/g (Table 3-11). The detected radionuclides consisted of Cs-137, Eu-152, Ra-226, Th-228, Th-232, and U-238. The complete results of the radionuclide analyses for the samples taken from borehole 116-H-9 are presented in Table A-10, Appendix A.

3.6.2.3 Field Screening. No VOCs were detected above the action level (10 ppm above background) during continuous field screening of borehole 116-H-9, nor was radionuclide activity detected above the background level of 50 CPM.

3.6.2.4 Geophysical Borehole Logging. Logging was performed on the 116-H-9 borehole using a spectral gamma-ray system. No man-made radionuclides (Co-60, Cs-137, Eu-152, and Eu-154) were detected in the borehole.

3.6.3 Conclusions

The 116-H-9 reactor confinement seal pit drainage crib was found to have no levels of inorganic, organic, or pesticide contamination based on review of the LFI data. Radionuclides were detected in small amounts generally at a depth of 17.6 to 20.1 ft bgs. The LFI data are supported by the historical data (Dorian and Richards 1978), which indicate a clean site. Figure 3-5 provides the geologic log and the depth of the LFI samples.

The results of the LFI on the analogous 116-D-9 crib (DOE-RL 1993c) support the non-radionuclide LFI data presented above. The radionuclides detected at the 116-D-9 site were Sr-90, Ra-226, Th-228, U-238, and Am-241 with the maximum concentration being that of Sr-90 at 2.9 pCi/g. The suite of radionuclides detected at the two sites are similar but not an exact match.

3.6.4 Groundwater Assessment

Results from sampling at monitoring well H4-49, located down gradient from the 116-H-9 site, did not indicate any contamination. The 116-H-9 site does not appear to be having an impact to the groundwater.

3.7 NON-INTRUSIVE INVESTIGATION OF OTHER HIGH-PRIORITY SITES

3.7.1 116-H-5 Process Effluent Outfall Structure

The 116-H-5 outfall structure was a compartmented concrete box that overflowed to the Columbia River via a concrete sluiceway. The 116-H-5 structure measures 378 ft long by 27 ft wide by 14 ft deep (115 m long by 8 m wide by 4 m deep) and is located directly to the north of the 116-H-7 retention basin. From 1949 to 1965, the outfall structure received treated process effluent from the 116-H-7 retention basin, directing it to the Columbia River through either dual 60-inch (152-cm) steel discharge pipes or a basalt-covered spillway down the river bank. The spillway was apparently used during periods when pipelines were unable to accommodate the effluent volume (Dorian and Richards 1978). The 116-H-5 outfall structure is now demolished and backfilled with 10 ft (3 m) of soil, except for the spillway. Waste inventories or sample analyses have not been conducted for the 116-H-5 outfall structure.

3.7.1.1 LFI Data and Analogous Sites. No LFI data have been collected for this waste site. The facilities associated with the 116-H-7 process effluent retention basin are proposed for remediation using the LFI results from the retention basin to make the decisions along the IRM path (DOE-RL 1992a). As reported in Section 3.5, the major contaminants found associated with the 116-H-7 retention basin were radionuclides consisting of Co-60, Sr-90, Cs-137, Eu-152, Eu-154, and small amounts of Pu-239/240.

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Analogous LFI data were collected from the 116-D-5 outfall structure located in the 100 D area (DOE-RL 1993c). Table 3-12 presents the analytes from this analogous site, which may be considered COPC. The LFI data from the 116-D-5 outfall structure showed no levels of radionuclides above what could be considered typical concentrations. Radium-226 and Th-228 were detected at levels of less than 1 pCi/g and are likely naturally occurring radionuclides in the soil.

3.7.1.2 Historical Data. No other data or historical information has been identified for the 116-H-5 outfall structure.

3.7.1.3 Conclusions. Because there is little information for these process outfall structures, the identification of potential contaminants is limited to information from the analogous 116-D-5 outfall structure. The data from the 116-H-7 process effluent retention basin is not likely to be representative of the 116-H-5 outfall structure site. Further analysis of the 116-H-5 outfall structure may be required in order to make an accurate assessment of the level and type of contamination at the site. Based solely on the analogous 116-D-5 data, little to no contamination would be expected at the 116-H-5 outfall structure.

3.7.1.4 Groundwater Assessment. Data from monitoring well H4-4, located immediately upgradient of the 116-H-5 outfall structure indicates high concentrations of gross alpha (66 pCi/liter) and Tc-99 (793 pCi/liter). The monitoring well data indicate that there is a current impact to the groundwater. However, due to the fact the well is upgradient of the 116-H-5 site, the process effluent pipelines or the 116-H-6 solar evaporation basins (WHC 1988) are more likely to be contributing contaminants.

3.7.2 Process Effluent Pipelines

Process effluent pipelines emanate from the H Reactor building to various process effluent disposal and treatment facilities. Process effluent pipelines also run from the 116-H-7 retention basin to both the Columbia River and the 116-H-1 trench. The lines are approximately 2,000 ft (610 m) long, constructed of steel pipe, and are buried approximately 20 ft (6 m) below the land surface. They are presumably still in place. Portions of this pipeline system lie beneath areas surrounded by security fences.

3.7.2.1 LFI Data and Analogous Sites. No LFI sampling was performed at this site. The facilities associated with the 116-H-7 process effluent retention basin are proposed for remediation using the LFI results from the retention basin to make the decisions along the IRM path (DOE-RL 1992a). As reported in Section 3.5, the major contaminants found associated with the 116-H-7 retention basin were radionuclides consisting of Co-60, Sr-90, Cs-137, Eu-152, Eu-154, and small amounts of Pu-239/240.

One of the process effluent lines located upstream of the 116-H-7 retention basin was investigated in 1991 (WHC 1991d) with a video camera and radiation monitor mounted on a remote-controlled crawler. No discernable breeches of the pipe integrity were observed, and the pipe was found to be sealed with concrete near the 116-H-7 retention basin. Gamma radiation levels were monitored and found to be less than 1 millirem. Smearable

contamination levels were obtained from the crawler and control cable, giving a good indication of the contamination levels of the rust scale in the pipe. These levels averaged 100 to 1,000 CPM. No analogous sites were sampled.

3.7.2.2 Historical Data. Dorian and Richards (1978) indicated that soil contamination from effluent pipeline leakage in the 116-H-7 area appears to be minimal. No measurable contamination was detected with a Geiger-Muller probe in the soil adjacent to the 116-H-7 effluent lines and junction boxes.

Limited radiological sampling was performed on the pipelines by Dorian and Richards (1978). Two sets of historical data are presented in the 100-HR-1 Qualitative Risk Assessment (WHC 1993a): the maximum concentrations of radionuclides in the soil column along the effluent pipelines, and the maximum concentrations of either the sludge from 116-H-7 retention basin or the sludge from inside the pipeline distribution box. These data show high concentrations (up to 26,100 pCi/g of Eu-152 when corrected for decay to 1992) in the sludge and scale samples taken from the effluent pipeline.

3.7.2.3 Conclusions. Both remote monitoring and historical data of the process effluent pipelines indicate elevated levels of radionuclide contamination. The contamination appears to be concentrated in the sludge and scale found on the inside walls of the pipe and at distribution boxes, based on the results of the historical sampling by Dorian and Richards (1978). The integrity of the section of pipeline inspected by remote sensors appeared to be adequate. The integrity of the other sections of pipeline within the 100-HR-1 Source Operable Unit is unknown. There are no known reasons to suspect that the investigated section of pipeline is not representative of the rest of the pipelines in the operable unit.

3.7.2.4 Groundwater Assessment. Because of the great linear extent of the process effluent pipelines across the 100-HR-1 Operable Unit, it is difficult to assess, from the existing monitoring wells, the current impact to groundwater posed by the process effluent pipelines. Because of the large volumes of effluent transported by the pipelines and their history of extensive leakage they are considered to be current sources of groundwater impact.

3.7.3 116-H-7 Sludge Burial Trench

The 116-H-7 (107-H) sludge burial trench is located to the east of the 116-H-7 retention basin, along the Columbia River in the southeast corner of the 100-HR-1 Source Operable Unit. (There are no available data that indicate the dimensions of the trench.) The trench is not enclosed by the H Reactor security fence. Sludge from the 116-H-7 retention basin was removed in 1953 and 1965. The material removed in 1953 was placed in the 116-H-7 sludge burial trench; the sludge removed in 1965 was deposited in the 116-H-1 trench.

3.7.3.1 LFI Data and Analogous Sites. No LFI sampling was performed at this site. The facilities associated with the 116-H-7 process effluent retention basin are proposed for remediation, using the LFI results from the retention basin to make the decisions along the

IRM path (DOE-RL 1992a). As reported in Section 3.5, the major contaminants found associated with the 116-H-7 retention basin were radionuclides consisting of Co-60, Sr-90, Cs-137, Eu-152, Eu-154, and small amounts of Pu-239/240.

The 116-H-1 process effluent burial trench is a similar site, and both trenches received sludge from the 116-H-7 retention basin. However, the 116-H-1 trench is not considered an analogous site, because in addition to sludge from the retention basin, the 116-H-1 site also received process effluent contaminated by fuel-element ruptures.

3.7.3.2 Historical Data. Analysis of a borehole sample taken at a depth of 15 ft (4.6 m) (Dorian and Richards 1978) detected no significant radioactive contamination. Chemical analysis was not performed. Radiological analysis identified very small amounts (less than 0.5 pCi/g) of Sr-90, Eu-154, and Eu-155. Carbon-14, Co-60, Cs-134, Cs-137, Eu-152, Pu-238, and Pu-239/240 were analyzed for but not detected. The 116-H-7 trench was removed from radiological controls in 1965.

No historic data has been found for organic or inorganic contaminants.

3.7.3.3 Conclusions. Based on the historical data presented in Section 3.7.3.2, the LFI data for the 116-H-7 retention basin and the 116-H-1 effluent disposal trench may not be accurate analogous sites to the 116-H-7 sludge burial trench with regard to radionuclide contamination levels. The historical data indicates that the 116-H-7 trench contains only very small amounts of radionuclide contamination. The levels of organic and inorganic contaminants are unknown.

There are no facilities in the 100 Area which have been or are being currently investigated as part of an LFI which are directly analogous to the 116-H-7 sludge burial trench.

3.7.3.4 Groundwater Assessment. As with the 116-H-7 retention basin, monitoring well H4-11, which was constructed and sampled as part of the 100-HR-3 Groundwater Operable Unit LFI (DOE-RL 1993d), is located downgradient from the 116-H-7 sludge burial trench and has elevated gross alpha levels (4.3 pCi/liter), as well as elevated levels of Tc-99 (36 pCi/liter), Sr-90 (26 pCi/liter), and chromium (90 μg/liter) relative to upgradient wells. Monitoring well H4-13, also located downgradient of the 116-H-7 sludge burial trench and south of H4-11, has elevated levels of Sr-90 only (33 pCi/liter). Monitoring well data indicate that there is a current impact to the groundwater though the 116-H-7 retention basin and the process effluent pipelines may also be contributing contaminants.

3.7.4 132-H-3 Effluent Pumping Station

The 132-H-3 effluent pumping station is located in the southwest corner of the 100-HR-1 Source Operable Unit, within the H Reactor building security fence, near the western edge of the H Reactor building. The 132-H-3 effluent pumping station consisted of four sumps containing approximately 80,000 gal (302,880 L) of water. At the time of de-commissioning in 1977, the basins also contained approximately 1,000 gal (3,786 L) of

sludge. This station collected and pumped water from the H Reactor building drains, including the irradiated fuel storage drains, into the process effluent system to the 116-H-7 retention basin. The facility was in service from 1949 to 1965. In 1977 sump water was removed and trucked to the 1325-N liquid waste disposal unit in the 100-N Area. The sludge was packaged in drums and placed in the H Reactor building for storage, and the 132-H-3 effluent pumping station was demolished in situ and backfilled with approximately 15 ft (5 m) of clean fill (WHC 1993a).

3.7.4.1 LFI Data and Analogous Sites. No LFI data for the 132-H-3 effluent pumping station were collected. Data collected from the analogous 132-D-3 effluent pumping station within the 110-DR-1 Source Operable Unit show no organic or inorganic contaminants and only one radionuclide [Ra-226 value of < 1 pCi/g at a depth of 19.8 ft (6.0 m)].

3.7.4.2 Historical Data. Sludge and water samples from four sumps in the 132-H-3 effluent pumping station were analyzed before the pumping station was decommissioned. Radionuclide concentrations from these samples ranged from 3.8 pCi/g for Pu-239/240 to 150 pCi/g for Co-60 and Cs-137. Radionuclides detected included H-3, C-14, Co-60, Sr-90, Cs-137, Eu-152, and Pu-239/240 (Dorian and Richards 1978). Radiological sampling (1977) using a Geiger-Mueller probe measured up to 4,000 CPM of activity along the pipelines and pumps within the pumping house station.

3.7.4.3 Conclusions. The LFI data for the analogous 132-D-3 site and the historical data for the 132-H-3 site vary greatly on the type and concentration levels of radionuclide contamination to be expected in the 132-H-3 pumping station. Since the historical data were taken before the sump was drained and the sludge removed, it is probably not representative of the site's present status. The 132-H-3 site should be addressed as a solid waste burial site.

3.7.4.4 Groundwater Assessment. Due to the location of the 132-H-3 effluent pumping station relative to other closely located sites, it is impossible to accurately assess the impact of any one of these sites on the groundwater. Monitoring wells located near the H Reactor building (adjacent to the 132-H-3 site) do not indicate elevated levels of contamination in the groundwater. Other sites located in the same area are the 116-H-4 pluto crib, the 116-H-9 reactor confinement seal pit drainage crib, the 116-H-2 effluent disposal trench, 132-H-2 exhaust air filter building, and the 132-H-1 reactor exhaust stack.

3.7.5 132-H-2 Exhaust Air Filter Building

The 132-H-2 (117-H) exhaust air filter building was located approximately 80 ft (24 m) southwest of the 118-H reactor building. The 132-H-2 building was a reinforced concrete structure, 59 ft (18 m) long, 39 ft (12 m) wide, and 35 ft (11 m) high, with a typical wall thickness of 15 inches (40 cm). Ninety percent of the structure was below the ground. It was built in 1960 to filter the H Reactor exhaust air before it was routed to the 132-H-1 reactor exhaust stack. The 132-H-2 building was built on the 116-H-4 pluto crib site and was subsequently demolished; the site was leveled and filled with clean soil in 1983.

Contaminated rubble was buried at least 3 ft (1 m) deep, and rubble from the seal pits was buried under a minimum of 15 ft (5 m) of clean soil (WHC 1993a).

3.7.5.1 LFI Data and Analogous Sites. No LFI data have been collected at the 132-H-2 exhaust air filter building, and there are no analogous or process-related sites that have been sampled as part of an LFI. The 116-D-2 exhaust air filter building is an analogous site that was investigated by Beckstrom and Loveland (1986) prior to the initiation of the LFI process.

3.7.5.2 Historical Data. Prior to demolition, radiation surveys and isotopic analyses of concrete and paint were made. The total estimated inventory was 0.41 millicuries of radionuclide activity including isotopes such as H-3, C-14, Co-60, Sr-90, Cs-137, Eu-152, Eu-154, and Pu-239/240 (Powers 1986).

3.7.5.3 Conclusions. Because the site was demolished and buried in situ, it should be treated as a solid waste burial ground. Remediation of the 132-H-2 filter building will be performed during the decontamination and decommissioning of the H Reactor building and facilities (DOE 1989). There are no facilities in the 100 Area currently investigated as part of an LFI which are directly analogous to the 132-H-2 exhaust air filter building.

3.7.5.4 Groundwater Assessment. Due to the location of the 132-H-2 exhaust air filter building relative to other closely located sites, it is impossible to accurately assess the impact of any one of these sites on the groundwater. Monitoring wells located near the H Reactor building (adjacent to the 132-H-2 site) do not indicate elevated levels of contamination in the groundwater. Other sites located in the same area are the 116-H-4 pluto crib, the 116-H-9 reactor confinement seal pit drainage crib, the 116-H-2 effluent disposal trench, 132-H-3 effluent pumping station, and the 132-H-1 reactor exhaust stack.

3.7.6 132-H-1 Reactor Exhaust Stack

The 132-H-1 reactor exhaust stack was a reinforced concrete stack measuring 200 by 16 ft (61 m by 5 m), formerly located directly to the southwest of the H Reactor building. The stack was demolished in 1983. After the demolition of the stack, about one-third of the foundation rubble was buried in a trench located between the demolished 132-H-2 and 132-H-3 buildings. The remainder of the foundation was buried in place and covered with approximately 3 ft (1 m) of clean fill.

3.7.6.1 LFI Data and Analogous Sites. No LFI data for the 132-H-1 reactor exhaust stack have been collected, and there are no analogous sites or process-related sites that have been sampled as part of an LFI.

3.7.6.2 Historical Data. A documented release of radionuclides from the stack occurred in 1955. A ruptured fuel element burned briefly during discharge, resulting in a stack emission.

Prior to demolition of the stack, five concrete core samples were taken from the stack and analyzed for radionuclides (Beckstrom 1987). The analysis detected some levels of H-3, C-14, Co-60, Sr-90, Cs-137, and Eu-152.

3.7.6.3 Conclusions. Radionuclides were detected in the concrete samples taken from the stack when it was demolished. Available data from this site are sufficient to allow it to be addressed as a solid waste burial ground.

3.7.6.4 Groundwater Assessment. Due to the location of the 132-H-1 reactor exhaust stack relative to other closely located sites, it is impossible to accurately assess the impact of any one of these sites on the groundwater. Monitoring wells located near the H Reactor building (adjacent to the 132-H-1 site) do not indicate elevated levels of contamination in the groundwater. Other sites located in the same area are the 116-H-4 pluto crib, the 116-H-9 reactor confinement seal pit drainage crib, the 116-H-2 effluent disposal trench, 132-H-3 effluent pumping station, and the 132-H-2 exhaust air filter building.

3.7.7 116-H-4 Pluto Crib

The 116-H-4 (105-H) pluto crib was located southwest of and adjacent to the 132-H-3 effluent pumping station. The dimensions were 4 by 4 by 2 ft (1.2 by 1.2 by 0.6 m) deep. The 116-H-4 crib received cooling water and discharge contaminated by failed fuel elements, at a flow rate of approximately 2 gal/minute (min) (7.6 L/min) for short periods. This crib was in service from 1950 to 1952. During its period of operation it was covered with 2 ft (0.6 m) of soil (Stenner et al. 1988). The Waste Information Data System (WIDS) (DOE-RL 1991b) reported 10 ft (3 m) of soil had been used to cover the pluto crib. In 1960, the 116-H-4 crib was excavated, and the material was buried in the 118-H-5 burial ground. Also, in 1960, the 132-H-2 (117-H) exhaust air filter building was built on the same location. After it was retired, the building was demolished and buried in situ. The filter building is discussed in Section 3.7.5.

3.7.7.1 LFI Data and Analogous Sites. No LFI data have been collected for this waste site. The 116-H-4 pluto crib was similar to the pluto cribs of the B, D, DR, and F Areas; however, the waste material has been dug up from 116-H-4 and moved to the 118-H-5 burial ground. The site is therefore not considered to be analogous to the other pluto cribs in the 100 Area. Material from the demolition of the 132-H-2 filter building is buried in place.

3.7.7.2 Historical Data. Approximately 2,200 lb (1,000 kg) of sodium dichromate were disposed of in the 116-H-4 crib. There is no radionuclide inventory of the exhumed 116-H-4 crib material.

3.7.7.3 Conclusions. The limited remains of 116-H-4 pluto crib and the 132-H-2 exhaust air filter building are viewed as a single site. The data are sufficient to indicate that the site should be addressed as a solid waste burial ground. Remediation of the site will be performed during the decontamination and decommissioning of the H Reactor building and facilities (DOE 1989). Materials from the 116-H-4 crib will likely be remediated in

conjunction with any activity undertaken at the 118-H-5 burial ground (100-HR-2 Source Operable Unit).

3.7.6.4 Groundwater Assessment. Due to the location of the 116-H-4 pluto crib relative to other closely located sites, it is impossible to accurately assess the impact of any one of these sites on the groundwater. Monitoring wells located near the H Reactor building (adjacent to the 116-H-4 site) do not indicate elevated levels of contamination in the groundwater. Other sites located in the same area are the 116-H-9 reactor confinement seal pit drainage crib, the 116-H-2 effluent disposal trench, 132-H-3 effluent pumping station, the 132-H-2 exhaust air filter building, and the 132-H-1 reactor exhaust stack,.

3.8 LOW-PRIORITY SITES INVESTIGATED DURING LFI

3.8.1 1607-H-2 Septic Tank

The 1607-H-2 septic tank served the 182-H, 183-H, 190-H, and several 1700-H office and maintenance service buildings. The system, now inactive, had a 500 person capacity and three manholes available for entry. The tank is located in the northwest section of the 100-HR-1 Source Operable Unit (Figure 2-1) (DOE-RL 1992a).

3.8.1.1 Chemical Analysis of Samples. The chemical analysis of the two sludge samples and five water samples taken from the 1607-H-2 septic tank system indicated high concentrations of heavy metal and sulfate contamination (Table 3-13). The detected contaminants were predominantly confined to the sludge samples. With the exception of a small amount of methylene chloride (300 μg/liter) detected in one water sample (Table 3-14), no VOCs were found in any of the samples. The heavy metal contaminants found included barium, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc; all in levels 20 to 100 times the 95 percent UTL (Table 3-13). Arsenic and thallium were also detected above the 95 percent UTL. Sulfate levels were detected at approximately five times the 95 percent UTL. Table B-1 of Appendix B presents the complete chemical analysis data for the 1607-H-2 septic tank samples.

3.8.1.2 Radionuclide Analysis of Samples. The radionuclide analysis of the 1607-H-2 samples showed high concentrations of many of the radionuclides analyzed. However, it should be noted that the data validation report for this analysis indicated calibration errors in the analysis equipment, prompting rejection of most of the radionuclide data. Of the radionuclide data which was not rejected, concentrations of six radionuclides, at levels <2.1 pCi/g, were detected. Table 3-15 presents these six radionuclides detected in the sludge samples and Table B-2 of Appendix B presents the complete radionuclide analysis results.

3.8.1.3 Conclusions. The predominant non-radionuclide contaminants detected in the 1607-H-2 septic tank samples were heavy metals and sulfate in the sludge. The source of the heavy metal contamination is unclear but may be from chemicals poured down the sanitary sewer system or may simply be from the concentration of human sewage. The radionuclide contaminants detected were Co-60, Cs-137, Eu-152, Ra-226, Th-228, and Th-232. Further

or reanalysis of water and sludge samples may be necessary to adequately determine the true extent, if any, of radionuclide contamination in the 1607-H-2 septic tank.

3.8.2 1607-H-4 Septic Tank

The 1607-H-4 septic tank received sanitary sewage from the 181-H river pumphouse. The system, now inactive, had a six-person capacity and a removable concrete cover. The tank is located south of the river and north of the 1607-H-2 site (Figure 2-1) (DOE-RL 1992a).

3.8.2.1 Chemical Analysis of Samples. The chemical analysis of the soil samples taken from the test pit at the 1607-H-4 septic tank indicates no contamination of the soil in the leach field. However, a sample taken from inside the septic tank discharge pipe (sample number B07211) did indicate contamination. This contamination consisted of several heavy metals (barium, copper, lead, and zinc) at levels above the 95 percent UTL and semivolatile PNA compounds (Tables 3-16, 3-17, and 3-18). The PNAs were detected in concentrations of less than 3 mg/kg. Pesticides 4,4-DDD, 4,4-DDE, and gamma-chlordane were detected at levels of less than 1 mg/kg in the sample taken from the discharge pipe (Table 3-19). As discussed earlier, PNAs may be associated with coal tars or creosote (Ekambaram et al. 1988). Table B-3, Appendix B, presents the complete chemical analysis data for 1607-H-4 soil samples.

3.8.2.2 Radionuclide Analysis of Samples. The soil samples taken from the test pit and from the septic tank discharge pipe contained small amounts of Cs-137, Eu-152, Ra-226, Th-228, Th-232, U-233/234, and U-238 in concentrations $\leq$ 1.2 pCi/g (Table 3-20). Table B-4, Appendix B, presents the complete radionuclide analysis results for the samples taken from the 1607-H-4 septic tank excavation.

3.8.2.3 Conclusions. Heavy metals, small amounts of PNAs, and radionuclide contamination were found in a sample taken from the discharge pipe of the 1607-H-4 septic tank. No contaminants were detected in the soil samples taken from the test pit in the septic tank leach field. This suggests that there may be isolated areas of concentrated contaminants within the septic tank itself (which is backfilled) and in and immediately around the discharge piping, but that there is little contamination within the leach field soil itself.

3.8.3 Electrical Facilities

Several abandoned electrical facilities exist within the 100-HR-1 Source Operable Unit. Electrical equipment, including transformers containing PCBs, were used at some of these sites. The sampling locations are shown in Figure 2-1 (DOE-RL 1992a).

3.8.3.1 PCB Analysis of Samples. Surface soil samples were taken from the electrical facilities where PCB contamination was suspected (i.e., visible spills and areas where equipment containing PCBs was used) and analyzed for PCB contamination. PCBs were detected in five of the eight samples analyzed in levels ranging from 32 to 1,200 μj/kg

(Table 3-21). Aroclor-1254 was detected in two of the samples taken from the 151-H facility area, and Aroclor-1260 was detected in two samples taken from the 151-H facility area and also in a sample taken from outside the 105-H building (Figure 2-1). Table B-5 in Appendix B provides the complete laboratory data results for the eight samples taken.

3.8.3.2 Conclusions. PCBs were detected in surface soil samples collected around abandoned electrical facilities in the 100-HR-1 Source Operable Unit. The physical extent of the contamination is not presently known but could likely be determined by visual inspection of the sample sites.

3.8.4 Support Facilities

The 100-HR-1 radiological survey field task consisted of two activities: characterization of the operable unit-specific background conditions and the radiological survey of the operable unit surface area. The purpose of the radiological survey was to measure gross gamma radiation levels of the surface soil.

The total surface area surveyed was approximately 105 acres. Within this area, a total of 126,425 data points were collected. Each of these data points represent a gross gamma radiation reading, along with the physical coordinates of the reading location. A total of 127 individual surveys were conducted in order to complete the 105 acres of surface area. Sections of the operable unit not surveyed include the area inside the 116-H-7 exclusion fence, the 116-H-6 solar basin, and the river shore.

During the period of time when the 100-HR-1 radiation survey was conducted, the Columbia River was relatively high; therefore, the portion of the 100-HR-1 Source Operable Unit below the riverbank crest could not be effectively surveyed.

Of the 127 surveys conducted at the 100-HR-1 site, 22 surveys recorded elevated readings. However, in only 10 of the 22 surveys could the elevated readings be verified and duplicated. The elevated readings in the remaining 12 surveys are interpreted to have been caused by noise spikes introduced by loose or faulty cables connecting the gamma detector to the digital rate meter. Any faulty cables were repaired or replaced. Figure 3-6 shows the ten locations where contamination was detected. Details on the radiological survey and the complete results are found in *100-HR-1 Radiological Surveys* (Beckstrom and Wade 1991).

3.9 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d) of CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), requires that fund-financed, enforcement, and federal facility remedial actions comply with ARARs of federal environmental laws and more stringent, promulgated state environmental or facility siting laws.

Comprehensive Environmental Response Compensation and Liability Act defines applicable requirements as those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under

federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

In addition to ARARs, CERCLA also provides for the consideration of to-be-considered (TBC) guidance, non-promulgated advisories or guidance documents issued by federal or state governments that do not have the status of potential ARARs but which may be considered in determining necessary levels of protection of health or the environment.

Applicable or relevant and appropriate requirements may be further subdivided into the following categories:

- *Chemical-specific requirements* - health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values. If a chemical has more than one such requirement that is an ARAR, compliance should generally be with the most stringent requirement.

- *Location-specific requirements* - restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations, such as wetlands or historic places.

- *Action-specific requirements* - technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy.

Potential chemical- and location-specific ARARs are defined during the field investigation portion of the CERCLA process and refined in the feasibility study and proposed plan. Action-specific ARARs are generally defined during the phase I and II feasibility study and refined in detailed analysis and the proposed plan. Potential ARARs and TBCs in all categories are defined in the *100 Area Feasibility Study Phases 1 and 2* (DOE-RL 1992c). For purposes of this LFI, only the chemical- and location-specific ARARs are discussed. The ARARs are presented in Tables 3-22 through 3-27.

Chemical-specific ARARs for soils are limited to those levels for hazardous constituents prescribed in the state's MTCA. Currently, MTCA has not defined levels for radionuclides. Additional soil limits are presented in Subpart S of RCRA for hazardous constituents and in DOE Order 5400.5 for radionuclides. These are considered TBCs for the 100 Area operable units. Potential chemical-specific ARARs for air emissions are also identified for the 100 Area; however, these tend to also be based on specific actions which have a tendency to increase releases to the air. Therefore, these are more appropriately

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addressed in the focused feasibility study. Potential chemical-specific ARARs are listed in Table 3-22 and 3-23; TBCs are included in Table 3-24.

Potential location-specific ARARs are identified for the 100 Area because of the presence of threatened or endangered species and archaeological resources. In addition, potential location-specific ARARs based on possible impacts to wetlands and floodplains are included. These are described in Tables 3-25 and 3-26; TBCs are in Table 3-27.

This discussion of potential ARARs is intended to be a refinement of ARARs presented in the work plan. Additional evaluation of potential ARARs will be done in the FS phase. Final ARARs will be determined in the ROD.

Figure 3-1

Sampling Results for 116-H-1 Process Effluent Disposal Trench

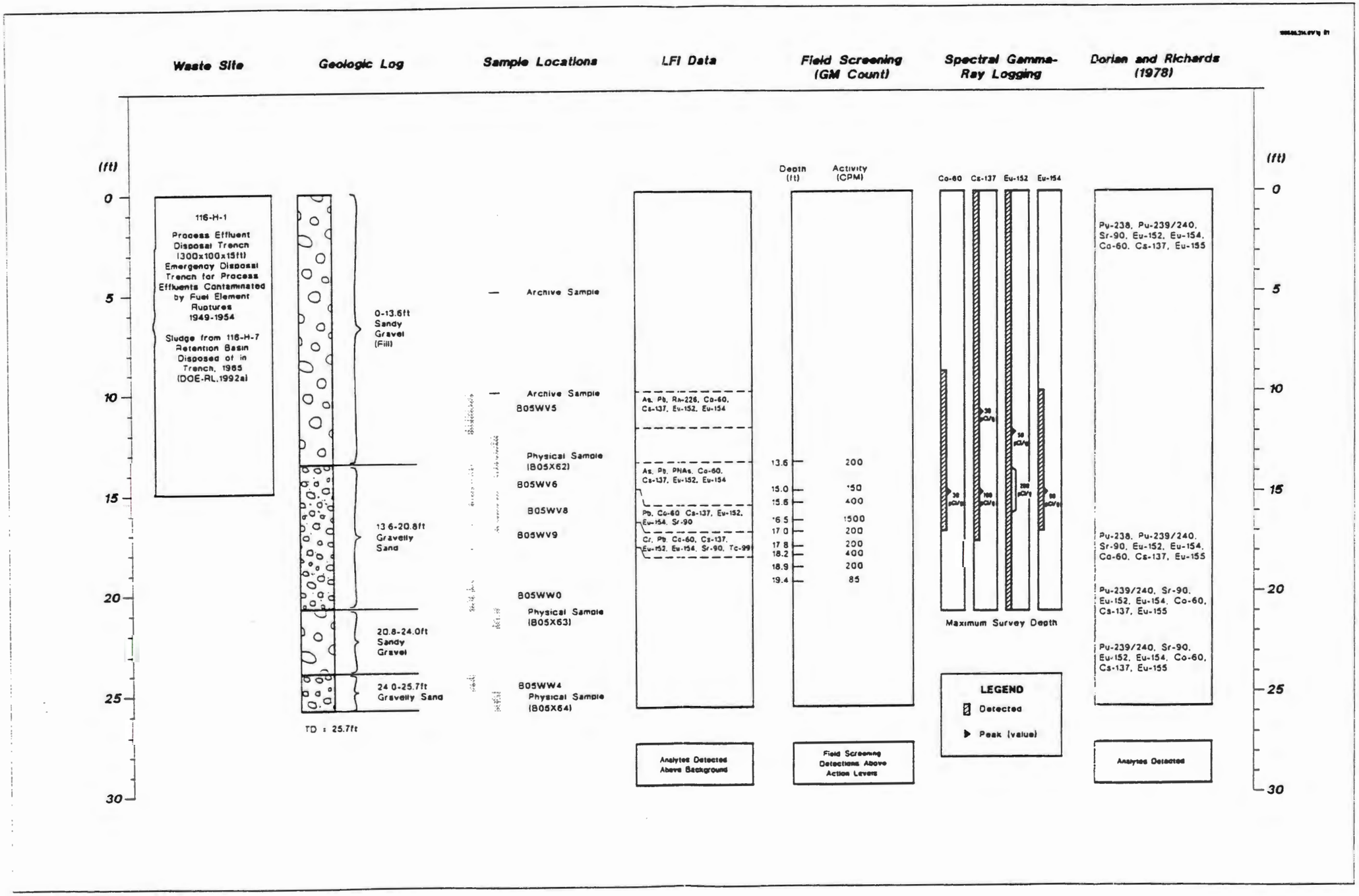

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Figure 3-2 Sampling Results for 116-H-2 Effluent Disposal Trench

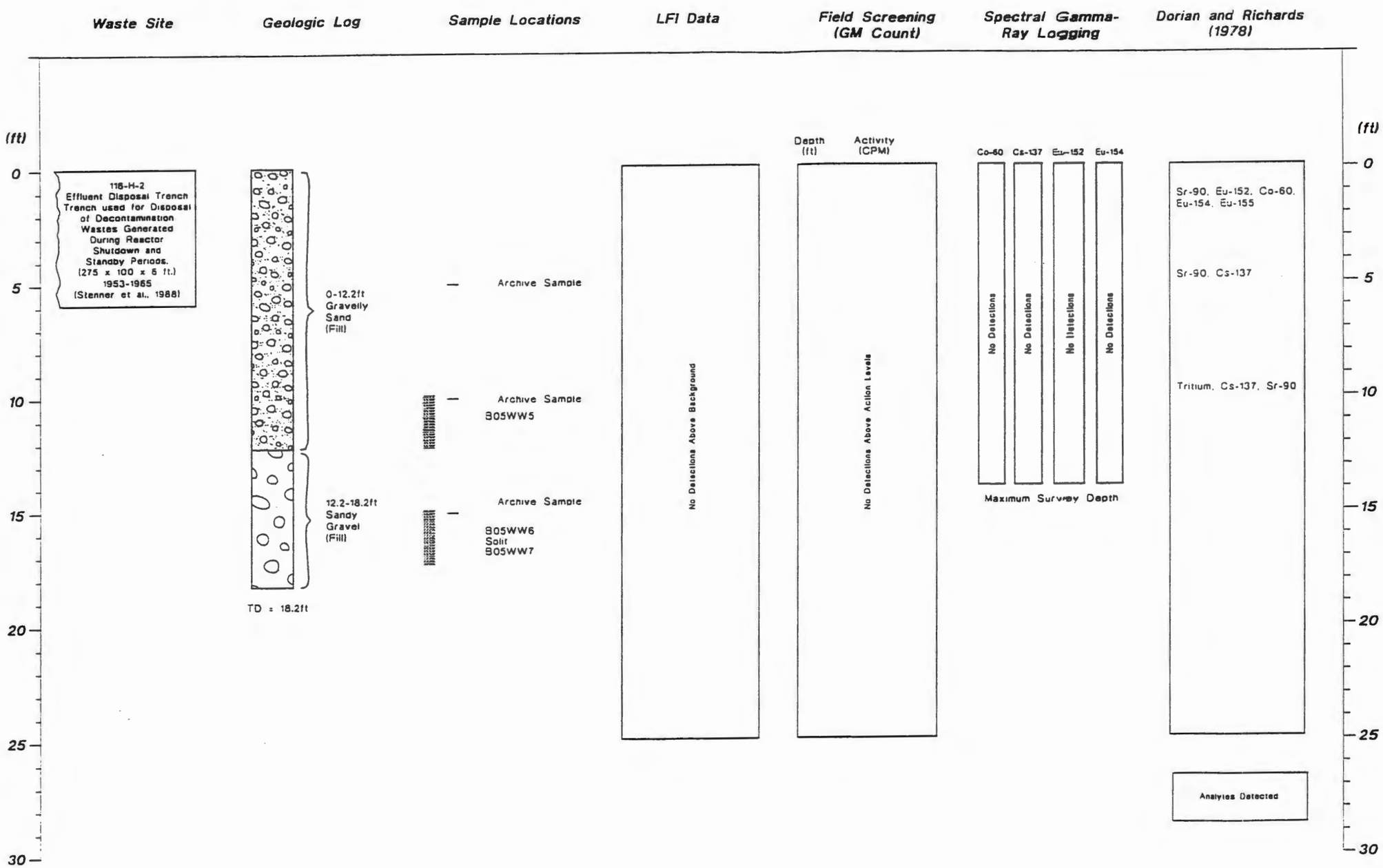

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Figure 3-3

Sampling Results for 116-H-3 Dummy Decontamination French Drain

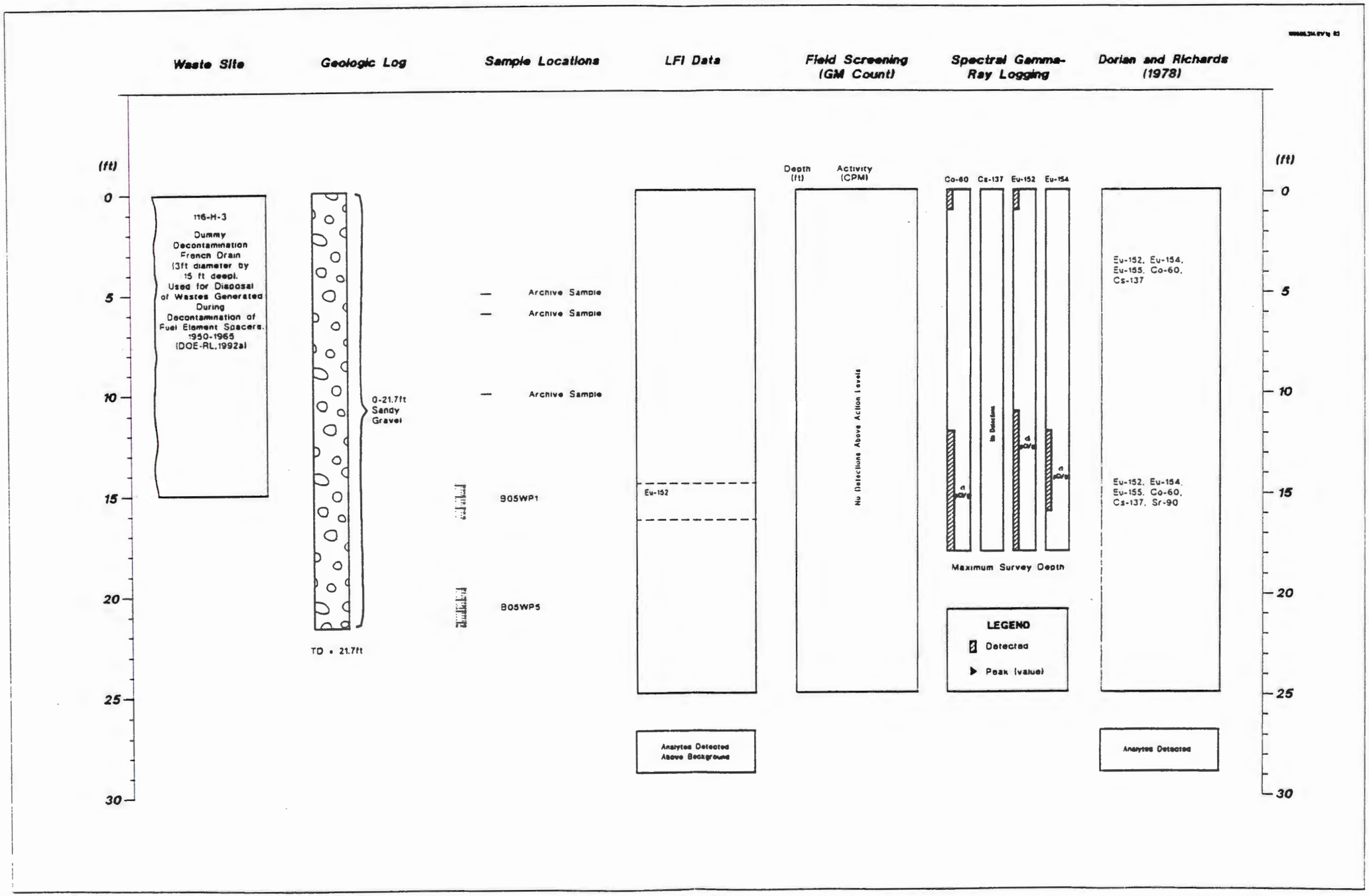

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Figure 3-4

Sampling Results for 116-H-7 Process Effluent Retention Basin

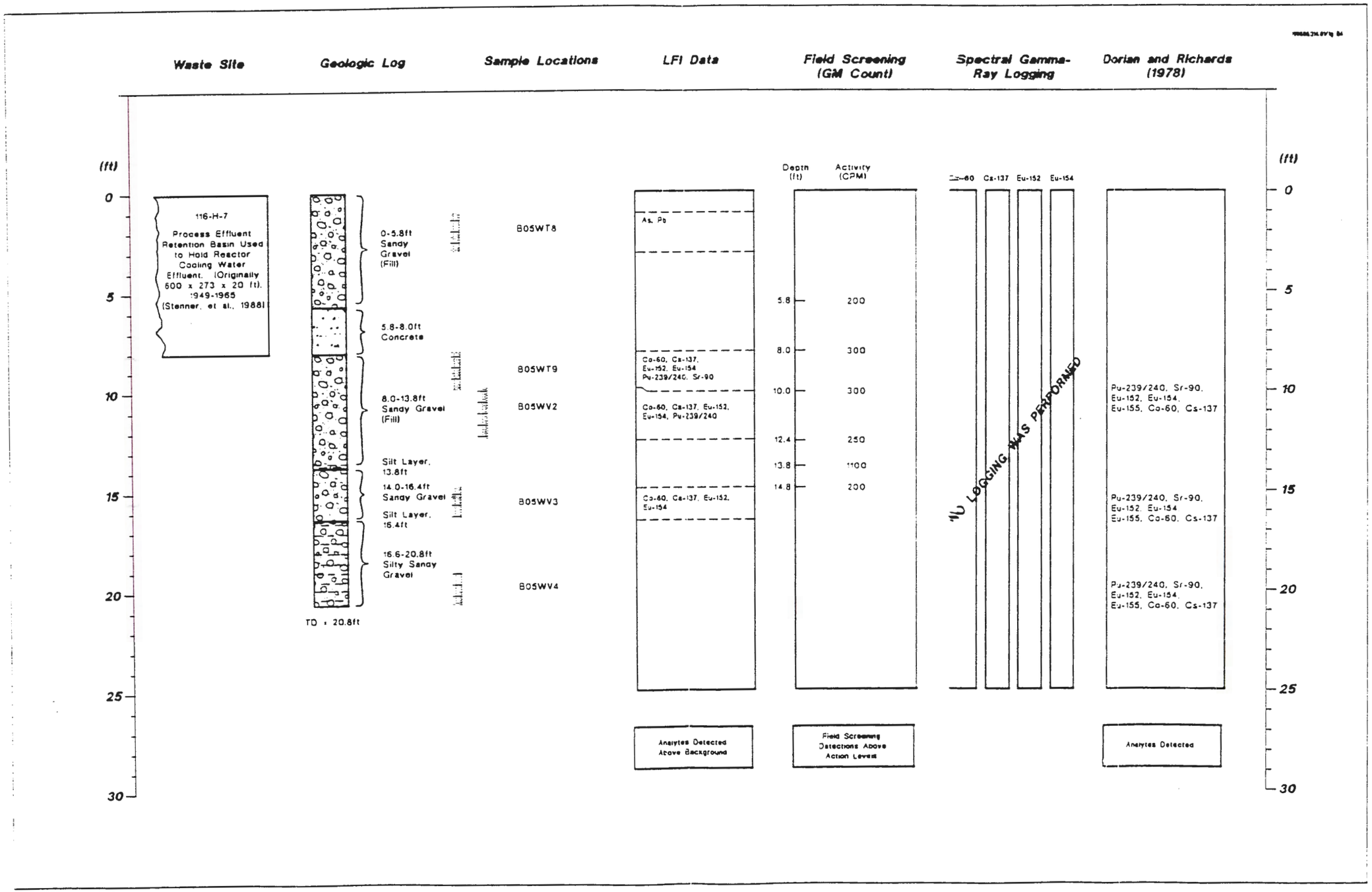

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Figure 3-5

Sampling Results for 116-H-9 Reactor Confinement Seal Pit Drainage Crib

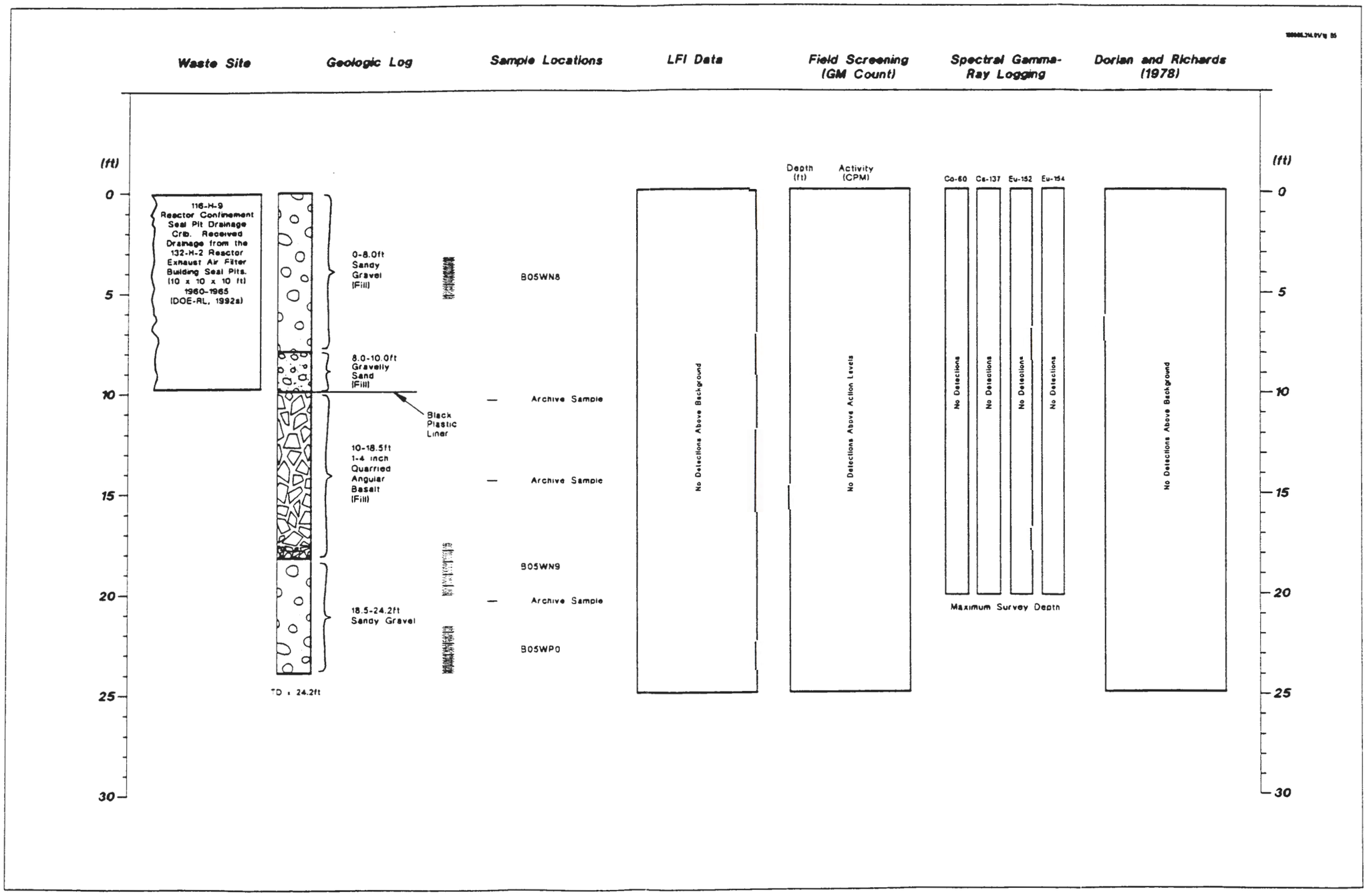

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Figure 3-6 100-HR-1 Surface Radiological Survey Contamination Points

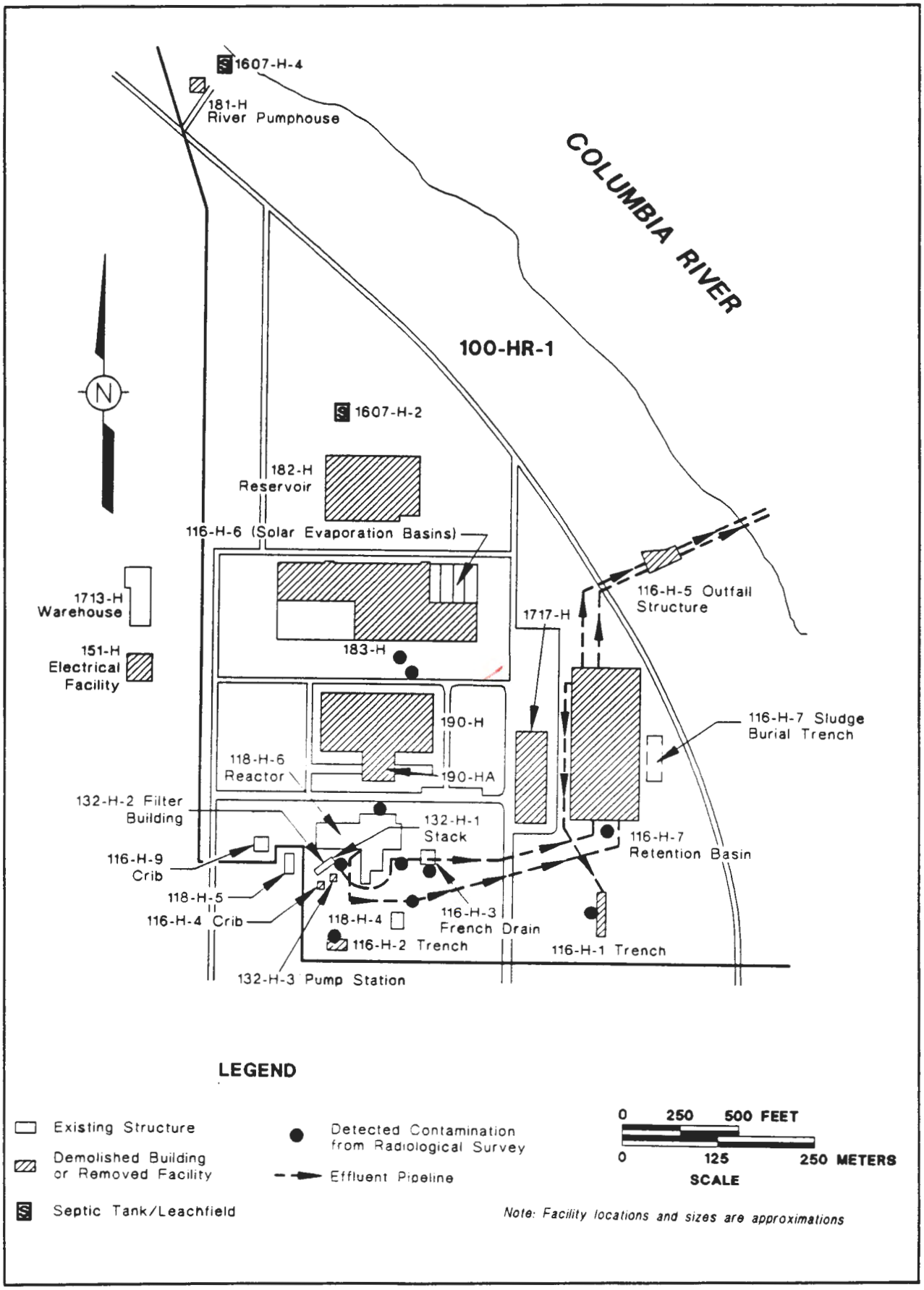

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Table 3-1. Summary Statistics and Upper Threshold Limits (UTL) for Inorganic Analytes*

Analyte	95% Distribution[a] (mg/kg)	95% UTL[b] (mg/kg)
Aluminum	13,800	15,600
Antimony	NR	15.7[c]
Arsenic	7.59	8.92
Barium	153	171
Beryllium	1.62	1.77
Cadmium	NR	0.66[c]
Calcium	20,410	23,920
Chromium	23.4	27.9
Cobalt	17.9	19.6
Copper	25.3	28.2
Iron	36,000	39,160
Lead	12.46	14.75
Magnesium	7,970	8,760
Manganese	562	612
Mercury	0.614	1.25
Nickel	22.4	25.3
Potassium	2,660	3,120
Selenium	NR	5[c]
Silver	1.4	2.7
Sodium	963	1,290
Thallium	NR	3.7[c]
Vanadium	98.2	111
Zinc	73.3	79
Molybdenum	NR	1.4[c]
Titanium	3,020	3,570
Zirconium	47.3	57.3
Lithium	35	37.1
Ammonia	15.3	28.2
Alkalinity	13,400	23,300
Silicon	108	192
Fluoride	6.4	12
Chloride	303	763
Nitrite	NR	21[c]
Nitrate	96.4	199
Ortho-phosphate	3.7	16
Sulfate	580	1,320

*Source: DOE-RL, 1993b.
NR = Not reported.
[a]95th percentile of the data for a lognormal distribution.
[b]95 percent confidence limit of the 95th percentile of the data distribution.
[c]Limit of detection.

Table 3-2 Vadose Zone Borehole 116-H-1 - Inorganic Analysis

Analyte	Sample Depth (ft)	Concentration Detected (mg/kg)	Background 95% UTL (mg/kg)	Qualifiers/ Comments
Arsenic	10.0 - 12.0	37.90	8.92	
	13.6 - 15.6	27.60	8.92	
Chromium	16.5 - 17.8	29.60	27.90	
Lead	10.0 - 12.0	187	14.75	
	13.6 - 15.6	145	14.75	
	15.0 - 17.0	36.90	14.75	
	16.5 - 17.8	82.10	14.75	

This table shows only those analytes that had levels above the 95 percent UTL.

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Table 3-3 Vadose Zone Borehole 116-H-1 - Volatile Organic Analysis

Analyte	Sample Depth (ft)	Concentration Detected (μg/kg)	Contract Required Quantitation Limit (μg/kg)[a]	Qualifiers/ Comments
Acetone	13.6 - 15.6	12	10.0	Split sample had no detection. Analyte is a typical laboratory contaminant and detection is probably laboratory contamination.
Methylene Chloride	10.0 - 12.0	11	10.0	Data for this sample was not validated. Other samples from lab had methylene chloride in lab blank. Detection is probably laboratory contamination.
Toluene	10.0 - 12.0	14	10.0	Data for this sample not validated. Analyte is a typical laboratory contaminant and detection is probably laboratory contamination.

This table shows only those analytes that had levels above the Contract Required Quantitation Limit.
[a]From QAPjP (DOE-RL, 1992a).

Table 3-4 Vadose Zone Borehole 116-H-1 - Semivolatile Organic Analysis

Analyte	Sample Depth (ft)	Concentration Detected (μg/kg)	Contract Required Quantitation Limit (μg/kg)[a]	Qualifiers/ Comments
Anthracene	13.6 - 15.6	430	330.0	
Benzo(a)anthracene	13.6 - 15.6	940	330.0	
Benzo(a)pyrene	13.6 - 15.6	810	330.0	
Benzo(b)fluoranthene	13.6 - 15.6	890	330.0	
Benzo(ghi)perylene	13.6 - 15.6	410	330.0	
Benzo(k)fluoranthene	13.6 - 15.6	760	330.0	
Chrysene	13.6 - 15.6	920	330.0	
Fluoranthene	13.6 - 15.6	1800	330.0	
Indeno(1,2,3-cd)pyrene	13.6 - 15.6	520	330.0	
Phenanthrene	13.6 - 15.6	1500	330.0	
Pyrene	13.6 - 15.6	1200	330.0	

This table shows only those analytes that had levels above the Contract Required Quantitation Limit.
[a]From QAPjP (DOE-RL, 1992a).

Table 3-5 Vadose Zone Borehole 116-H-1 - Radionuclide Analysis (page 1 of 2)

Radionuclide	Half-Life (years)	Sample Depth (ft)	Concentration Detected (pCi/g)	Contract Required Detection Limit (pCi/g)[a]	Comparison to Dorian and Richards (1978) Data			Qualifiers/ Comments
					Sample Number	Sample Depth (ft)	Concentration (pCi/g)	
Uranium-233/234	1.62 E5 / 2.47 E5	15.0 - 17.0	0.53	1.0				
		16.5 - 17.8	0.62	1.0				
Uranium-238	4.51 E9	10.0 - 12.0	0.61	1.0				
		15.0 - 17.0	0.31	1.0				
		19.3 - 20.8	0.39	1.0				
		24.0 - 25.1	0.58	1.0				
Plutonium-239/240	24,390 / 6580	10.0 - 12.0	0.74	1.0	F2	2	6.6	
		13.6 - 15.6	0.58	1.0	U17.5	17.5	11	
		15.0 - 17.0	0.64	1.0	R18	18	0.13	
		16.5 - 17.8	0.33	1.0	U20	20	0.24	
		19.3 - 20.8	0.06	1.0	S23	23	1.8	
Americium-241	458	10.0 - 12.0	0.20	1.0				
		13.6 - 15.6	0.16	1.0				
		15.0 - 17.0	0.16	1.0				
		16.5 - 17.8	0.07	1.0				
Strontium-90	27.7	15.0 - 17.0	6.2	1.0	F2	2	52	
		16.5 - 17.8	5.5	1.0	U17.5	17.5	82	
					R18	18	82	
					U20	20	1.7	
					S23	23	16	
Technetium-99	2.12 E5	16.5 - 17.8	0.67	N/A				
Cobalt-60	5.26	10.0 - 12.0	2.5	0.5	F2	2	280	
		13.6 - 15.6	1.8	0.5	U17.5	17.5	180	
		15.0 - 17.0	2.2	0.5	R18	18	440	
		16.5 - 17.8	2.0	0.5	U20	20	46	
					S23	23	61	

Table 3-5 Vadose Zone Borehole 116-H-1 - Radionuclide Analysis (page 2 of 2)

Radionuclide	Half-Life (years)	Sample Depth (ft)	Concentration Detected (pCi/g)	Contract Required Detection Limit (pCi/g)[a]	Comparison to Dorian and Richards (1978) Data			Qualifiers/ Comments
					Sample Number	Sample Depth (ft)	Concentration (pCi/g)	
Cesium-137	30.0	10.0 - 12.0	32.0	0.5	F2	2	580	
		13.6 - 15.6	24.0	0.5	U17.5	17.5	400	
		15.0 - 17.0	23.0	0.5	R18	18	520	
		16.5 - 17.8	11.0	0.5	U20	20	120	
		19.3 - 20.8	0.25	0.5	S23	23	56	
Radium-226	1602	15.0 - 17.0	0.78	0.5				
		16.5 - 17.8	0.85	0.5				
		19.3 - 20.8	0.55	0.5				
		24.0 - 25.1	0.40	0.5				
Thorium-228	1.91	13.6 - 15.6	0.95	0.5				Thorium-228 is a naturally-occurring daughter of thorium-232 and is generally in a 1:1 ratio with it.
		15.0 - 17.0	0.52	0.5				
		16.5 - 17.8	0.44	0.5				
		19.3 - 20.8	0.75	0.5				
		24.0 - 25.1	0.53	0.5				
Thorium-232	1.41 E10	19.3 - 20.8	0.89	0.5				
		24.0 - 25.1	0.64	0.5				
Europium-152	12.7	10.0 - 12.0	54.0	0.5	F2	2	1200	
		13.6 - 15.6	36.0	0.5	U17.5	17.5	2100	
		15.0 - 17.0	34.0	0.5	R18	18	1800	
		16.5 - 17.8	42.0	0.5	U20	20	33	
		19.3 - 20.8	0.72	0.5	S23	23	250	
Europium-154	16	10.0 - 12.0	5.4	0.5	F2	2	310	
		13.6 - 15.6	3.6	0.5	U17.5	17.5	2500	
		15.0 - 17.0	3.6	0.5	R18	18	590	
		16.5 - 17.8	3.6	0.5	U20	20	8.4	
		19.3 - 20.8	0.34	0.5	S23	23	65	

[a]From QAPjP (DOE-RL, 1992a).
N/A = Not Available -- There is no Contract Required Detection Limit specified in the QAPjP for this radionuclide.

Table 3-6 Vadose Zone Borehole 116-H-2 - Radionuclide Analysis

Radionuclide	Half-Life (years)	Sample Depth (ft)	Concentration Detected (pCi/g)	Contract Required Detection Limit (pCi/g)[a]	Qualifiers/ Comments
Uranium-238	4.51 E9	9.9 - 12.1 14.9 - 17.2	0.33 0.54	1.0 1.0	
Radium-226	1602	9.9 - 12.1 14.9 - 17.2	0.37 0.50	0.5 0.5	
Thorium-228	1.91	9.9 - 12.1 14.9 - 17.2	0.49 0.63	0.5 0.5	Thorium-228 is a naturally-occurring daughter of thorium-232 and is generally found in a 1:1 ratio with it.
Thorium-232	1.41 E10	9.9 - 12.1	0.35	0.5	

There were no radionuclides detected in both LFI vadose borehole analysis data and Dorian and Richards (1978) historical data to allow a comparison.
[a]From QAPjP (DOE-RL, 1992a).

Table 3-7 Vadose Zone Borehole 116-H-3 - Radionuclide Analysis

Radionuclide	Half-Life (years)	Sample Depth (ft)	Concentration Detected (pCi/g)	Contract Required Detection Limit (pCi/g)[a]	Comparison to Dorian and Richards (1978) Data			Qualifiers/ Comments
					Sample Number	Sample Depth (ft)	Concentration (pCi/g)	
Uranium-233/234	1.62 E5 / 2.47 E5	19.6 - 21.7	0.35	1.0				
Uranium-238	4.51 E9	14.5 - 16.3 19.6 - 21.7	0.58 0.44	1.0 1.0				
Cobalt-60	5.26	14.5 - 16.3 19.6 - 21.7	0.38 0.13	0.5 0.5	C4 D4 A15	4 4 15	30 110 1.6	
Radium-226	1602	19.6 - 21.7	0.45	0.5				
Thorium-228	1.91	14.5 - 16.3 19.6 - 21.7	0.58 0.57	0.5 0.5				Thorium-228 is a naturally-occurring daughter of thorium-232 and is generally found in a 1:1 ratio with it.
Thorium-232	1.41 E10	14.5 - 16.3 19.6 - 21.7	0.44 0.39	0.5 0.5				
Europium-152	12.7	14.5 - 16.3	0.54	0.5	C4 D4 A15	4 4 15	72 24 2.0	

[a]From QAPjP (DOE-RL, 1992a).

Table 3-8 Vadose Zone Borehole 116-H-7 - Inorganic Analysis

Analyte	Sample Depth (ft)	Concentration Detected (mg/kg)	Background 95% UTL (mg/kg)	Qualifiers/ Comments
Arsenic	1.0 - 3.0	47	8.92	
Lead	1.0 - 3.0	540	14.75	

This table shows only those analytes that had levels above the 95 percent UTL.

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Table 3-9 Vadose Zone Borehole 116-H-7 - Volatile Organic Analysis

Analyte	Sample Depth (ft)	Concentration Detected (μg/kg)	Contract Required Quantitation Limit (μg/kg)[a]	Qualifiers/ Comments
Toluene	8.0 - 10.0	49	10.0	No other samples from borehole had levels above the detection limit. Analyte is a typical laboratory contaminant and detection is probably laboratory contamination.

This table shows only those analytes that had levels above the Contract Required Quantitation Limit.
[a]From QAPjP (DOE-RL, 1992a).

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Table 3-10 Vadose Zone Borehole 116-H-7 - Radionuclide Analysis (page 1 of 2)

Radionuclide	Half-Life (years)	Sample Depth (ft)	Concentration Detected (pCi/g)	Contract Required Detection Limit (pCi/g)[a]	Comparison to Dorian and Richards (1978) Data			Qualifiers/ Comments
					Sample Number	Sample Depth (ft)	Concentration (pCi/g)	
Uranium-235	7.8 E8	9.8 - 12.4	0.38	1.0				
Uranium-238	4.51 E9	1.0 - 3.0	0.69	1.0				
		8.0 - 10.0	0.47	1.0				
		9.8 - 12.4	0.68	1.0				
		14.8 - 16.4	0.50	1.0				
		19.2 - 20.8	0.53	1.0				
Plutonium-239/240	24,390 / 6580	1.0 - 3.0	0.03	1.0	L10	10	1.2	
		8.0 - 10.0	1.10	1.0	K15	15	0.16	
		9.8 - 12.4	1.30	1.0	B20	20	1.2	
		14.8 - 16.4	0.07	1.0	I25	25	0.50	
Americium-241	458	8.0 - 10.0	0.54	1.0				
		9.8 - 12.4	0.72	1.0				
Strontium-90	27.7	8.0 - 10.0	3.20	1.0	L10	10	0.69	
					K15	15	4.1	
					B20	20	4.7	
					I25	25	0.87	
Cobalt-60	5.26	8.0 - 10.0	14.0	0.5	L10	10	130	
		9.8 - 12.4	36.0	0.5	K15	15	100	
		14.8 - 16.4	0.68	0.5	B20	20	120	
					I25	25	300	
Cesium-137	30.0	8.0 - 10.0	11.0	0.5	L10	10	67	
		9.8 - 12.4	35.0	0.5	K15	15	41	
		14.8 - 16.4	1.7	0.5	B20	20	18	
					I25	25	14	

Refer to footnotes at end of table.

Table 3-10 Vadose Zone Borehole 116-H-7 - Radionuclide Analysis (page 2 of 2)

Radionuclide	Half-Life (years)	Sample Depth (ft)	Concentration Detected (pCi/g)	Contract Required Detection Limit (pCi/g)[a]	Comparison to Dorian and Richards (1978) Data			Qualifiers/ Comments
					Sample Number	Sample Depth (ft)	Concentration (pCi/g)	
Radium-226	1602	1.0 - 3.0 14.8 - 16.4 19.2 - 20.8	0.29 0.65 0.44	0.5 0.5 0.5				
Thorium-228	1.91	1.0 - 3.0 14.8 - 16.4 19.2 - 20.8	0.41 0.81 0.46	0.5 0.5 0.5				Thorium-228 is a naturally-occurring daughter of thorium-232 and is generally found in a 1:1 ratio with it.
Thorium-232	1.41 E10	1.0 - 3.0 19.2 - 20.8	0.41 0.44	0.5 0.5				
Europium-152	12.7	8.0 - 10.0 9.8 - 12.4 14.8 - 16.4	120.0 260.0 4.0	0.5 0.5 0.5	L10 K15 B20 I25	10 15 20 25	160 42 160 320	
Europium-154	16	8.0 - 10.0 9.8 - 12.4 14.8 - 16.4	19.0 37.0 0.50	0.5 0.5 0.5	L10 K15 B20 I25	10 15 20 25	53 16 47 110	

[a]From QAPjP (DOE-RL, 1992a).

Table 3-11 Vadose Zone Borehole 116-H-9 - Radionuclide Analysis

Radionuclide	Half-Life (years)	Sample Depth (ft)	Concentration Detected (pCi/g)	Contract Required Detection Limit (pCi/g)[a]	Qualifiers/ Comments
Uranium-238	4.51 E9	3.1 - 5.3 21.7 - 24.2	0.47 0.45	1.0 1.0	
Cesium-137	30.0	17.6 - 20.1	0.29	0.5	
Radium-226	1602	3.1 - 5.3 17.6 - 20.1 21.7 - 24.2	0.64 0.71 0.50	0.5 0.5 0.5	
Thorium-228	1.91	3.1 - 5.3 17.6 - 20.1 21.7 - 24.2	1.20 1.10 0.73	0.5 0.5 0.5	Thorium-228 is a naturally-occurring daughter of thorium-232 and is generally found in a 1:1 ratio
Thorium-232	1.41 E10	3.1 - 5.3 17.6 - 20.1 21.7 - 24.2	0.75 1.10 0.39	0.5 0.5 0.5	
Europium-152	12.7	17.6 - 20.1	0.36	0.5	

There were no radionuclides detected in both LFI vadose borehole analysis data and Dorian and Richards (1978) historical data to allow a comparison.
[a]From QAPjP (DOE-RL, 1992a).

Table 3-12 116-H-5 Process Effluent Outfall Structure - Analogous Data from 116-D-5 Outfall Structure

Analyte	Sample Depth (ft)	Concentration Detected (μg/kg)	Contract Required Quantitation Limit (μg/kg)[a]	Qualifiers/ Comments
Bis(2-ethylhexyl) phthalate	25	5200	330.0	
Butyl benzylphthalate	25	2500	330.0	

This table shows only those analytes that had levels above the Contract Required Quantitation Limit.
[a]From QAPjP (DOE-RL, 1992a).

Table 3-13 Septic Tank 1607-H-2 - Inorganic Analysis

Analyte	Sludge Sample Number	Concentration Detected (mg/kg)	Background 95% UTL (mg/kg)	Qualifiers/ Comments
Antimony	B00ZM7	18.6	15.7	
Arsenic	B00ZM6	24.1	8.92	
Barium	B00ZM6 B00ZM7	1930 4260	171	
Cadmium	B00ZM6 B00ZM7	22.5 28.5	0.66	
Chromium	B00ZM6 B00ZM7	1020 2510	27.9	
Copper	B00ZM6 B00ZM7	534 627	28.2	
Lead	B00ZM6 B00ZM7	419 499	14.75	
Mercury	B00ZM6 B00ZM7	34.1 37.0	1.25	
Nickel	B00ZM6 B00ZM7	56.4 51.2	25.3	
Selenium	B00ZM6	7.8	5	
Silver	B00ZM6 B00ZM7	119 107	2.7	
Thallium	B00ZM7	5.4	3.7	
Zinc	B00ZM6 B00ZM7	4080 6160	79	
Sulfate	B00ZM6 B00ZM7	4425 7115	1320	

This table shows only those analytes that had levels above the 95 percent UTL.

Table 3-14 Septic Tank 1607-H-2 - Volatile Organic Analysis

Analyte	Sample Number	Concentration Detected (μg/liter)	Contract Required Quantitation Limit (μg/liter)[a]	Qualifiers/ Comments
Methylene Chloride	B01609 (Water sample)	300	10.0	No other samples from septic tank had levels above the detection limit for this analyte. Analyte detection may be result of laboratory contamination.

This table shows only those analytes that had levels above the Contract Required Quantitation Limit.
[a]From QAPjP (DOE-RL, 1992a).

Table 3-15 Septic Tank 1607-H-2 - Radionuclide Analysis

Radionuclide	Half-Life (years)	Sludge Sample Number	Concentration Detected (pCi/g)	Contract Required Detection Limit (pCi/g)[a]	Qualifiers/ Comments
Cobalt-60	5.26	B00ZM6 B00ZM7	0.48 1.38	0.5 0.5	
Cesium-137	30.0	B00ZM6 B00ZM7	0.87 0.75	0.5 0.5	
Radium-226	1602	B00ZM6 B00ZM7	0.68 1.36	0.5 0.5	
Thorium-228	1.91	B00ZM6 B00ZM7	0.86 0.91	0.5 0.5	Thorium-228 is a naturally-occurring daughter of thorium-232 and is generally found in a 1:1 ratio
Thorium-232	1.41 E10	B00ZM6 B00ZM7	1.43 2.04	0.5 0.5	
Europium-152	12.7	B00ZM6 B00ZM7	0.95 1.12	0.5 0.5	

[a]From QAPjP (DOE-RL, 1992a).

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Table 3-16 Septic Tank 1607-H-4 - Inorganic Analysis

Analyte	Sample Number	Concentration Detected (mg/kg)	Background 95% UTL (mg/kg)	Qualifiers/ Comments
Barium	B07211	226	171	
Copper	B07211	40.2	28.2	
Lead	B07211	50.0	14.75	
Zinc	B07211	194	79	

This table shows only those analytes that had levels above the 95 percent UTL.

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Table 3-17 Septic Tank 1607-H-4 - Volatile Organic Analysis

Analyte	Sample Number	Concentration Detected (μg/kg)	Contract Required Quantitation Limit (μg/kg)[a]	Qualifiers/ Comments
Acetone	B07208	17	10.0	Analyte detected in laboratory blanks associated with other samples taken from site. Analyte is a typical laboratory contaminant. Detection here is probably due to laboratory contamination.

This table shows only those analytes that had levels above the Contract Required Quantitation Limit.
[a]From QAPjP (DOE-RL, 1992a).

Table 3-18 Septic Tank 1607-H-4 - Semivolatile Organic Analysis

Analyte	Sample Number	Concentration Detected (μg/kg)	Contract Required Quantitation Limit (μg/kg)[a]	Qualifiers/ Comments
Carbazole	B07211	150	330.0	
Anthracene	B07211	320	330.0	
Benzo(a)anthracene	B07211	1800	330.0	
Benzo(a)pyrene	B07211	940	330.0	
Benzo(b)fluoranthene	B07211	2400	330.0	
Benzo(ghi)perylene	B07211	460	330.0	
Chrysene	B07211	920	330.0	
Fluoranthene	B07211	2900	330.0	
Fluorene	B07211	110	330.0	
Indeno(1,2,3-cd)pyrene	B07211	480	330.0	
Phenanthrene	B07211	1600	330.0	
Acenaphthene	B07211	130	330.0	
Pyrene	B07211	2700	330.0	

This table shows only those analytes that had levels above the Contract Required Quantitation Limit.
[a]From QAPjP (DOE-RL, 1992a).

Table 3-19 Septic Tank 1607-H-4 - Pesticide Analysis

Analyte	Sample Number	Concentration Detected (μg/kg)	Contract Required Detection Limit (μg/kg)[a]	Qualifiers/ Comments
4,4' - DDD	B07211	110	3.3	
4,4' - DDE	B07211	12.0	3.3	
gamma-Chlordane	B07211	18.0	1.7	

This table shows only those analytes that had levels above the Contract Required Detection limit.
[a]From QAPjP (DOE-RL, 1992a).

Table 3-20 Septic Tank 1607-H-4 - Radionuclide Analysis

Radionuclide	Half-Life (years)	Sample Number	Concentration Detected (pCi/g)	Contract Required Detection Limit (pCi/g)[a]	Qualifiers/ Comments
Uranium-233/234	1.62 E5 / 2.47 E5	B07206 B07208 B07211	0.57 0.41 0.62	1.0	
Uranium-238	4.51 E9	B07206 B07208 B07211	0.48 0.44 0.31	1.0	
Cesium-137	30.0	B07211	0.67	0.5	
Radium-226	1602	B07206 B07208 B07211	0.45 0.44 0.37	0.5	
Thorium-228	1.91	B07206 B07208 B07211	0.54 0.56 0.40	0.5	Thorium-228 is a naturally-occurring daughter of thorium-232 and is generally found in a 1:1 ratio with it.
Thorium-232	1.41 E10	B07206 B07208 B07211	0.51 0.62 0.44	0.5	
Europium-152	12.7	B07211	1.2	0.5	

[a]From QAPjP (DOE-RL, 1992a).

Table 3-21 Electrical Facilities - PCB Analysis

Analyte	Sample Number	Concentration Detected (μg/kg)	Qualifiers/ Comments
Aroclor-1254	B018S8	350	
	B018T0	32	
Aroclor-1260	B018S5	1200	
	B018S6	770	
	B018S7	630	

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Table 3-22 Potential Federal Chemical-Specific Applicable or Relevant and Appropriate Requirements for the 100-HR-1 Operable Unit (page 1 of 3)

Description	Citation	A/ R&A*	Requirements	Remarks
Atomic Energy Act of 1954, as amended	42 U.S.C. 2011 et seq.		Authorizes DOE to set standards and restrictions governing facilities used for research, development, and utilization of atomic energy.	
Radiation Protection Standards	40 CFR Part 191		Establishes standards for management and disposal of high-level and transuranic waste and spent nuclear fuel.	
Standards for Management and Storage	40 CFR §191.03	A	Requires that management and storage of spent nuclear fuel or high-level or transuranic radioactive wastes at all facilities for the disposal of such fuel or waste that are operated by the DOE and that are not regulated by the Commission or Agreement States shall be conducted in such a manner as to provide reasonable assurance that the combined annual dose equivalent to any member of the public in the general environment resulting from discharges of radioactive material and direct radiation from such management and storage shall not exceed 25 millirems to the whole body and 75 millirems to any critical organ.	Applicable to wastes disposed of after November 18, 1985.
Nuclear Regulatory Commission Standards for Protection Against Radiation	10 CFR Part 20			
Radiation Dose Standards	10 CFR §§20.101-20.105	R&A	Sets specific radiation doses, levels, and concentrations for restricted and unrestricted areas.	May be relevant and appropriate, as radioactive materials in the 100 Area can contribute radiation doses, levels, and concentrations which could exceed the limits; however, Hanford is not an NRC-licensed facility.

Table 3-22 Potential Federal Chemical-Specific Applicable or Relevant and Appropriate Requirements for the 100-HR-1 Operable Unit (page 2 of 3)

Description	Citation	A/ R&A*	Requirements	Remarks
Safe Drinking Water Act	42 U.S.C. 300f et seq.		Creates a comprehensive national framework to ensure the quality and safety of drinking water.	
National Primary Drinking Water Regulations	40 CFR Part 141	R&A	Establishes maximum contaminant levels (MCL) and maximum contaminant level goals (MCLG) for organic, inorganic, and radioactive constituents. The MCL for combined Re-226 and Ra-228 is 5 pCi/L. The MCL for gross alpha particle activity (including Ra-226 but excluding radon and uranium) is 15 pCi/L. The average annual concentration of beta particle and photon radioactivity from manmade radionuclides in drinking water shall not produce an annual dose equivalent to total body or any internal organ in excess of 4 millirem/year.	Applicable to public water systems. Potential chemicals and radionuclides of concern may migrate to the drinking water supply as a result of remedial activities. Although federal MCLGs are not enforceable standards, they are potential ARARs under the Washington State Model Toxics Control Act when more stringent than other standards. See state ARARs.
National Secondary Drinking Water Regulations	40 CFR Part 143	R&A	Controls contaminants in drinking water that primarily affect the aesthetic qualities relating to the public acceptance of drinking water.	Although federal secondary drinking water standards are not enforceable, they are potential ARARs under the Washington State Model Toxics Control Act when more stringent than other standards. See state ARARs.
Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA)	42 U.S.C. 6901 et seq.		Establishes the basic framework for federal regulation of solid and hazardous waste.	
Groundwater Protection Standards	40 CFR §264.92 [WAC 173-303 -645][1]	A	A facility shall not contaminate the uppermost aquifer underlying the waste management area beyond the point of compliance, which is a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated area. The concentration of certain chemicals shall not exceed background levels, certain specified maximum concentrations, or alternate concentration limits, whichever is higher.	Groundwater concentration limits in this section do not exceed 40 CFR 141, except for chromium which has a limit of 50 μg/L.

[1]These are State of Washington regulatory citations which are equivalent to Title 40 Code of Federal Regulations, Parts 264 and 268 as stated in Washington Administrative Code 173-303.

Table 3-22 Potential Federal Chemical-Specific Applicable or Relevant and Appropriate Requirements for the 100-HR-1 Operable Unit (page 3 of 3)

Description	Citation	A/ R&A*	Requirements	Remarks
Uranium Mill Tailings Radiation Control Act of 1978	Public Law 95-604, as amended			
Standards for Uranium and Thorium Mill Tailings	40 CFR 192		Establishes standards for control, cleanup, and management of radioactive materials from inactive uranium processing sites.	
Land Cleanup Standards	40 CFR §§192.10 - 192.12	R&A	Requires remedial actions to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site, the concentration of radium-226 in lend averaged over any area of 100 square meters shall not exceed the background level by more than 5 pCi/g, averaged over the first 15 cm of soil below the surface, and 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface. In any habitable building, a reasonable effort shall be made during remediation to achieve an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 Working Level (WL). In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL and the level of gamma radiation shall not exceed the background level by more than 20 microroentegens per hour.	May be relevant and appropriate, as any radium-226 encountered during remediation did not result from urenium processing.
Implementation	40 CFR §§192.20 - 192.23	R&A	Requires that when radionuclides other than radium-226 and its decay products are present in sufficient quantity and concentration to constitute a significant radiation hazard from residual radioactive materials, remedial action shall reduce other residual radioactivity to levels as low as reasonably achievable (ALARA).	May be relevant and appropriate, as any radium-226 encountered during remediation did not result from uranium processing.

*NOTE: A = Applicable, R&A = Relevant and Appropriate

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Table 3-23 Potential State Chemical-Specific Applicable or Relevant and Appropriate Requirements for the 100-HR-1 Operable Unit (page 1 of 3)

Description	Citation	A/ R&A*	Requirements	Remarks
Model Toxics Control Act (MTCA)	70.105D RCW		Requires remedial actions to attain a degree of cleanup protective of human health and the environment.	
Cleanup Regulations	WAC 173-340		Establishes cleanup levels and prescribes methods to calculate cleanup levels for soils, groundwater, surface water, and air.	
Groundwater Cleanup Standards	WAC 173-340-720	A	Requires that where the groundwater is a potential source of drinking water, cleanup levels under Method B must be at least as stringent as concentrations established under applicable state and federal laws, including the following: (A) Maximum contaminant levels established under the Safe Drinking Water Act and published in 40 CFR 141, as amended; (B) Maximum contaminant level goals for noncarcinogens established under the Safe Drinking Water Act and published in 40 CFR 141, as amended; (C) Secondary maximum contaminant levels established under the Safe Drinking Water Act and published in 40 CFR 143, as amended; and (D) Maximum contaminant levels established by the state board of health and published in Chapter 248-54 WAC, as amended.	Federal maximum contaminant level goals for drinking water (40 CFR Part 141) and federal secondary drinking water regulation standards (40 CFR Part 143) are potential ARARs under MTCA when they are more stringent then other standards. Method B cleanup levels are levels applicable to remediation at Hanford unless a demonstration can be made that method C (alternate cleanup levels) is valid.

Table 3-23 Potential State Chemical-Specific Applicable or Relevant and Appropriate Requirements for the 100-HR-1 Operable Unit (page 2 of 3)

Description	Citation	A/ R&A*	Requirements	Remarks
Soil Cleanup Standards	WAC 173-340-740	A	MTCA Method B concentration limits in milligrams per kilogram for potential contaminants in soils, sediments, and sludges are: Barium 5,600 Cadmium 40 Chromium (III) 80,000 Chromium (VI) 400 Copper 2,960 Manganese 8,000 Mercury 24 Silver 240 Zinc 16,000 Acetone 8,000 Benzene 34.5 Carbon disulfide 8,000 Methyl ethyl ketone 4,000 Methyl Isobutyl Ketone 4,000 Methylene chloride 133 Toluene 16,000 Anthracene 24,000 Benzo(a)anthracene 0.172 Benzo(b)fluoranthene 0.172 Benzo(k)fluoranthene 0.172 Benzoic acid 320,000 Benzyl alcohol 24,000 Bis(2-ethylhexyl)phthalate 71.4 Chrysene 0.172 Di-n-butylphthalate 8,000 Diethyl phthalate 64,000 Fluoranthene 3,200 N-nitrosodiphenylamine 204 Pyrene 2040 Pentachlorophenol 8.33	

Table 3-23 Potential State Chemical-Specific Applicable or Relevant and Appropriate Requirements for the 100-HR-1 Operable Unit (page 3 of 3)

Description	Citation	A/ R&A*	Requirements	Remarks
Washington State Department of Health	RCW 43.70			
Radiation Protection -- Air Emissions	WAC 246-247		Establishes procedures for monitoring, control, and reporting of airborne radionuclide emissions.	
New and Modified Sources	WAC 246-247-070	A	Requires the use of best available radionuclide control technology (BARCT),	
Radiation Protection Standards	WAC 246-221		Establishes standards for protection against radiation hazards.	
Radiation dose to individuals in restricted areas	WAC 246-221-010	A	Specifies dose limits to individuals in restricted areas for hands and wrists, ankles and feet of 18.75 rem/quarter and for skin of 7.5 rem/quarter.	

*NOTE: A = Applicable, R&A = Relevant and Appropriate

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Table 3-24 Potential Chemical-Specific To-Be-Considered Guidance for the 100-HR-1 Operable Unit (page 1 of 2)

Description	Citation	Requirements	Remarks
Model Toxics Control Act	70.105D RCW		
Cleanup Regulations	WAC 173-340	The State Department of Ecology is currently adapting the calculations in MTCA to be applicable to radioactive contaminants. These cleanup standards may become available prior to or during remediation.	
Solid Waste Disposal Act, as amended by RCRA	42 U.S.C. 6901 et seq.		
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR §257.3-4	A facility or practice shall not contaminate an underground drinking water source beyond the solid waste boundary.	The courts or the state may establish alternate boundaries.
Corrective Action for Solid Waste Management Units	40 CFR 264 Subpart S, proposed	Establishes requirements for investigation and corrective action for releases of hazardous waste from solid waste management units.	
U.S. Department of Energy Orders			
Radiation Protection of the Public and the Environment	DOE 5400.5	Establishes radiation protection standards for the public and environment.	
Radiation Dose Limit (All Pathways)	DOE 5400.5, Chapter II, Section 1a	The exposure of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem from all exposure pathways, except under specified circumstances.	Pertinent if remedial activities are "routine DOE activities."
Radiation Dose Limit (Drinking Water Pathway)	DOE 5400.5, Chapter II, Section 1d	Provides a level of protection for persons consuming water from a public drinking water supply operated by DOE so that persons consuming water from the supply shall not receive an effective dose equivalent greater than 4 mrem per year. Combined radium-226 and radium-228 shall not exceed 5×10^{-8} μCi/mL and gross alpha activity (including radium-226 but excluding radon and uranium) shall not exceed 1.5×10^{-8} μCi/mL.	Pertinent if radionuclides may be released during remediation.

Table 3-24 Potential Chemical-Specific To-Be-Considered Guidance for the 100-HR-1 Operable Unit (page 2 of 2)

Description	Citation	Requirements	Remarks
Residual Radionuclides in Soil	DOE 5400.5 Chapter IV, Section 4a	Generic guidelines for radium-226 and radium-228 are: • 5 pCi/g averaged over the first 15 cm of soil below the surface; and • 15 pCi/g averaged over 15-cm-thick layers of soil more than 15 cm below the surface. Guidelines for residual concentrations of other radionuclides must be derived from the basic dose limits by means of an environmental pathway analysis using specific property data where available. Procedures for these deviations are given in "A Manual for Implementing Residual Radioactive Material Guidelines" (DOE/CH-8901). Procedures for determination of "hot spots," "hot-spot cleanup limits," and residual concentration guidelines for mixtures are in DOE/CH-8901. Residual radioactive materials above the guidelines must be controlled to the required levels in 5400.5, Chapter II and Chapter IV.	Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 m^2.

Table 3-25 Potential Federal Location-Specific Applicable or Relevant and Appropriate Requirements for the 100-HR-1 Operable Unit

Description	Citation	A/ R&A*	Requirements	Remarks
Archaeological and Historical Preservation Act of 1974	16 U.S.C. 469	A	Requires action to recover and preserve artifacts in areas where activity may cause irreparable harm, loss, or destruction of significant artifacts.	Applicable when remedial action threatens significant scientific, prehistorical, historical, or archaeological data.
Endangered Species Act of 1973	16 U.S.C. 1531 et seq.		Prohibits federal agencies from jeopardizing threatened or endangered species or adversely modifying habitats essential to their survival.	
Fish and Wildlife Services List of Endangered and Threatened Wildlife and Plants	50 CFR Parts 17, 222, 225, 226, 227, 402, 424	A	Requires identification of activities that may affect listed species. Actions must not threaten the continued existence of a listed species or destroy critical habitat.	Requires consultation with the Fish and Wildlife Service to determine if threatened or endangered species could be impacted by activity.
Historic Sites, Buildings, and Antiquities Act	16 U.S.C. 461	A	Establishes requirements for preservation of historic sites, buildings, or objects of national significance. Undesirable impacts to such resources must be mitigated.	
National Historic Preservation Act of 1966, as amended.	16 U.S.C. 470 et seq.	A	Prohibits impacts on cultural resources. Where impacts are unavoidable, requires impact mitigation through design and data recovery.	Applicable to properties listed in the National Register of Historic Places, or eligible for such listing. B reactor is listed on the Register.
Wild and Scenic Rivers Act	16 U.S.C 1271	A	Prohibits federal agencies from recommending authorization of any water resource project that would have a direct and adverse effect on the values for which a river was designated as a wild and scenic river or included as a study area.	The Hanford Reach of the Columbia River is under study for inclusion as a wild and scenic river.

*NOTE: A = Applicable, R&A = Relevant and Appropriate

Table 3-26 Potential State Location-Specific Applicable or Relevant and Appropriate Requirements for the 100-HR-1 Operable Unit

Description	Citation	A/ R&A*	Requirements	Remarks
Habitat Buffer Zone for Bald Eagle Rules	RCW 77.12.655			
Bald Eagle Protection Rules	WAC 232-12-292	A	Prescribes action to protect bald eagle habitat, such as nesting or roost sites, through the development of a site management plan.	Applicable if the areas of remedial activities includes bald eagle habitat.
Regulating the Taking or Possessing of Game	RCW 77.12.040			
Endangered, Threatened, or Sensitive Wildlife Species Classification	WAC 232-12-297	A	Prescribes action to protect wildlife classified as endangered, threatened, or sensitive, through development of a site management plan.	Applicable if wildlife classified as endangered, threatened, or sensitive are present in areas impacted by remedial activities.

*NOTE: A = Applicable, R&A = Relevant and Appropriate

Table 3-27 Potential Location-Specific To-Be-Considered Guidance for the 100-HR-1 Operable Unit

Description	Citation	Requirements	Remarks
Floodplains/Wetlands Environmental Review	10 CFR Part 1022	Requires federal agencies to avoid, to the extent possible, adverse effects associated with the development of a floodplain or the destruction or loss of wetlands.	Pertinent if remedial activities take place in a floodplain or wetlands.
Protection and Enhancement of the Cultural Environment	Executive Order 11593	Provides direction to federal agencies to preserve, restore, and maintain cultural resources.	Pertains to sites, structures, and objects of historical, archeological, or architectural significance.
Hanford Reach Study Act	PL 100-605	Provides for a comprehensive river conservation study. Prohibits the construction of any dam, channel, or navigation project by a federal agency for 8 years after enactment. New federal and non-federal projects and activities are required, to the extent practicable, to minimize direct and adverse effects on the values for which the river is under study and to utilize existing structures.	This law was enacted November 4, 1988.

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4.0 QUALITATIVE RISK ASSESSMENT

This chapter provides a summary of the methods and results of the qualitative risk assessment (QRA) that was performed for the high-priority waste sites in the 100-HR-1 Operable Unit. Complete results of the QRA are provided in *Qualitative Risk Assessment of the 100-HR-1 Source Operable Unit* (WHC 1993a).

4.1 QUALITATIVE RISK ASSESSMENT PROCESS

The QRA is an evaluation of risk for a predefined set of human and ecological exposure scenarios. The QRA is not intended to replace or be a substitute for a baseline risk assessment. Consequently, the QRA is streamlined to consider only two human health scenarios (high and low frequency usage) with four exposure pathways (soil ingestion, fugitive dust inhalation, inhalation of volatile organics, and external radiation exposure) and a limited ecological evaluation. The use of these scenarios and pathways was agreed to by the 100 Area Tri-Party Unit Managers (December 21, 1992, and February 8, 1993). Future waste site risk estimates considering the decay of radionuclides to the year 2018, and the effect on external radiation exposure by shielding provided by current soil and gravel covers, is also presented.

4.1.1 Approach

The QRA is conducted using the HSBRAM (DOE-RL 1993b) as guidance and consists of:

- An evaluation of the data sources and/or process information
- Identification of maximum constituent concentrations, where data are available
- A human health risk evaluation
- An ecological risk evaluation
- An analysis of potential impacts to groundwater

Key factors that contribute to uncertainty throughout the risk assessment process are also identified.

4.1.2 Guidelines Used in the Qualitative Risk Assessment

The following guidelines were agreed to by the Tri-Party Unit Managers prior to performing the QRA:

- Site-wide soil background concentration data are used to screen inorganic constituents.

- Historical radionuclide concentrations are decayed to 1992.

- The maximum contaminant concentration within the upper 4.6m (15 ft) of soil, either from historical or LFI data, are used to estimate risk in the QRA.

- Two scenarios, high frequency usage and low frequency usage, are evaluated in the human health section of the QRA.

- For the human health exposure assessment, the pathways evaluated in the QRA are: soil ingestion, fugitive dust inhalation, inhalation of volatile organics, and external radiation exposure.

- Ecological scenarios are evaluated using the Great Basin pocket mouse because it is a key component of the Hanford area food chain and a biological endpoint with a range similar in size to the dimensions of most individual waste sites.

Several other guidelines are used in the QRA. The data collection during the LFI for the operable unit followed a known process and therefore the data are considered to be of high quality. Historical data (e.g., Dorian and Richards 1978) are considered to be of medium quality because the data were not validated and documentation was less rigorous. Where historical data do not specify uranium isotopes, U-238 is evaluated because it represents >99% of natural uranium. Chromium is assumed to be present as chromium (VI) because it provides the most conservative evaluation and chromium was not speciated during analysis. Nickel in the soil environment is not considered carcinogenic because the pyrolytic activity which generates the carcinogenic form of nickel was not present in the operable unit. If toxicity factors are not available for a constituent, surrogate factors are generally not used, unless specifically noted.

The qualitative risk estimations are grouped into high (incremental cancer risk [ICR] > 1E-02), medium (ICR > 1E-04 to 1E-02), low (ICR 1E-06 to 1E-04), and very low (ICR < 1E-06) risk categories. A high frequency scenario is evaluated in 2018 to ascertain potential future risks associated with each waste site after additional radionuclide decay. For the current low frequency scenario, the effect of radiation shielding by the upper 2 m (6 ft) of soil on the external exposure risk at each waste site is evaluated.

For the ecological risk assessment, metals are assumed to be bioavailable for uptake by vegetation. The identified concentrations are assumed to be uniformly distributed over the site, biologically active, and available for transport. Hazard quotients (HQ) for ecological exposure to radionuclides are based on an exposure limit of 1 rad/day (DOE Order 5400.5) and the lowest observable effect level (LOEL) dose.

4.2 HUMAN HEALTH QUALITATIVE RISK ASSESSMENT

The QRA provides estimates of risk that might occur under high frequency or low frequency scenarios based on the best available knowledge of current contaminant conditions, but does not represent actual risks since neither high frequency nor low frequency usage of high priority sites currently occurs.

4.2.1 Overview of the Human Health Risk Evaluation Process

The high frequency and low frequency scenarios are evaluated using residential and recreational exposure parameters from HSBRAM (DOE-RL 1993b), respectively. The high frequency scenario is addressed for current (1992) and future (2018) contaminant concentrations. Air inhalation of volatile organics is eliminated from this analysis because volatile organics are not present above preliminary risk-based screening levels in the soil at any waste site. Therefore, inhalation of volatile organics is not a likely exposure pathway for this operable unit. For the soil ingestion and external exposure pathways, maximum sample concentrations from the upper 4.6 m (15 ft) of soil are used. For the fugitive dust inhalation pathway, maximum contaminant concentrations in the upper 4.6 m (15 ft) of soil are used in conjunction with a particulate emission factor. This factor relates contaminant concentrations in the soil to concentrations of respirable particles in the air due to fugitive dust emissions. Quantification of exposures is conducted using Section 2.3 of HSBRAM (DOE-RL 1993b).

The external exposure pathway is also evaluated for the current low frequency scenario while considering the effect of shielding by existing soil cover. In this evaluation, only radionuclides detected in the upper 2 m (6 ft) of soil are considered as contributors to external radiation exposure. These external exposure risks are considered to be more representative of current site conditions where activities in a contaminated zone are controlled.

Section 2.3 of the HSBRAM (DOE-RL 1993b) contains the general procedures followed in the QRA for toxicity assessment. The toxicity assessment in the QRA involves the selection of slope factors and reference doses for contaminants of potential concern and includes sufficient toxicity information on contaminants of potential concern to assist project managers in reaching decisions on IRMs.

Risk characterization for the individual waste sites differs depending on the type and amount of data available for the specific waste site. Risk characterization is conducted in accordance with Section 2.4 of HSBRAM (DOE-RL 1993b). The risk characterization for each site is performed by calculating contaminant-specific ICRs and HQs and then summing contaminant-specific risks to obtain a risk estimate for the waste site.

For sites where sampling data are not available to calculate ICRs and HQs, the risk characterization consists of a qualitative discussion of the site, the potential threat

posed by the site, and the confidence in the information available to assess the threat. Risk estimates from analogous sites are used, where appropriate, to qualitatively determine possible contaminants and potential risk levels. The basic intake equations presented in Appendix C of the 100-HR-1 QRA (WHC 1993a) are modified to identify soil contaminant concentrations associated with an ICR of 1E-06 or an HQ of 1, using HSBRAM (DOE-RL 1993b) exposure parameters.

4.2.2 Results of the Human Health QRA

An overview of the human health QRA, and associated uncertainties, for the 100-HR-1 QRA are summarized in the following sections.

Information summarized in Tables 4-1, 4-2 and 4-3 for the human health QRA includes:

- Data availability and confidence in data
- The qualitative risk estimation
- The risk-driving contaminants for the high frequency and low frequency scenarios
- The risk-driving pathways for the high frequency and low frequency scenarios

The risk-driving contaminants for both the high frequency and low frequency scenarios are generally radionuclides and the primary risk-driving pathway is usually the external exposure pathway.

The high-priority waste sites listed in Table 4-2 of the 100-HR-1 work plan (DOE 1992a) are evaluated in the QRA. Where LFI data were not collected, historical data were used in the risk assessment. Where sampling data were not available, risk estimates from analogous waste sites (if any) were considered in evaluating the potential risk from the waste site.

Based on the QRA, the high-priority waste sites within the 100-HR-1 Operable Unit are grouped into high, medium, low, and very low risk categories as shown in Table 4-3. The results of the high frequency scenario are summarized as follows:

- The waste site(s) considered high risk for the high frequency scenario are the 116-H-1 trench (1992, 2018), 116-H-3 french drain (1992), 116-H-7 retention basin (1992, 2018), and process effluent pipelines (sludge) (1992, 2018).

- The waste site(s) considered medium risk for the high frequency scenario are the 116-H-2 trench (1992, 2018), 116-H-3 french drain (2018), and 116-H-9 crib (1992, 2018).

- The waste site(s) considered low risk for the high frequency scenario are the process effluent pipelines (soil) (1992, 2018) and 116-H-7 sludge burial trench (1992).

- The waste site(s) considered very low risk for the high frequency scenario is the 116-H-7 sludge burial trench (2018).

The results of the low frequency scenario are summarized as follows:

- The waste site(s) considered high risk for the low frequency scenario are the 116-H-7 retention basin and process effluent pipelines (sludge). The risk-driving radionuclides at the process effluent pipelines (sludge) waste site are not present in the upper 2 m (6 ft) of soil.

- The waste site(s) considered medium risk for the low frequency scenario is the 116-H-1 trench.

- The waste site(s) considered low risk for the low frequency scenario are the 116-H-2 trench, 116-H-3 french drain, and 116-H-9 crib.

- The waste site(s) considered very low risk for the low frequency scenario are the process effluent pipelines (soil) and 116-H-7 sludge burial trench.

Other results of the QRA as presented in Tables 4-2 and 4-3 are:

- Radionuclides are identified as the primary contributors to the overall risks via the external exposure pathway. The specific radionuclides identified as key contributors are Co-60, Cs-137, Eu-152, and Eu-154.

- There are several sites where potential contaminants are identified only on the basis of historical information and no contaminant concentrations are known. These sites include the 116-H-5 outfall structure, 132-H-2 pump station, 116-H-6 retention basin, 132-H-2 building, 132-H-1 stack, and 116-H-4 crib. Concentrations at which an ICR of 1E-06 or an HQ of 1.0 would exist are calculated for the potential contaminants. Estimated risks are considered qualitative estimates and are based on suspected risk-driving contaminants, disposal information, and the size of the waste site.

The risks, both carcinogenic and non-carcinogenic, presented in this QRA are deterministic estimates given multiple assumptions about exposure, toxicity, and variables. Consequently, uncertainty exists for the evaluation of the contaminants, the exposures, the toxicities, and the risk characterization for the QRA. This uncertainty is discussed more extensively in the following sections.

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4.2.3 Summary of Key Uncertainties in the Human Health Risk Assessment

In general, the QRA is based on a limited data set. Uncertainties are associated with both the contaminants identified for each waste site and the concentrations of the contaminants. Collected samples may not be representative of conditions throughout the waste site and historical data may not accurately represent current conditions. Because the samples may not be completely representative of the site, risks may be underestimated or overestimated.

Uncertainty exists with respect to the identification of specific contaminants. Where the isotope of uranium is not specified uranium is evaluated as U-238. The slope factors for the various uranium isotopes differ slightly from one another, resulting in slightly different risks if each is evaluated separately. The valence state of chromium identified in the QRA samples was not known. For the risk estimate, the most toxic form was assumed (Cr VI). However, risks are overestimated if chromium exists as the less toxic form (Cr III).

External exposure slope factors are appropriate for a uniform contaminant distribution, infinite in depth and areal extent (i.e., an infinite slab source), with no clean soil cover. For high-energy gamma emitters (e.g., Co-60 and Cs-137), the assumption of an infinite slab source can only be satisfied if these radionuclides extend to nearly 2 m (6 ft) below ground surface, and over a distance of a few hundred meters or more. If the site being evaluated is smaller than this, or if the site has a clean soil cover, then use of external exposure slope factors is likely to provide risk estimates that may be unrealistic. The fact that the external exposure pathway is the risk-driver at many waste sites is not surprising and in some cases may be indicative of the conservatism built into the evaluation of this pathway rather than the actual associated risk.

There is uncertainty associated with the toxicity information available to assess potential adverse effects. The interpretation of the toxicity data and the actual toxicity values used for the QRA are both sources of uncertainty. These uncertainties contribute to the uncertainty in the risk assessment.

When there is a high degree of uncertainty associated with the information used to determine toxicity, there is less confidence in the assessment of the risk associated with exposure. The primary sources of these uncertainties include the following:

- Use of information on dose-response effects from high-dose exposure scenarios to predict effect at low-dose exposure scenarios.
- Use of animal dose-response data to predict effects in humans.
- Use of short-term exposure data to extrapolate to long-term exposure, or vice versa.

- Use of dose-response information from a homogeneous animal or healthy human population to predict the effects that may occur in the general population where there are varying sensitivities to different contaminants.

Uncertainty in the risk characterization also results from summing ICRs and HQs across contaminants and pathways, a process which gives equal weight to toxicity information derived from different sources or species. Exposures to multiple contaminants may result in additive effects or effects that are greater or less than additive.

Historical information and risk estimates from analogous sites may be used to evaluate some of the high-priority waste sites. The selection of analogous sites for the QRA is based on available information at the time the QRA was prepared. As additional information is identified and incorporated into the LFI report for an operable unit, the QRA should be updated to utilize additional pertinent information.

4.3 ECOLOGICAL QUALITATIVE RISK ASSESSMENT

The purpose of the qualitative ecological risk assessment is to estimate the ecological risks from existing contaminant concentrations in the 100-HR-1 Operable Unit to selected ecological receptors.

The 100-HR-1 Operable Unit is a terrestrial waste unit. The approach consistent with the objective of the QRA is to assess the dose to the Great Basin pocket mouse which is the indicator ecological receptor of risk from each of the waste sites within the 100-HR-1 operable unit. The mouse is used as the indicator receptor because it's home range is comparable to the size of most waste sites and will receive most of it's dose from a waste site. This allows a risk comparison between waste sites.

Ecological Effects. Contaminants found in the soil at waste sites within the 100-HR-1 Operable Unit include radioactive and nonradioactive elements. For nonradioactive elements, ecological effects were evaluated from uptake from the soil by plants, and by accumulation of these elements through the foodweb. Radioactive elements have ecological effects resulting from their presence in the abiotic environment (external dose), and from ingestion (e.g., dose from contaminated food consumption), resulting in a total body burden. Total daily doses to an organism can be estimated as the sum of doses (weighted by energy of radiation) received from all radioactive elements ingested, residing in the body, and available in the organism's environment. Radiological dose calculation methodology as reviewed by Baker and Soldat (1992), were applied in this QRA.

The radiological dose an organism receives is usually expressed as rad/day. Exposure can result from both external environmental radiation and internal radiation from body burden. All exposure pathways are added in determining total organism dose. Internal exposure includes both body burden (contaminants that are taken into the body from all pathways) and dose from recent food consumption which is still in the gut.

Endpoint Selection. The assessment and measurement endpoint is the health and mortality of the Great Basin pocket mouse, respectively. This is consistent with the objective of the qualitative ecological risk assessment. The dose to the pocket mouse was used to screen the level of risk of an individual waste site. For radionuclides, mouse dose is compared to 1 rad/day (Order DOE 5400.5) (IAEA 1992). For nonradiological contaminants, dose is compared to toxicity values.

Risk is evaluated for the Great Basin pocket mouse based on a two-step accumulation model operated on a waste-site-by-waste-site basis, since each waste site approximates the size of the Great Basin pocket mouse home range. The method of integration is based on averaging waste site constituent concentrations over the operable unit as a fraction of the total operable unit area.

Exposure Analysis. The purpose of the exposure analysis is to integrate the spatial and temporal distributions of the ecological components and stressors to evaluate exposure.

All nonradioactive and radioactive constituents identified as of potential concern in the human health risk assessment (before the screening of constituents with the greatest human health risk) were considered to be of concern in the ecological risk assessment. Because of the lack of site-specific data other than soil, it was assumed the receptor spends some fraction of it's life in the site, obtains all its food from the site when present, and all consumed food is contaminated. However, because there is no source of water within the site, drinking water was not considered a route of exposure.

For nonradiological constituents, concentrations estimated in mice were compared to the reported benchmark or potentially toxic concentrations. For radiological constituents, mice concentrations were converted to dose. Total dose for all radionuclides are compared to published effect levels and regulatory standards where available.

Exposure Profile. The ecological risk assessment focuses on potential noncarcinogenic effects on the Great Basin pocket mouse potentially exposed to constituents present in the 100-HR-1 Operable Unit waste sites. Terrestrial vegetation is represented as a generic plant species for uptake from the soil and as a food source for mice.

The major route of contaminants to plants is assumed to be direct uptake from soil. Ingestion of vegetation is assumed to be a major route of exposure to the mouse and ingestion of mice and insects is the major route for the shrike, for both nonradiological and radiological constituents. For radionuclides, the exposure pathway considered uptake from contaminated food resulting in internal exposure. For both radiological and nonradiological contaminants, the dose is based on receptor whole-body concentrations. Metals stressors are assumed to be bioavailable for uptake by vegetation, which is consistent with the objectives of the QRA.

4.3.1 Results of the Ecological Evaluation

A qualitative ecological risk assessment was completed for the 100-HR-1 Operable Unit. Site 116-H-1 Trench, 116-H-2 Trench, 116-H-7 Retention Basin, Process Effluent Pipelines (sludge) exceeded the 1 rad/day with an EHQ >1.

Routine surveying of surface soil contamination in the 116-H-1, 116-H-2, and 116-H-7 sites showed beta levels which indicated surface contamination. For nonradiological constituents, site 116-H-1 Trench exceeded the NOEL (No Observable Effect Level) for arsenic, however the concentration used in the risk characterization is from the 0-15 feet soil interval. The NOELs for arsenic, lead and zinc are exceeded at site 116-H-7. Waste site 116-H-9 Crib exceeded NOELs for barium, manganese and vanadium.

Other results of the QRA as presented in Tables 4.4 and 4.5 are:

For sites that exceeded the radionuclide 1 rad/day benchmark, all of the dose is from Sr-90.

The estimated dose from Sr-90 to the Great Basin pocket mouse exceeded 1 rad/day from all waste sites that had measurable Sr-90 at the 100-HR-1 Operable Unit (Table 4-4 of the QRA). This extremely high calculated dose is believed to be an artifact of the modeling parameters (e.g., source term) and does not reflect actual conditions. The significance of dose estimates, either radiological or hazardous chemicals, as the risk driver is governed by the accuracy of the source terms. If the source of Sr-90 is 6-15 feet below the surface, the dose may not represent real ecological risk since the exposure scenario is unrealistic. The approach in the QRA is to use the maximum level of contamination irrespective of depth (anywhere from 0-15 ft depth) which drives the QRA far into the conservative side and makes the results useful only for comparison between waste sites.

4.3.2 Summary of Key Uncertainties in the Ecological Evaluation

The uncertainty in contaminant concentrations for the ecological evaluation is related to the accuracy of the data. For the QRA, uncertainty exists in both contaminants identified and exposure concentrations. As for the human health assessment, the maximum contaminant concentration was used.

The QRA models the potential exposure of wildlife suspected to actually be present in or near the waste site. The issues of concern with regard to ecological risk assessment (particularly qualitative) are the uncertainties in using an assortment of environmental variables in risk modeling. This begins with the source term. If this number is not realistic, no amount of modeling will overcome this deficiency. For example, in the case of the QRAs, the maximum reported waste concentration was used as the source term no matter how deep this concentration.

Generally, site specific organisms (e.g., pocket mouse), are identified as being associated with a site, but little if any data may exist concerning transfer of contaminants to site specific organisms. Often, it is necessary to use biological trophic transfer information for related species.

A significant source of uncertainty in the exposure scenario is that the waste site is uniformly contaminated and in the case of the mouse, all foodstuff is assumed to be contaminated. No provision is made for dilution of contaminated foodstuff by non-contaminated foodstuff. It was also assumed contaminants were not passed through the gut but completely retained (100% absorption efficiency).

To complete the QRA for the 100-HR-1 Operable Unit it was necessary to use data from surrogate organisms in place of the pocket mouse since no site data is available for this organism. This contributes to overall QRA uncertainty. In addition, transfer coefficients used to model uptake of contaminants from soil to plants were not Hanford specific, the approach did not consider whether roots of a plant actually grow deep enough to contact a contaminant, and the model did not account for reduced concentrations from plant to seed (it was assumed the seed concentration was the same as the plant). The pocket mouse food consumption rate was generalized and seasonal behavior (hibernation) that would reduce exposure and body burden was not considered.

Uncertainty associated with wildlife toxicity values is significant, particularly for non-radiological contaminants. The approach used in the QRA tends to build conservatism into the toxicity value.

4.4 QUALITATIVE OVERVIEW OF POTENTIAL GROUNDWATER IMPACTS

4.4.1 Evaluation of Potential Groundwater Impacts

The constituents present in sediments or soils associated with high-priority waste sites in the 100-HR-1 Operable Unit have the potential to migrate through the vadose zone and into groundwater. The only constituents detected at significant levels in groundwater beneath the 100-HR-1 Operable Unit are gross beta, Sr-90, U, Tc-99, H-3, chromium, and nitrate.

The reactor cooling water effluent is the likely source of the radionuclides and chromium and is associated primarily with the 116-H-7 retention basin and 116-H-1 trench. Nitrate, as well as U and Tc-99, are associated with the 116-H-6 retention basin. Other radionuclides associated with the reactor cooling water have generally flushed to the river, decayed, or are sorbed to soils in the vadose zone.

Because of the high degree of uncertainty related to groundwater impacts, numerical risk estimates are not calculated. Instead, the potential for groundwater impacts is qualified as either high, medium, or low, as shown in Tables 4-2 and 4-3. "High" indicates that there is a significant possibility that groundwater is being impacted

from the waste site. "Medium" indicates that it is possible, but not highly likely, that groundwater is being impacted from the waste site. "Low" indicates that there is a very small chance that groundwater is being impacted from the waste site. An "unknown" rating indicates that there is insufficient information available to assess the possibility of groundwater being impacted from the waste site.

4.4.2 Uncertainties Associated with Evaluating Potential Groundwater Impacts

Uncertainty exists in the evaluation of potential impact to groundwater for the following reasons:

- Little contaminant data are available from vadose zone soils near the water table.
- Little information exists regarding constituent solubilities, soil/water partitioning, and infiltration rates.
- In general, the QRA is based on a limited data set. Actual sources responsible for observed groundwater contamination are difficult to identify.

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Table 4-1 Summary of Data Availability and Data Confidence (for sites where data are available).

Waste Site	Summary of Data Availability and Data Confidence				
	Historical Data[a]	LFI Data[a]	Data from the same Medium[b]	Confidence in Contaminant Identification	Confidence in Contaminant Concentrations
Sites with LFI data and historical data					
116-H-1 trench	R	R,I,O	Yes	high	medium
116-H-2 trench	R	R,I,O	Yes	medium	medium
116-H-3 french drain	R	R,I,O	Yes	high to med.	medium
116-H-7 retention basin	R	R,I,O	No	high	low
116-H-9 crib	-	R,I,O	-	high	high
Sites with historical data only					
Process Effluent Pipelines	R	-	-	medium	low
116-H-7 sludge burial trench	R	-	-	med. to low	low

- = Not applicable
[a] R = radionuclide, I = inorganic, O = organic contaminant
[b] LFI and Historical Data are from the same medium (e.g., both from soil) or from different media (e.g., soil and sludge)

Table 4-2 Human Health Data and Risk Assessment Summary (for sites where only process knowledge is available).

Site	Disposal Information	Suspected Risk-Driving Contaminants	Description and Notes	Qualitative Risk Rating*	Rationale for Rating	Potential Groundwater Impact
116-H-5 outfall structure	Unknown volume of treated process effluent from the 116-H-7 retention basin between 1949 and 1965.	Co-60, Eu-152, Eu-154, As	Compartmented concrete box measuring 378 x 27 x 14 ft.	medium	116-D-5 outfall structure in the 100-DR-1 operable unit has a high risk estimate.	low
132-H-3 pump station	Pumped water from H reactor drains from 1949 to 1965. Sump water and sludge removed in 1987.	Co-60, Cs-134, Ra-226, Th-228, As, Hg	Demolished and buried in-situ in 1987. Backfilled with a minimum of 15 ft of clean fill.	low	Building rubble buried under 15 ft of fill.	unknown
116-H-6 retention basin	Received fuel fabrication wastes from the N reactor, treated wastes by solar evaporation. Received wastes through 1985.	uranium, P, thallium oxide, As, Hg, Sb, Be	Four concrete basins measuring 45 x 33 x 10 ft. Decommissioned in 1991.	medium	Possible effluent leakage; high volume of liquid waste received.	high
132-H-2 building	Filtered reactor exhaust air prior to emission using HEPA and halogen filters.	Co-60, Sr-90, Cs-137, Eu-152, Eu-154	59 x 39 x 35 ft. concrete building, 90% below ground. Demolished and buried in-situ in 1983 and covered with 3 ft of soil.	low	Building rubble buried under 3 ft. of fill; filters removed.	low
132-H-1 stack	Emitted filtered air from the 132-H-2 building. Documented radionuclide release in 1955.	Co-60, Sr-90, Cs-137, Eu-152	200 x 16 ft concrete stack, demolished in 1983 and covered with 3 ft of soil.	low	Building rubble buried under 3 ft of soil.	low
116-H-4 crib	Received low volumes of cooling water during periods of fuel element failure; discharged waste from fuel element failure.	(See 132-H-2 building evaluation)	4 x 4 x 2 ft crib used from 1950 to 1952. Excavated in 1960 to a depth of 30 ft for construction of 132-H-2 building on same site.	low (See 132-H-2 building evaluation)	Crib was in service only two years, has been excavated to a 30 ft depth.	low

* Rating is qualitative based on process information, analogous site information, and site-specific information such as size, potential contaminants, and location of contamination as indicated under rationale column. Additional discussion on the rating is provided for each site in the 100-HR-1 QRA (WHC 1993a)

Table 4-3 Human Health Risk Assessment Summary (for sites where data are available).

Waste Site	Human Health Risk Assessment Summary					Potential Groundwater Impact
	Frequent-Use Scenario			Occasional-Use Scenario		
	Qualitative Risk Estimation		Risk Driving Contaminant[a] (and pathway[c])	Qualitative Risk Estimation (1992)	Risk Driving Contaminant[a] (and pathway[c])	
	1992	2018				
Sites with LFI and historical data						
116-H-1 trench	high	high	R(O,I,E)[e]I(O,I) O(I)	medium	R (E), I(O)	high
116-H-2 trench	medium	medium	R(O,I,E)	low	R (E)	low
116-H-3 french drain	high	medium	R(O,I,E)	low	R[d] (E)	low
116-H-7 retention basin	high	high	R (O,I,E) I(O,I)	high	R (O,I,E) I(O)	high
116-H-9 crib	medium	medium	R(I,E)[e] I(O,I)	low	R(E) I	low
Sites with historical data only						
process effluent pipelines (soil)	low	low	R[dg](E)	very low	-	medium
process effluent pipelines (sludge)	high	high	R[g](O,I,E)	high	R[g](O,I,E)	medium
116-H-7 sludge burial trench	low	very low	R[dfg](E)	very low	-	low

- = Not applicable
[a] R = radionuclide, I = inorganic, O = organic contaminant
[b] LFI and Historical Data are from the same medium (e.g., both from soil) or from different media (e.g., soil and sludge).
[c] O = oral, I = inhalation, E = external exposure pathways.
[d] Radionuclides contributing >1E-06 to the risk have half-lives of 30 years or less.
[e] Only the external exposure pathway has the risk driving contaminants for 2018.
[f] No risk driving contaminants present in 2018.
[g] Radionuclide concentrations analyzed and detected in upper 2 m (6 ft) did not exceed ICR of 1E-06 (see Appendix F in WHC 1993b).

Table 4-4 Environmental Hazard Quotients Summary for Radionuclides by Waste Site.

Waste Site	Dose Rate Exceeds EHQ of 1
116-H-1 Trench	yes
116-H-2 Trench	yes
116-H-3 Drain	no
116-H-7 Retention Basin	yes
116-H-9 Crib	no
Process Effluent Pipelines (Soil)	no
Process Effluent Pipelines (sludge)	yes

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Table 4-5 Environmental Hazard Quotient Summary for Non-radiological Contaminants by Waste Site.

Contaminant	Dose Rate Exceeds EHQ of 1
116-H-1 Trench	yes-arsenic
116-H-7 Retention Basin	yes-arsenic, lead, zinc
116-H-9 Crib	yes-barium, manganese, vanadium

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5.0 RECOMMENDATIONS

The primary purpose of the LFI report is to recommend those high-priority sites that should remain candidates on the IRM path and those high-priority sites which should not remain candidates for the IRM path. Sites that are not recommended as candidates for an IRM will be addressed in the final remedy selection process. These recommendations are generally independent of future land-use scenarios.

5.1 GENERAL CONSIDERATIONS

Analysis of LFI samples from the high priority sites did not detect any pesticide or PCB compounds and only three VOCs were found. The VOCs are most likely the result of contamination from analytical procedures used in the off-site analytical laboratories. The detected semi-volatile compounds were PNAs which are typical constituents in coal tars and creosote. The source of this contamination is likely creosote treated timbers and pipes. Timbers were used to construct the cribs and the wood baffles in the retention basins. Contamination by metals was found at the 116-H-7 retention basin and the 116-H-1 trench. Radionuclide contamination was detected at both these sites and at the 116-H-3 drain where a very small concentration of Eu-152 was detected. Radionuclide contamination was detected at all five sites investigated during the LFI. The 116-H-7 retention basin and the 116-H-1 trench had the highest detected concentrations of man-made radionuclides. The other three sites (116-H-2 trench, 116-H-3 drain, and 116-H-9 crib) had small concentrations, <2 pCi/g, of radionuclide contaminants.

The historical data (Dorian and Richards 1978) were found to be generally reliable in predicting the probability of radionuclide contamination but unreliable in predicting the levels of contamination. The historical analytical results were consistently found to indicate levels of radionuclide contamination one to three orders of magnitude higher than the LFI data. The cause of this disparity is unclear but may be due to differences in analytical instrumentation accuracy or sampling locations.

None of the sites pose an imminent threat to human health or the environment, or pose risks sufficient to warrant an ERA. The evaluation of sites is presented in the following sections.

5.2 HIGH-PRIORITY SITE IRM CANDIDATE EVALUATION CRITERIA

The 100-HR-1 high-priority sites were evaluated using the following criteria to identify those sites where continuing the IRM pathway is recommended:

- An assessment of the adequacy of the waste site conceptual model
- Identification of any ARAR exceedance for vadose zone contaminants

- The 100-HR-1 QRA (WHC 1993a)
- An evaluation of site-specific contaminant impact on groundwater
- Identification of sites where natural attenuation by the year 2018 may mitigate contamination.

5.2.1 Conceptual Model

The conceptual model for the waste site includes sources of contamination, types of contaminants, nature and extent of contamination in each affected media, known and potential routes of migration, known or potential human and environmental receptors, and the general understanding of the site structure/process. This information is included in Chapter 3 of the 100-HR-1 work plan (DOE-RL 1992a) and has been revised using data obtained during the LFI. Table 5-1 presents sources of contamination, contaminants of potential concern, nature and extent of contamination in each affected media, and the general understanding of the structure/process for each high-priority waste site. Figure 5-1 presents the known and potential routes of migration, known or potential human and environmental receptors for the operable unit. If the conceptual model of a site is incomplete the site is recommended to remain as an IRM candidate while the data needed to complete the model are collected. After the data are available the site will be reevaluated for continued candidacy for an IRM. The additional data may be obtained through limited field sampling.

5.2.2 Applicable or Relevant and Appropriate Requirements

The Washington State MTCA Method B concentrations are potential ARARs for soil contamination, as discussed in Section 3.25 of this report and in the *100 Area Feasibility Study, Phases 1 and 2* (DOE-RL 1992c). Model Toxics Control Act Method B regulatory limits for soil contaminant concentrations are utilized since they are the standard approach and are conservative. Table 5-2 lists the Hanford Site background 95% UTL values for metallic constituents in soils and MTCA Method B guidelines for soil. Sites that have concentrations of contaminants which exceed this potential chemical-specific ARAR are recommended to continue as IRM candidates.

5.2.3 Qualitative Risk Assessment

The QRA provides risk estimates for human health and for adverse ecological effects. Human health risks, specifically ICR, for the high-priority sites were developed in the QRA using two scenarios: high-frequency use and low-frequency use. The low-frequency use risk values are used to evaluate the continued candidacy of high-priority sites for IRMs. The qualitative risk estimations presented in Table 5-3 are grouped into high (ICR > 1E-02), medium (ICR > 1E-04 to 1E-02), low (ICR 1E-06 to 1E-04), and very low (ICR < 1E-06) risk categories based on results presented in Chapter 3 of the

100-HR-1 QRA (WHC 1993a). Sites that pose medium or high risks to human health under the low-frequency use scenario are recommended to continue as IRM candidates.

Environmental hazard quotient (EHQ) ratings are from the qualitative ecological risk assessment that was performed in the QRA. Sites that have an EHQ rating greater than 1 for radionuclides or non-radiological constituents present potentially adverse ecological impact and are recommended to continue as IRM candidates.

5.2.4 Current Impact on Groundwater

If LFI results indicate that a site is a current source of groundwater contamination or has a high probability of being a current contamination source, then the site is recommended to continue as an IRM candidate. The evaluation is based on review of monitoring well data from the 100-HR-3 Groundwater Operable Unit LFI (DOE-RL 1993d), the analysis presented in the 100-HR-1 QRA (WHC 1993a), and hydrogeological evaluation.

5.2.5 Potential for Natural Attenuation

The potential for the contaminants at a site to be reduced by natural attenuation, i.e., radioactive decay by the year 2018, may be a consideration at sites where radionuclides with half lives less than 30 years are the primary contaminant and external exposure is the only pathway. Sites with excess risk, i.e., greater than 1E-06, attributed to radionuclides with half lives less than 30 years, i.e., Co-60, Cs-137, Eu-152, and Eu-154, have potential for natural reduction of risk through radioactive decay. Natural attenuation is not a consideration for sites contaminated by metals, by radionuclides with half-lives greater than 30 years, or where multiple exposure pathways drive the risk.

5.3 HIGH-PRIORITY SITE IRM CANDIDATE RECOMMENDATIONS

The final selection of IRM sites, priority of action, and order performance are decisions left to the Tri-Party Agreement signatories. Factors that the Tri-Party Agreement signatories may consider in the selection and prioritization of IRM sites include:

- Impact of IRM actions in relation to the 100 Area Environmental Impact Statement, e.g., disposition of the reactors
- Access control
- Relation to the IRM Program Plan recommendations
- Land use

- Point of compliance
- Time of compliance
- Feasibility
- Bias-for-action, and
- Threat to human health and the environment.

The high-priority sites recommended to continue as IRM candidates are identified in the "IRM Candidate" column of the Table 5-3. The recommendations are discussed below.

5.3.1 116-H-1 Process Effluent Disposal Trench

The 116-H-1 process effluent disposal trench is recommended to continue as an IRM candidate because the human health risks are medium, the EHQ is greater than 1, the site contains concentrations of metals in excess of the MTCA Method B guidelines, and there is a high probability of current or future impact on the groundwater. Monitoring wells H4-13 and H4-45, constructed and sampled as part of the 100-HR-3 Groundwater Operable Unit LFI (DOE-RL 1993d), have elevated levels of Strontium-90 relative to upgradient wells (33 and 13 pCi/l respectively). The conceptual model of the site was confirmed by the LFI vadose borehole sampling activities. There is no potential for natural attenuation by the year 2018 due to the elevated levels of Sr-90, and Tc-99, both of which have half-lives greater than 30 years.

5.3.2 116-H-2 Effluent Disposal Trench

The 116-H-2 effluent disposal trench is recommended to continue as an IRM candidate because the conceptual model is considered incomplete. The historical data are inconsistent with the LFI data. The LFI data indicate that the only contaminants present are very small amounts (< 1 pCi/g) of naturally occurring radionuclides. The historical data indicates the presence of considerably higher amounts of man-made radionuclides. The vadose borehole drilled as part of the LFI investigation was located in the southwest corner of the 116-H-2 site. It is possible that a second borehole, located near the center of the trench, would detect contamination at similar levels to that detected by Dorian and Richards (1978). Additional investigation is required to either confirm the historical or existing LFI data. The status of the site as an IRM candidate should then be re-evaluated.

5.3.3 116-H-3 Dummy Decontamination French Drain

The 116-H-3 dummy decontamination French drain is recommended to be removed as a candidate for an IRM because the human health risk is low, the EHQ is less than 1, and no contaminants exceed MTCA Method B guidelines. The conceptual model of the site was confirmed by the LFI vadose borehole sampling activities. The probability of current impact to the groundwater is low. Natural attenuation of the site by the year 2018 will reduce the risk posed by the radionuclide contaminants.

5.3.4 116-H-7 Process Effluent Retention Basin

The 116-H-7 process effluent retention basin is recommended to continue as an IRM candidate because the human health risk is high, the EHQ is greater than 1, the site contains concentrations of metals in excess of the MTCA Method B guidelines, and there is a high probability of current or future impact on the groundwater. Monitoring well H4-11, constructed and sampled as part of the 100-HR-3 LFI (DOE-RL 1993d), is located downgradient from the retention basin and has elevated gross alpha levels, as well as elevated levels of Sr-90, Tc-99, and chromium relative to upgradient wells. Monitoring well H4-13 also has elevated levels of Sr-90 relative to upgradient wells. The conceptual model of the site was confirmed by the LFI vadose borehole sampling activities. The potential for natural attenuation by the year 2018 is low due to presence of Sr-90 and Pu-239/240.

5.3.5 116-H-9 Confinement Seal Pit Drainage Crib

The 116-H-9 confinement seal pit drainage crib is recommended to be removed as an IRM candidate. The site has a low human health risk, an EHQ of less than 1, and no contaminants exceed MTCA Method B guidelines. Data from monitoring wells H3-1 and H4-49 (DOE-RL 1993d) indicate that the site is not impacting the groundwater. Natural attenuation of the site by the year 2018 will reduce the risk posed by the radionuclide contaminants and the associated pathway.

5.3.6 116-H-5 Process Effluent Outfall Structure

The 116-H-5 process effluent outfall structure is recommended to continue as an IRM candidate because the human health risk is medium. No concentrations of metals were found in the investigation of the analogous site that exceeded MTCA Method B guidelines. The probability is low that the outfall structure is currently impacting the groundwater. The conceptual model of the site was confirmed by the intrusive investigations of the 100-DR-1 LFI (DOE-RL 1993c). The potential for natural attenuation of the radionuclides is low since some of the radionuclides expected to be present (Ra-226 and Th-228) have half-lives greater than 30 years.

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5.3.7 Process Effluent Pipelines - Sludge and Soil

The process effluent pipelines are recommended to continue as IRM candidates. Based on the sludge, the pipelines have a high human health risk and a medium probability of a current or future impact on groundwater. Because of the great linear extent of the process effluent pipelines across the 100-HR-1 Operable Unit, it is difficult to assess, from the existing monitoring wells, the current impact to groundwater posed by the process effluent pipelines. Because of the large volumes of effluent transported by the pipelines and their history of extensive leakage they are considered to be current sources of groundwater impact.

The conceptual model for the pipelines was confirmed by LFI activities. The potential for natural attenuation by the year 2018 is low due to presence of Sr-90 and Pu-239/240.

5.3.8 116-H-7 Sludge Burial Trench

The 116-H-7 sludge burial trench is recommended to be removed as an IRM candidate. The site has a very low human health risk. The probability of the site impacting the groundwater is low. Natural attenuation of the site by the year 2018 will further reduce the risk posed by the radionuclide contaminants and the associated pathway.

5.3.9 132-H-3 Effluent Pumping Station, 132-H-2 Exhaust Air Filter Building, 132-H-1 Reactor Exhaust Stack, and 116-H-4 Pluto Crib

The 132-H-3 effluent pumping station, 132-H-2 exhaust air filter building, 132-H-1 reactor exhaust stack, and 116-H-4 pluto crib are recommended to be addressed as solid waste burial grounds.

Based on a qualitative risk estimate for these sites, the human health risk is low. Based on monitoring well information from the 100-HR-3 Groundwater Operable Unit LFI (DOE-RL 1993d), the probability of current impact on the groundwater by these sites is low. The potential for natural attenuation by the year 2018 of these sites is also low since some of the radionuclides expected to be present have half-lives greater than 30 years.

5.4 LOW-PRIORITY SITES RECOMMENDATIONS

The low-priority sites investigated during the LFI were the 1607-H-2 septic tank, the 1607-H-4 septic tank, and the electrical facilities. These sites were determined to be low-priority sites and recommendations concerning IRM candidacy are not applicable.

The 1607-H-2 site had levels of heavy metals which greatly exceeded the 95% UTL values and the MTCA Method B guidelines. Man-made radionuclides were also detected at the site. It is recommended that the priority rating (high or low) be reevaluated for this site.

The 1607-H-4 site had levels of heavy metals above the 95% UTL, semivolatile organics, pesticides, and man-made radionuclides. The concentrations of the heavy metals and the radionuclides were considerably lower than those found at the 1607-H-2 septic tank. The semivolatile organics detected are typical of coar tars or creosote preservatives. It is not recommended that the priority rating for this site be reevaluated.

The PCBs Aroclor 1254 or Aroclor 1260 were detected in small quantities in five of the surface-soil samples taken around the electrical facilities. The PCB contamination appears to be localized to visible spots. It is not recommended that the priority rating for this site be reevaluated.

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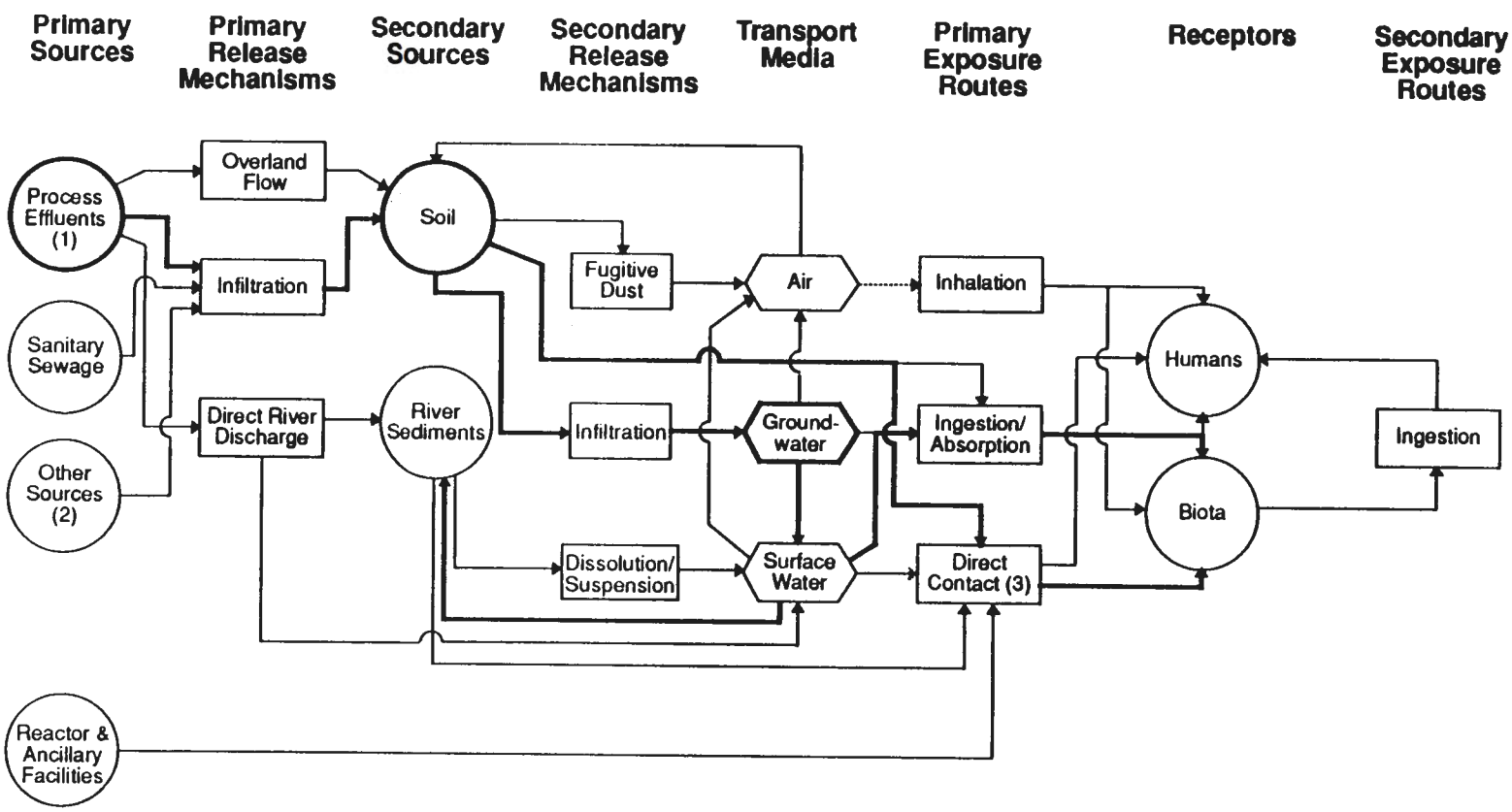
Figure 5-1 Conceptual Model Contaminant Exposure Pathway for the 100-HR-1 Operable Unit



(1) Includes all facilities that received process effluents, including pipelines, basins, cribs, trenches, french drains, and outfall structures.

(2) Includes other sources within limited existing information.

(3) Includes exposure to radiation.

LEGEND:

→ Potential Exposure Pathway

→ Potential Primary Exposure Pathway

○ ⬭ Primary contaminant sources and known contaminated media

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Table 5-1 100-HR-1 Conceptual Model for High Priority Sites (page 1 of 3)

Site	Structure/Process	Contaminant Source	Contaminants of Potential Concern	Nature and Extent of Contamination[a]
116-H-1 Process Effluent Disposal Trench	Effluent disposal trench, unlined - 91m x 30m x 4.6m deep	Received high activity effluent produced by ruptured fuel elements. Received sludge from 116-H-7 retention basin when 100-H Area was deactivated. Also received 90 kg of sodium dichromate.	As, Cr, Pb, PNA semivolatiles, Co-60, Sr-90, Tc-99, Co-60, Cs-137, Pu-238, Pu-239/240, Ra-226, Th-228, Th-232, Eu-152, Eu-154, Eu-155	Soil contamination to at least 5.5m; possible groundwater contamination
116-H-2 Effluent Disposal Trench	Effluent disposal trench, unlined - 84m x 30m 1.8m deep	Received decontamination wastes from the 132-H-3 effluent pumping station during reactor shutdown and standby periods. Received 600 kg of sodium dichromate.	From historical data: Sr-90, Eu-152, Eu-154, Eu-155, Co-60, Cs-137, Tritium. LFI data and historical data are inconsistent.	Soil contamination, based solely on historical data, to 3m. LFI data and historical data are inconsistent. Actual nature and vertical extent of contaminants is unknown.
116-H-3 Dummy Decontamination French Drain	Vertical leaching drain, unlined - 0.9m diameter x 4.6m deep	Received wastes generated during decontamination of fuel-element spacers. Received 2000 kg of sodium dichromate, sodium oxalate, and sodium sulfamate.	Eu-152, Eu-154, Eu-155, Co-60, Cs-137, Sr-90	Soil contamination to 4.9m
116-H-7 Process Effluent Retention Basin	Retention basin, reinforced concrete, single containment - 183m x 83m x 6m deep	Held cooling water effluent from H reactor for cooling/decay before release to the Columbia River, large leaks of effluent to the soil.	As, Pb, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, Pu-238, Pu-239/240, Sr-90, Ni-63, U	Soil contamination to at least 6m, contaminated concrete (foundation) and groundwater
116-H-9 Confinement Seal Pit Drainage Crib	Unlined crib - 3m x 3m x 3m deep	Received 300,000 liters of waste from the 132-H-2 reactor exhaust air filter building seal pits.	None	No evidence of contamination

Table 5-1 100-HR-1 Conceptual Model for High Priority Sites (page 2 of 3)

Site	Structure/Process	Contaminant Source	Contaminants of Potential Concern	Nature and Extent of Contamination[a]
116-H-5 Process Effluent Outfall Structure	Outfall structure, reinforced concrete sump and spillway; sumps located on riverbank above high water line; spillway extends from sump into river - 115m x 8m x 4m	Discharged cooling water effluent to bottom center of Columbia River through effluent pipeline from sump or at shore using spillway.	Analogous site had semivolatile phthalates	Possible soil and concrete contamination; extent unknown
Process Effluent Pipelines	Total length approx. 610m, pipe diameter 152cm, buried 6m below surface	Transported reactor cooling water from reactors to retention basins, outfall structures, and 116-H-1 trench, leacked effluent to soil, contains contaminated sludge and scale.	Cs-134, Cs-137, Co-60, Eu-152, Eu-154, Eu-155, Ni-63, Pu-238, Pu-239/240, Sr-90, Tritium, U	Possible surface soil contamination along pipelines, depth unknown
116-H-7 Sludge Burial Trench	Burial trench, unlined - unknown dimensions	Received sludge from the 116-H-7 process effluent retention basin.	less than 0.5 pCi/g Eu-154, Eu-155, and Sr-90	Possible soil contamination, extent unknown
132-H-3 Effluent Pumping Station	Four concrete sumps - capacity of approx. 300,000 liters	Collected and pumped water from the H reactor drains, including the irradiated fuel storage drains, into the 116-H-7 process effluent retention basin. Water and sludge in sumps was removed before station was demolished in place and covered with 5m of fill.	Nature of contamination is unknown. Remaining wastes are tied to rubble material.	Nature and vertical extent of contamination is unknown, but is most likely tied to demolishion rubble.
132-H-2 Exhaust Air Filter Building	Demolished reinforced concrete building - 18m x 12m x 11m high	Contaminated building demolished in place, buried, covered with 5m fill. Buillding was built on the site of the demolished and removed 116-H-4 pluto crib.	Assumed to be: Tritium, C-14, Co-60, Sr-90, Cs-137, Eu-152, Eu-154, Pu-239/240	Nature and vertical extent of contamination is assumed to coincide with demolishion rubble.

Table 5-1 100-HR-1 Conceptual Model for High Priority Sites (page 3 of 3)

Site	Structure/Process	Contaminant Source	Contaminants of Potential Concern	Nature and Extent of Contamination[a]
132-H-1 Reactor Exhaust Stack	Demolished reinforced concrete exhaust stack - 61m high x 5m diameter	Contaminated stack demolished in place, buried, covered with 1m fill.	Assumed to be: Tritium, C-14, Co-60, Sr-90, Cs-137, Eu-152	Nature and vertical extent of contamination is assumed to coincide with stack demolition rubble.
116-H-4 Pluto Crib	Pluto crib, unlined - 1.2m x 1.2m x 0.6m deep	Received cooling water discharge contaminated by failed fuel elements. Received 1000 kg of sodium dichromate. Crib was excavated and the material was buried in the 118-H-5 burial ground. 132-H-2 exhaust air filter building was later built on the same site.	Nature of any remaining contamination is unknown	Nature and vertical extent of any remaining contamination is unknown. Remaining contamination is assumed to coincide with building demolishion rubble.

[a]Lateral extent of contamination is assumed to be equal to the facility dimensions, unless otherwise noted. The limited fiel investigation was not designed to establish the lateral (areal) extent of contamination

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Table 5-2 Hanford Site Background 95% Upper Threshold Limits (UTLs) and Model Toxics Control Act (MTCA) Method B Guidelines for Inorganic Analytes.

Analyte[a]	95% UTL[b](mg/kg)	MTCA Method B[c] (mg/kg)
Alkalinity	23,300	N/L
Ammonia	28.2	N/L
Antimony	15.7[d]	32
Arsenic	8.92	60 (1.4)[e]
Barium	171	5,600
Beryllium	1.77	400 (0.23)[e]
Cadmium	0.66[d]	40
Chloride	763	N/L
Chromium	27.9	400[f]
Cobalt	19.6	N/L
Copper	28.2	2,960
Fluoride	12	4,800
Lead	14.75	U
Lithium	37.1	N/L
Manganese	612	8,000
Mercury	1.25	24
Molybdenum	1.4[d]	320
Nickel	25.3	U
Nitrate	199	N/L
Nitrite	21[d]	8,000
Ortho-phosphate	16	N/L
Selenium	5[d]	N/L
Silicon	192	N/L
Silver	2.7	240
Sulfate	1,320	N/L
Thallium	3.7[d]	5.6 - 7.2[g]
Titanium	3,570	N/L
Vanadium	111	560
Zinc	79	16,000
Zirconium	57.3	N/L

Source: DOE-RL 1993a
NL = Not listed in MTCA Human Health Risk Based Method B Formula Values table for soil
U = Unavailable
[a] Analytes essentially non-toxic in soil are not listed (DOE-RL 1993b). These include aluminum, calcium, iron, magnesium, potassium, sodium.
[b] 95% confidence limit of the 95th percentile of the data distribution
[c] Non-carcinogen risk-based concentration, no carcinogen risk except as shown in parenthesis
[d] Limit of detection
[e] Carcinogen risk-based concentration in parenthesis
[f] Hexavalent chromium
[g] Range of risk-based concentrations for thallium compounds

Table 5-3 IRM Recommendations for 100-HR-1 High-Priority Sites

Waste Site	Qualitative Risk Estimation		Conceptual Model	Exceeds ARAR	Probable Current Impact on Groundwater	Potential for Natural Attenuation by 2018	IRM Candidate yes/no
	Low-frequency scenario	EHQ > 1					
116-H-1 Process Effluent Disposal Trench	Medium	Yes	Adequate	Yes	Yes	No	Yes
116-H-2 Effluent Disposal Trench	Low	Yes	Incomplete*	No	No	No	Yes*
116-H-3 Dummy Decontamination French Drain	Low	No	Adequate	No	No	Yes	No
116-H-7 Process Effluent Retention Basin	High	Yes	Adequate	Yes	Yes	No	Yes
116-H-9 Confinement Seal Pit Drainage Crib	Low	No	Adequate	No	No	Yes	No
116-H-5 Process Effluent Outfall Structure	Medium	--	Adequate	No	No	No	Yes
Process Effluent Pipelines (Soil)	Very Low	No	Adequate	No	Yes	No	Yes
Process Effluent Pipelines (Sludge)	High	No	Adequate	No	Yes	No	Yes
116-H-7 Sludge Burial Trench	Very Low	--	Adequate	No	No	No	No
132-H-3 Effluent Pumping Station	Low	--	Adequate	Unknown	Unknown	Unknown	Yes
132-H-2 Exhaust Air Filter Building	Low	--	Adequate	Unknown	No	Unknown	Yes
132-H-1 Reactor Exhaust Stack	Low		Adequate	Unknown	No	Unknown	Yes
116-H-4 Pluto Crib	Low	--	Adequate	Unknown	No	Unknown	Yes

EHQ = Environmental Hazard Quotient calculated by the qualitative ecological risk assessment (WHC, 1993)
-- = Not rated by the qualitative ecological risk assessment
* = Data needed concerning nature and vertical extent of contamination, site remains an IRM candidate until data are available.
* = Conceptual model is considered incomplete due to discrepencies between the LFI data and the historical data. The LFI data indicates little or no contamination which contradicts with the historical data. Additional investigation may be necessary.
ARAR = Applicable or Relevant and Appropriate Regulation, specifically the Washington state Model Toxics Control Act Method B concentration values for soils (DOE-RL, 1992a)
Shaded areas indicate driving factors keeping site as IRM candidate.

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APPENDIX A
RESULTS OF LABORATORY ANALYSES FOR HIGH-PRIORITY SITES

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Table A-1 Chemical Analysis Results for Borehole 116-H-1 (page 1 of 6)

Analyte	Sample Numbers													
	B05WV5[a]		B05WV6		B05WV7[b,c]		B05WV8		B05WV9		B05WW0		B05WW4	
	top: 10.0 ft bottom: 12.0 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 15.0 ft bottom: 17.0 ft	Q	top: 16.5 ft bottom: 17.8 ft	Q	top: 19.3 ft bottom: 20.8 ft	Q	top: 24.0 ft bottom: 25.1 ft	Q
Inorganic Analysis[d]														
Aluminum	6170.00		7500.00		6890.00		5550.00		4800.00		5560.00		5720.00	
Antimony	1.70	U	1.60	U	4.60	U	1.60	U	1.60	U	1.50	U	1.60	U
Arsenic	37.90		25.30	J	27.60	J	7.30	J	1.80	U	1.20	U	1.20	U
Barium	72.30		74.50		66.00		59.60		52.90		56.80		72.50	
Beryllium	0.77	B	0.56	U	0.46		0.55	U	0.20	U	0.54	U	0.45	U
Cadmium	0.21	U	0.20	U	0.80	U	0.20	U	0.20	U	0.19	U	0.20	U
Calcium	4650.00		5520.00		4960.00		4120.00		3180.00		4330.00		4520.00	
Chromium	16.00		18.90		23.50		17.90		29.60		12.50		10.60	
Cobalt	7.70	B	8.30		9.30		7.40		6.40		8.10		9.90	
Copper	19.00		19.50		11.80		19.30		20.50		17.60		16.90	
Cyanide	5.20	U	5.30	U	5.00	U	5.20	U	5.10	U	5.00	U	4.70	U
Iron	15800.00		16900.00		17900.00		15800.00		12700.00		15000.00		18700.00	
Lead	187.00		145.00	J	118.00	J	36.90	J	82.10	J	2.80	J	2.50	J
Magnesium	4120.00		4630.00		3930.00		4210.00		3420.00		3940.00		4190.00	
Manganese	278.00		292.00		275.00		252.00		215.00		242.00		266.00	
Mercury	0.10	U	0.10	U	0.05		0.09	U	0.09	U	0.09	U	0.10	U
Nickel	10.80		11.50		13.90		9.30		7.90		9.60		9.00	
Potassium	1320.00		1270.00		1160.00		707.00		509.00		575.00		946.00	
Selenium	4.10	U	0.82	U	0.40	U	0.83	U	4.10	U	4.20	U	0.77	U
Silver	0.42	U	0.40	U	0.60	J	0.40	U	0.40	U	0.39	U	0.40	U
Sodium	179.00	B	207.00		249.00	U	205.00		249.00		399.00		480.00	
Thallium	0.61	U	0.62	U	0.40	U	0.62	U	0.62	U	0.63	U	0.58	U
Vanadium	32.00		35.80		40.80		32.90		32.80		38.20		51.00	
Zinc	48.70		53.10		52.70	J	45.10		38.60		30.50		39.10	
Organic Analysis[e]														
1,1,1-Trichloroethane	5	U	5	U	5	U	5	U	5	U	5	U	5	U

Refer to footnotes at end of table.

Table A-1 Chemical Analysis Results for Borehole 116-H-1 (page 2 of 6)

Analyte	Sample Numbers													
	B05WV5[a]		B05WV6		B05WV7[b,c]		B05WV8		B05WV9		B05WW0		B05WW4	
	top: 10.0 ft bottom: 12.0 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 15.0 ft bottom: 17.0 ft	Q	top: 16.5 ft bottom: 17.8 ft	Q	top: 19.3 ft bottom: 20.8 ft	Q	top: 24.0 ft bottom: 25.1 ft	Q
1,1,2,2-Tetrachloroethane	5	U	5	U	5	U	5	U	5	U	5	U	5	U
1,1,2-Trichloroethane	5	U	5	U	5	U	5	U	5	U	5	U	5	U
1,1-Dichloroethane	5	U	5	U	5	U	5	U	5	U	5	U	5	U
1,1-Dichloroethene	5	U	5	U	5	U	5	U	5	U	5	U	5	U
1,2-Dichloroethane	5	U	5	U	5	U	5	U	5	U	5	U	5	U
1,2-Dichloroethene	5	U	5	U	5	U	5	U	5	U	5	U	5	U
1,2-Dichloropropane	5	U	5	U	5	U	5	U	5	U	5	U	5	U
2-Butanone	11	U	11	U	10	U	11	U	10	U	11	U	10	U
2-Hexanone	11	U	11	U	10	U	11	U	10	U	11	U	10	U
4-Methyl-2-pentanone	11	U	11	U	10	U	11	U	10	U	11	U	10	U
Acetone	13	B	11	U	12		15	U	10	U	130	U	15	U
Benzene	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Bromodichloromethane	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Bromoform	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Bromomethane	11	U	11	U	10	U	11	U	10	U	11	U	10	U
Carbon disulfide	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Carbon tetrachloride	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Chlorobenzene	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Chloroethane	11	U	11	U	10	U	11	U	10	U	11	U	10	U
Chloroform	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Chloromethane	11	U	11	U	10	U	11	U	10	U	11	U	10	U
Dibromochloromethane	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Ethylbenzene	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Methylene chloride	11		11	U	10	U	11	U	10	U	11	U	10	U
Styrene	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Tetrachloroethene	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Toluene	14		4	J	5	U	1	J	2	J	5	U	5	U

Refer to footnotes at end of table.

Table A-1 Chemical Analysis Results for Borehole 116-H-1 (page 3 of 6)

Analyte	Sample Numbers													
	B05WV5[a]		B05WV6		B05WV7[b,c]		B05WV8		B05WV9		B05WW0		B05WW4	
	top: 10.0 ft bottom: 12.0 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 15.0 ft bottom: 17.0 ft	Q	top: 16.5 ft bottom: 17.8 ft	Q	top: 19.3 ft bottom: 20.8 ft	Q	top: 24.0 ft bottom: 25.1 ft	Q
Trichloroethene	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Vinyl acetate	11	U	11	U	10	U	11	U	10	U	11	U	10	U
Vinyl chloride	11	U	11	U	10	U	11	U	10	U	11	U	10	U
Xylenes (total)	5	U	5	U	5	U	5	U	5	U	5	U	5	U
cis-1,3-Dichloropropene	5	U	5	U	5	U	5	U	5	U	5	U	5	U
trans-1,3-Dichloropropene	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Semivolatile Organics[a]														
1,2,4-Trichlorobenzene			340	U	1800	U	340	U	340	U	350	U	330	U
1,2-Dichlorobenzene			340	U	1800	U	340	U	340	U	350	U	330	U
1,3-Dichlorobenzene			340	U	1800	U	340	U	340	U	350	U	330	U
1,4-Dichlorobenzene			340	U	1800	U	340	U	340	U	350	U	330	U
2,4,5-Trichlorophenol			1700	U	8800	U	1700	U	1600	U	1700	U	1600	U
2,4,6-Trichlorophenol			340	U	1800	U	340	U	340	U	350	U	330	U
2,4-Dichlorophenol			340	U	1800	U	340	U	340	U	350	U	330	U
2,4-Dimethylphenol			340	U	1800	U	340	U	340	U	350	U	330	U
2,4-Dinitrophenol			1700	U	8800	U	1700	U	1600	U	1700	U	1600	U
2,4-Dinitrotoluene			340	U	1800	U	340	U	340	U	350	U	330	U
2,6-Dinitrotoluene			340	U	1800	U	340	U	340	U	350	U	330	U
2-Chloronaphthalene			340	U	1800	U	340	U	340	U	350	U	330	U
2-Chlorophenol			340	U	1800	U	340	U	340	U	350	U	330	U
2-Methylnaphthalene			42	J	350	U	340	U	340	U	350	U	330	U
2-Methylphenol			340	U	1800	U	340	U	340	U	350	U	330	U
2-Nitroaniline			1700	U	8800	U	1700	U	1600	U	1700	U	1600	U
2-Nitrophenol			340	U	1800	U	340	U	340	U	350	U	330	U
3-Nitroaniline			1700	U	8800	U	1700	U	1600	U	1700	U	1600	U
3,3-Dichlorbenzidine			690	U	3500	U	690	U	670	U	690	U	660	U
4,6-Dinitro-2-methyl phenol			1700	U	8800	U	1700	U	1600	U	1700	U	1600	U

Refer to footnotes at end of table.

Table A-1 Chemical Analysis Results for Borehole 116-H-1 (page 4 of 6)

Analyte	Sample Numbers													
	B05WV5[a]		B05WV6		B05WV7[b,c]		B05WV8		B05WV9		B05WW0		B05WW4	
	top: 10.0 ft bottom: 12.0 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 15.0 ft bottom: 17.0 ft	Q	top: 16.5 ft bottom: 17.8 ft	Q	top: 19.3 ft bottom: 20.8 ft	Q	top: 24.0 ft bottom: 25.1 ft	Q
4-Bromophenylphenyl ether			340	U	1800	U	340	U	340	U	350	U	330	U
4-Chloro-3-methylphenol			340	U	1800	U	340	U	340	U	350	U	330	U
4-Chlorophenylphenyl ether			340	U	1800	U	340	U	340	U	350	U	330	U
4-Chloroaniline			340	U	1800	U	340	U	340	U	350	U	330	U
4-Methylphenol			340	U	1800	U	340	U	340	U	350	U	330	U
4-Nitroaniline			1700	U	8800	U	1700	U	1600	U	1700	U	1600	U
4-Nitrophenol			1700	U	8800	U	1700	U	1600	U	1700	U	1600	U
Acenaphthene			210	J	2100		340	U	340	U	350	U	330	U
Acenaphthylene			340	U	1800	U	340	U	340	U	350	U	330	U
Anthracene			430	J	4100	J	340	U	340	U	350	U	330	U
Benzo(a)anthracene			940	J	8600	J	39	J	78	J	350	U	330	U
Benzo(a)pyrene			810	J	8700	J	340	U	61	J	350	U	330	U
Benzo(b)fluoranthene			890	J	6500	J	340	U	130	J	350	U	330	U
Benzo(ghi)perylene			410	J	4900	J	340	U	340	U	350	U	330	U
Benzo(k)fluoranthene			760	J	7200	J	340	U	340	U	350	U	330	U
Benzoic acid			1700	U	8800	U	1700	U	1600	U	1700	U	1600	U
Benzyl alcohol			340	U	1800	U	340	U	340	U	350	U	330	U
Bis(2-chloroethoxy)methane			340	U	1800	U	340	U	340	U	350	U	330	U
Bis(2-chloroethyl)ether			340	U	1800	U	340	U	340	U	350	U	330	U
Bis(2-chloroisopropyl)ether			340	U	1800	U	340	U	340	U	350	U	330	U
Bis(2-ethylhexyl)phthalate			340	U	1800	U	68	J	340	U	350	U	330	U
Butylbenzylphthalate			340	U	1800	U	340	U	340	U	350	U	330	U
Chrysene			920	J	7800	J	340	U	77	J	350	U	330	U
Di-n-butylphthalate			59	J	1800	U	68	J	50	J	350	U	46	J
Di-n-octylphthalate			340	U	1800	U	340	U	340	U	350	U	330	U
Dibenz[a,h]anthracene			340	U	2000	J	340	U	340	U	350	U	330	U
Dibenzofuran			130	J	1200	J	340	U	340	U	350	U	330	U

Refer to footnotes at end of table.

Table A-1 Chemical Analysis Results for Borehole 116-H-1 (page 5 of 6)

Analyte	Sample Numbers													
	B05WV5[a]		B05WV6		B05WV7[b,c]		B05WV8		B05WV9		B05WW0		B05WW4	
	top: 10.0 ft bottom: 12.0 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 15.0 ft bottom: 17.0 ft	Q	top: 16.5 ft bottom: 17.8 ft	Q	top: 19.3 ft bottom: 20.8 ft	Q	top: 24.0 ft bottom: 25.1 ft	Q
Diethyl phthalate			340	U	1800	U	340	U	340	U	350	U	330	U
Dimethyl phthalate			340	U	1800	U	340	U	340	U	350	U	330	U
Fluoranthene			1800	J	18000	J	63	J	110	J	350	U	330	U
Fluorene			190	J	1900		340	U	340	U	350	U	330	U
Hexachlorobenzene			340	U	1800	U	340	U	340	U	350	U	330	U
Hexachlorobutadiene			340	U	1800	U	340	U	340	U	350	U	330	U
Hexachlorocyclopentadiene			340	U	1800	U	340	U	340	U	350	U	330	U
Hexachloroethane			340	U	1800	U	340	U	340	U	350	U	330	U
Ideno(1,2,3-cd)pyrene			520	J	4700	J	340	U	340	U	350	U	330	U
Isophorone			340	U	1800	U	340	U	340	U	350	U	330	U
N-Nitroso-di-n-dipropylamine			340	U	1800	U	340	U	340	U	350	U	330	U
N-Nitrosodiphenylamine			340	U	1800	U	59	U	340	U	350	U	1600	U
Naphthalene			180	U	1800	U	340	U	340	U	350	U	330	U
Nitrobenzene			340	U	1800	U	340	U	340	U	350	U	330	U
Pentachlorophenol			1700	U	8800	U	1700	U	1600	U	1700	U	1600	U
Phenanthrene			1500	J	16000	J	41	J	35	J	350	U	330	U
Phenol			340	U	1800	U	340	U	340	U	350	U	330	U
Pyrene			1200	J	17000	J	48	J	85	J	350	U	330	U
Pesticides[e]														
4,4' - DDD			17	U	31	U	17	U	16	U	17	U	16	U
4,4' - DDE			17	U	31	U	17	U	16	U	17	U	16	U
4,4' - DDT			17	U	31	U	17	U	16	U	17	U	16	U
Aldrin			8	U	16	U	8	U	8	U	8	U	8	U
Alpha-BHC			8	U	16	U	8	U	8	U	8	U	8	U
Aroclor-1016			84	U	160	U	84	U	82	U	84	U	80	U
Aroclor-1221			84	U	160	U	84	U	82	U	84	U	80	U
Aroclor-1232			84	U	160	U	84	U	82	U	84	U	80	U

Refer to footnotes at end of table.

Table A-1 Chemical Analysis Results for Borehole 116-H-1 (page 6 of 6)

Analyte	Sample Numbers													
	B05WV5[a]		B05WV6		B05WV7[b,c]		B05WV8		B05WV9		B05WW0		B05WW4	
	top: 10.0 ft bottom: 12.0 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 15.0 ft bottom: 17.0 ft	Q	top: 16.5 ft bottom: 17.8 ft	Q	top: 19.3 ft bottom: 20.8 ft	Q	top: 24.0 ft bottom: 25.1 ft	Q
Aroclor-1242			84	U	160	U	84	U	82	U	84	U	80	U
Aroclor-1248			84	U	160	U	84	U	82	U	84	U	80	U
Aroclor-1254			170	U	310	U	170	U	160	U	170	U	160	U
Aroclor-1260			170	U	310	U	170	U	160	U	170	U	160	U
Beta-BHC			8	U	16	U	8	U	8	U	8	U	8	U
Delta-BHC			8	U	16	U	8	U	8	U	8	U	8	U
Dieldrin			17	U	31	U	17	U	16	U	17	U	16	U
Endosulfan I			8	U	16	U	8	U	8	U	8	U	8	U
Endosulfan II			17	U	31	U	17	U	16	U	17	U	16	U
Endosulfan sulfate			17	U	31	U	17	U	16	U	17	U	16	U
Endrin			17	U	31	U	17	U	16	U	17	U	16	U
Endrin ketone			17	U	31	U	17	U	16	U	17	U	16	U
Gamma-BHC (Lindane)			8	U	16	U	8	U	8	U	8	U	8	U
Heptachlor			8	U	16	U	8	U	8	U	8	U	8	U
Heptachlor epoxide			8	U	16	U	8	U	8	U	8	U	8	U
Methoxychlor			84	U	160	U	84	U	84	U	84	U	80	U
Toxaphene			170	U	310	U	170	U	160	U	170	U	160	U
alpha-Chlordane			84	U	160	U	84	U	84	U	84	U	80	U
gamma-Chlordane			84	U	160	U	84	U	84	U	84	U	80	U

[a]No semivolatile or pasticide data reported.
[b]Split with B05WV6.
[c]Semivolatile data is suspect.
[d]Units in mg/kg.
[e]Units in μg/kg.
Q = Laboratory qualifier.
U = Below detection limit; detection limit reported.
J = Estimated value—QC discrepancies occurred.
B = Detected in laboratory blank.

Table A-2 Chemical Analysis Results for Borehole 116-H-2 (page 1 of 6)

Analyte	SAMPLE NUMBERS					
	B05WW5		B05WW6		B05WW7[a]	
	top: 9.9 ft bottom: 12.1 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q
Inorganic Analysis[b]						
Aluminum	4560.00		5640.00		4900.00	
Antimony	1.60	U	1.60	U	1.60	U
Arsenic	1.40	U	2.00		2.10	
Barium	57.60		55.30		69.90	
Beryllium	0.32	U	0.35	U	0.34	U
Cadmium	0.19	U	0.20	U	0.19	U
Calcium	7890.00		11000.00	J	9920.00	J
Chromium	7.60		17.50	J	19.00	J
Cobalt	6.90		7.70		7.10	
Copper	13.60		18.40		15.80	
Cyanide	4.70	U	0.52	U	0.50	U
Iron	12800.00		14700.00		12600.00	
Lead	2.90	J	4.00		3.30	
Magnesium	3330.00		4720.00	J	4530.00	J
Manganese	211.00		246.00	J	212.00	J
Mercury	0.09	U	0.09	U	0.09	U
Nickel	7.40		19.20	J	24.40	J
Potassium	766.00		916.00		749.00	
Selenium	0.78	U	3.90	U	4.00	U
Silver	0.39	U	0.39	U	0.39	U
Sodium	277.00		229.00		193.00	
Thallium	0.58	U	0.79	U	0.79	U
Vanadium	32.20		34.60		30.40	
Zinc	31.70		35.70		30.90	
Organic Analysis[c]						
1,1,1-Trichloroethane	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane	5	U	5	U	5	U
1,1,2-Trichloroethane	5	U	5	U	5	U

Refer to footnotes at end of table.

Table A-2 Chemical Analysis Results for Borehole 116-H-2 (page 2 of 6)

Analyte	SAMPLE NUMBERS					
	B05WW5		B05WW6		B05WW7[a]	
	top: 9.9 ft bottom: 12.1 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q
1,1-Dichloroethane	5	U	5	U	5	U
1,1-Dichloroethene	5	U	5	U	5	U
1,2-Dichloroethane	5	U	5	U	5	U
1,2-Dichloroethene	5	U	5	U	5	U
1,2-Dichloropropane	5	U	5	U	5	U
2-Butanone	10	U	10	U	10	U
2-Hexanone	10	U	10	U	10	U
4-Methyl-2-pentanone	10	U	10	U	10	U
Acetone	14	U	78	U	120	U
Benzene	5	U	5	U	5	U
Bromodichloromethane	5	U	5	U	5	U
Bromoform	5	U	5	U	5	U
Bromomethane	10	U	10	U	10	U
Carbon disulfide	5	U	5	U	5	U
Carbon tetrachloride	5	U	5	U	5	U
Chlorobenzene	5	U	5	U	5	U
Chloroethane	10	U	10	U	10	U
Chloroform	5	U	5	U	5	U
Chloromethane	10	U	10	U	10	U
Dibromochloromethane	5	U	5	U	5	U
Ethylbenzene	5	U	5	U	5	U
Methylene chloride	10	U	5	U	3	J
Styrene	5	U	5	U	5	U
Tetrachloroethene	5	U	5	U	5	U
Toluene	5	U	5	U	2	U
Trichloroethene	5	U	5	U	5	U
Vinyl acetate	10	U	10	U	10	U
Vinyl chloride	10	U	10	U	10	U
Xylenes (total)	5	U	5	U	5	U

Refer to footnotes at end of table.

Table A-2 Chemical Analysis Results for Borehole 116-H-2 (page 3 of 6)

Analyte	SAMPLE NUMBERS					
	B05WW5		B05WW6		B05WW7[a]	
	top: 9.9 ft bottom: 12.1 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q
cis-1,3-Dichloropropene	5	U	5	U	5	U
trans-1,3-Dichloropropene	5	U	5	U	5	U
Semivolatile Organic Analysis[c]						
1,2,4-Trichlorobenzene	340	U	340	U	340	U
1,2-Dichlorobenzene	340	U	340	U	340	U
1,3-Dichlorobenzene	340	U	340	U	340	U
1,4-Dichlorobenzene	340	U	340	U	340	U
2,4,5-Trichlorophenol	1600	U	1700	U	1700	U
2,4,6-Trichlorophenol	340	U	340	U	340	U
2,4-Dichlorophenol	340	U	340	U	340	U
2,4-Dimethylphenol	340	U	340	U	340	U
2,4-Dinitrophenol	1600	U	1700	U	1700	U
2,4-Dinitrotoluene	340	U	340	U	340	U
2,6-Dinitrotoluene	340	U	340	U	340	U
2-Chloronaphthalene	340	U	340	U	340	U
2-Chlorophenol	340	U	340	U	340	U
2-Methylnaphthalene	340	U	340	U	340	U
2-Methylphenol	340	U	340	U	340	U
2-Nitroaniline	1600	U	1700	U	1700	U
2-Nitrophenol	340	U	340	U	340	U
3-Nitroaniline	1600	U	1700	U	1700	U
3,3-Dichlorbenzidine	680	U	690	U	690	U
4,6-Dinitro-2-methyl phenol	1600	U	1700	U	1700	U
4-Bromophenylphenyl ether	340	U	340	U	340	U
4-Chloro-3-methylphenol	340	U	340	U	340	U
4-Chlorophenylphenyl ether	340	U	340	U	340	U
4-Chloroaniline	340	U	340	U	340	U
4-Methylphenol	340	U	340	U	340	U
4-Nitroaniline	1600	U	1700	U	1700	U

Refer to footnotes at end of table.

Table A-2 Chemical Analysis Results for Borehole 116-H-2 (page 4 of 6)

Analyte	SAMPLE NUMBERS					
	B05WW5		B05WW6		B05WW7[a]	
	top: 9.9 ft bottom: 12.1 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q
4-Nitrophenol	1600	U	1700	U	1700	U
Acenaphthene	340	U	340	U	340	U
Acenaphthylene	340	U	340	U	340	U
Anthracene	340	U	340	U	340	U
Benzo(a)anthracene	340	U	340	U	340	U
Benzo(a)pyrene	340	U	340	U	340	U
Benzo(b)fluoranthene	340	U	340	U	340	U
Benzo(ghi)perylene	340	U	340	U	340	U
Benzo(k)fluoranthene	340	U	340	U	340	U
Benzoic acid	1600	U	1700	U	1700	U
Benzyl alcohol	340	U	340	U	340	U
Bis(2-chloroethoxy)methane	340	U	340	U	340	U
Bis(2-chloroethyl)ether	340	U	340	U	340	U
Bis(2-chloroisopropyl)ether	340	U	340	U	340	U
Bis(2-ethylhexyl)phthalate	340	U	340	U	340	U
Butylbenzylphthalate	340	U	340	U	340	U
Chrysene	340	U	340	U	340	U
Di-n-butylphthalate	48	J	340	U	340	U
Di-n-octylphthalate	340	U	340	U	340	U
Dibenz[a,h]anthracene	340	U	340	U	340	U
Dibenzofuran	340	U	340	U	340	U
Diethyl phthalate	340	U	340	U	340	U
Dimethyl phthalate	340	U	340	U	340	U
Fluoranthene	340	U	340	U	340	U
Fluorene	340	U	340	U	340	U
Hexachlorobenzene	340	U	340	U	340	U
Hexachlorobutadiene	340	U	340	U	340	U
Hexachlorocyclopentadiene	340	U	340	U	340	U
Hexachloroethane	340	U	340	U	340	U

Refer to footnotes at end of table.

9 3 1 3 0 2 4 0 4 3 9

Table A-2 Chemical Analysis Results for Borehole 116-H-2 (page 5 of 6)

Analyte	SAMPLE NUMBERS					
	B05WW5		B05WW6		B05WW7[a]	
	top: 9.9 ft bottom: 12.1 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q
Ideno(1,2,3-cd)pyrene	340	U	340	U	340	U
Isophorone	340	U	340	U	340	U
N-Nitroso-di-n-dipropylamine	340	U	340	U	340	U
N-Nitrosodiphenylamine	340	U	340	U	340	U
Naphthalene	340	U	340	U	340	U
Nitrobenzene	340	U	340	U	340	U
Pentachlorophenol	1600	U	1700	U	1700	U
Phenanthrene	340	U	340	U	340	U
Phenol	340	U	340	U	340	U
Pyrene	340	U	340	U	340	U
Pesticide Analysis[c]						
4,4' - DDD	16	U	16	U	16	U
4,4' - DDE	16	U	16	U	16	U
4,4' - DDT	16	U	16	U	16	U
Aldrin	8	U	8	U	8	U
Alpha-BHC	8	U	8	U	8	U
Aroclor-1016	82	U	82	U	82	U
Aroclor-1221	82	U	82	U	82	U
Aroclor-1232	82	U	82	U	82	U
Aroclor-1242	82	U	82	U	82	U
Aroclor-1248	82	U	82	U	82	U
Aroclor-1254	160	U	160	U	160	U
Aroclor-1260	160	U	160	U	160	U
Beta-BHC	8	U	8	U	8	U
Delta-BHC	8	U	8	U	8	U
Dieldrin	16	U	16	U	16	U
Endosulfan I	8	U	8	U	8	U
Endosulfan II	16	U	16	U	16	U
Endosulfan sulfate	16	U	16	U	16	U

Refer to footnotes at end of table.

Table A-2 Chemical Analysis Results for Borehole 116-H-2 (page 6 of 6)

Analyte	SAMPLE NUMBERS					
	B05WW5		B05WW6		B05WW7[a]	
	top: 9.9 ft bottom: 12.1 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q
Endrin	16	U	16	U	16	U
Endrin ketone	16	U	16	U	16	U
Gamma-BHC (Lindane)	8	U	8	U	8	U
Heptaclor	8	U	8	U	8	U
Heptaclor epoxide	8	U	8	U	8	U
Methoxyclor	82	U	82	U	82	U
Toxaphene	160	U	160	U	160	U
alpha-Chlordane	82	U	82	U	82	U
gamma-Chlordane	82	U	82	U	82	U

[a]Duplicate of Sample B05WW6
[b]Units in mg/kg.
[c]Units in μg/kg.
Q=Laboratory qualifier.
U=Below dection limit; detection limit reported.
J=Estimated value—QC discrepancies occurred.
B=Detected in laboratory blank.

Table A-3 Chemical Analysis Results for Borehole 116-H-3 (page 1 of 6)

Analyte	SAMPLE NUMBERS			
	B05WP1		B05WP5	
	top: 14.5 ft bottom: 16.3 ft	Q	top: 19.6 ft bottom: 21.7 ft	Q
Inorganic Analysis[a]				
Aluminum	5200.00		4280.00	
Antimony	5.90	U	1.60	U
Arsenic	1.30	U	1.10	B
Barium	42.50		36.70	B
Beryllium	0.22	U	0.52	B
Cadmium	0.78	U	0.20	U
Calcium	4990.00	J	4700.00	
Chromium	10.50	J	10.20	
Cobalt	9.20	J	7.00	B
Copper	12.90		22.50	
Cyanide	5.10	U	4.80	U
Iron	15900.00		13500.00	
Lead	2.10	J	8.60	
Magnesium	3690.00		3320.00	
Manganese	231.00		214.00	
Mercury	0.09	U	0.09	U
Nickel	9.60		8.90	
Potassium	739.00		562.00	B
Selenium	3.80	U	0.75	U
Silver	0.96	U	0.39	U
Sodium	403.00		277.00	B
Thallium	0.38	U	0.57	U
Vanadium	47.10		32.10	
Zinc	39.10	J	26.20	
Organic Analysis[b]				
1,1,1-Trichloroethane	5	U	5	U

Refer to footnotes at end of table.

9 3 1 3 0 4 0 4 9 2

Table A-3 Chemical Analysis Results for Borehole 116-H-3 (page 2 of 6)

Analyte	SAMPLE NUMBERS			
	B05WP1		B05WP5	
	top: 14.5 ft bottom: 16.3 ft	Q	top: 19.6 ft bottom: 21.7 ft	Q
1,1,2,2-Tetrachloroethane	5	U	5	U
1,1,2-Trichloroethane	5	U	5	U
1,1-Dichloroethane	5	U	5	U
1,1-Dichloroethene	5	U	5	U
1,2-Dichloroethane	5	U	5	U
1,2-Dichloroethene	5	U	5	U
1,2-Dichloropropane	5	U	5	U
2-Butanone	10	U	10	U
2-Hexanone	10	U	10	U
4-Methyl-2-pentanone	10	U	10	U
Acetone	33	U	7	BJ
Benzene	5	U	5	U
Bromodichloromethane	5	U	5	U
Bromoform	5	U	5	U
Bromomethane	10	U	10	U
Carbon disulfide	5	U	5	U
Carbon tetrachloride	5	U	5	U
Chlorobenzene	5	U	5	U
Chloroethane	10	U	10	U
Chloroform	5	U	5	U
Chloromethane	10	U	10	U
Dibromochloromethane	5	U	5	U
Ethylbenzene	5	U	5	U
Methylene chloride	10	U	3	BJ
Styrene	5	U	5	U
Tetrachloroethene	5	U	5	U
Toluene	2	U	7	

Refer to footnotes at end of table.

Table A-3 Chemical Analysis Results for Borehole 116-H-3 (page 3 of 6)

Analyte	SAMPLE NUMBERS			
	B05WP1		B05WP5	
	top: 14.5 ft bottom: 16.3 ft	Q	top: 19.6 ft bottom: 21.7 ft	Q
Trichloroethene	5	U	5	U
Vinyl acetate	10	U	10	U
Vinyl chloride	10	U	10	U
Xylenes (total)	5	U	5	U
cis-1,3-Dichloropropene	5	U	5	U
trans-1,3-Dichloropropene	5	U	5	U
Semivolatile Organic Analysis[b]				
1,2,4-Trichlorobenzene	320	U	340	U
1,2-Dichlorobenzene	320	U	340	U
1,3-Dichlorobenzene	320	U	340	U
1,4-Dichlorobenzene	320	U	340	U
2,4,5-Trichlorophenol	1600	U	1600	U
2,4,6-Trichlorophenol	320	U	340	U
2,4-Dichlorophenol	320	U	340	U
2,4-Dimethylphenol	320	U	340	U
2,4-Dinitrophenol	1600	U	1600	U
2,4-Dinitrotoluene	320	U	340	U
2,6-Dinitrotoluene	320	U	340	U
2-Chloronaphthalene	320	U	340	U
2-Chlorophenol	320	U	340	U
2-Methylnaphthalene	320	U	340	U
2-Methylphenol	320	U	340	U
2-Nitroaniline	1600	U	1600	U
2-Nitrophenol	320	U	340	U
3-Nitroaniline	1600	U	1600	U
3,3-Dichlorbenzidine	650	U	670	U
4,6-Dinitro-2-methyl phenol	1600	U	1600	U

Refer to footnotes at end of table.

Table A-3 Chemical Analysis Results for Borehole 116-H-3 (page 4 of 6)

Analyte	SAMPLE NUMBERS			
	B05WP1		B05WP5	
	top: 14.5 ft bottom: 16.3 ft	Q	top: 19.6 ft bottom: 21.7 ft	Q
4-Bromophenylphenyl ether	320	U	340	U
4-Chloro-3-methylphenol	320	U	340	U
4-Chlorophenylphenyl ether	320	U	340	U
4-Chloroaniline	320	U	340	U
4-Methylphenol	320	U	340	U
4-Nitroaniline	1600	U	1600	U
4-Nitrophenol	1600	U	1600	U
Acenaphene	320	U	340	U
Acenaphthylene	320	U	340	U
Anthracene	320	U	340	U
Benzo(a)anthracene	320	U	340	U
Benzo(a)pyrene	320	U	340	U
Benzo(b)fluoranthene	320	U	340	U
Benzo(ghi)perylene	320	U	340	U
Benzo(k)fluoranthene	320	U	340	U
Benzoic acid	1600	U	1600	U
Benzyl alcohol	320	U	340	U
Bis(2-chloroethoxy)methane	320	U	340	U
Bis(2-chloroethyl)ether	320	U	340	U
Bis(2-chloroisopropyl)ether	320	U	340	U
Bis(2-ethylhexyl)phthalate	320	U	340	U
Butylbenzylphthalate	320	U	340	U
Chrysene	320	U	340	U
Di-n-butylphthalate	320	U	340	U
Di-n-octylphthalate	320	U	340	U
Dibenz[a,h]anthracene	320	U	340	U
Dibenzofuran	320	U	340	U

Refer to footnotes at end of table.

Table A-3 Chemical Analysis Results for Borehole 116-H-3 (page 5 of 6)

Analyte	SAMPLE NUMBERS			
	B05WP1		B05WP5	
	top: 14.5 ft bottom: 16.3 ft	Q	top: 19.6 ft bottom: 21.7 ft	Q
Diethyl phthalate	320	U	230	J
Dimethyl phthalate	320	U	340	U
Fluoranthene	320	U	340	U
Fluorene	320	U	340	U
Hexachlorobenzene	320	U	340	U
Hexachlorobutadiene	320	U	340	U
Hexachlorocyclopentadiene	320	U	340	U
Hexachloroethane	320	U	340	U
Ideno(1,2,3-cd)pyrene	320	U	340	U
Isophorone	320	U	340	U
N-Nitroso-di-n-dipropylamine	320	U	340	U
N-Nitrosodiphenylamine	320	U	340	U
Naphthalene	320	U	340	U
Nitrobenzene	320	U	340	U
Pentachlorophenol	1600	U	1600	U
Phenanthrene	320	U	340	U
Phenol	320	U	340	U
Pyrene	320	U	340	U
Pesticides[b]				
4,4' - DDD	16	U	16	U
4,4' - DDE	16	U	16	U
4,4' - DDT	16	U	16	U
Aldrin	7	U	8	U
Alpha-BHC	7	U	8	U
Aroclor-1016	79	U	80	U
Aroclor-1221	79	U	80	U
Aroclor-1232	79	U	80	U

Refer to footnotes at end of table.

9 3 1 3 0 4 0 4 9 6

Table A-3 Chemical Analysis Results for Borehole 116-H-3 (page 6 of 6)

Analyte	SAMPLE NUMBERS			
	B05WP1		B05WP5	
	top: 14.5 ft bottom: 16.3 ft	Q	top: 19.6 ft bottom: 21.7 ft	Q
Aroclor-1242	79	U	80	U
Aroclor-1248	79	U	80	U
Aroclor-1254	160	U	160	U
Aroclor-1260	160	U	160	U
Beta-BHC	7	U	8	U
Delta-BHC	7	U	8	U
Dieldrin	16	U	16	U
Endosulfan I	7	U	8	U
Endosulfan II	16	U	16	U
Endosulfan sulfate	16	U	16	U
Endrin	16	U	16	U
Endrin ketone	16	U	16	U
Gamma-BHC (Lindane)	7	U	8	U
Heptaclor	7	U	8	U
Heptaclor epoxide	7	U	8	U
Methoxyclor	79	U	80	U
Toxaphene	160	U	160	U
alpha-Chlordane	79	U	80	U
gamma-Chlordane	79	U	80	U

[a]Units in mg/kg.
[b]Units in μg/kg.
Q=Laboratory qualifier.
U=Below dection limit; detection limit reported.
J=Estimated value–QC discrepancies occurred.
B=Detected in laboratory blank.

Table A-4 Chemical Analysis Results for Borehole 116-H-7 (page 1 of 7)

Analyte	SAMPLE NUMBERS									
	B05WT8		B05WT9		B05WV2		B05WV3		B05WV4	
	top: 1.0 ft bottom: 3.0 ft	Q	top: 8.0 ft bottom: 10.0 ft	Q	top: 9.8 ft bottom: 12.4 ft	Q	top: 14.8 ft bottom: 16.4 ft	Q	top: 19.2 ft bottom: 20.8 ft	Q
Inorganic Analysis[a]										
Aluminum	9070.00		5330.00		5520.00		6400.00		5210.00	
Antimony	6.40	U	6.70	U	6.10	U	6.90	U	5.90	U
Arsenic	47.00		6.20		2.80		1.80	U	1.60	U
Barium	94.90		67.20		64.70		62.10		43.80	
Beryllium	0.37		0.24	U	0.25	U	0.25	U	0.21	U
Cadmium	0.75	U	0.72	U	0.78	U	0.85	U	0.52	U
Calcium	5220.00		8620.00	J	7110.00	J	7220.00	J	3280.00	J
Chromium	12.30		14.60	J	28.30	J	21.60	J	13.10	J
Cobalt	9.20		7.50	U	7.10	U	8.50	U	6.80	U
Copper	17.00		17.60		23.40		16.60		13.50	
Cyanide	5.20	U	5.80	U	5.20	U	5.30	U	4.70	U
Iron	19000.00		14800.00		14400.00		15700.00		13400.00	
Lead	540.00		10.90		5.90		3.80		2.40	
Magnesium	4630.00		3520.00		3780.00		4550.00		3340.00	
Manganese	325.00		249.00		245.00		262.00		220.00	
Mercury	0.09	U	0.45		1.10		0.09	U	0.09	U
Nickel	11.80		7.30	U	7.60	U	12.70		7.60	
Potassium	1720.00		692.00		778.00	U	927.00		583.00	
Selenium	4.20	R	4.50	U	0.81	U	4.20	U	0.80	U
Silver	1.00	U	1.10	U	0.98	U	1.10	U	0.95	U
Sodium	182.00	U	291.00		233.00		283.00		405.00	
Thallium	0.63	U	0.45	U	0.40	U	0.42	U	0.40	U
Vanadium	40.00		32.70		31.70		36.80		34.70	

Refer to footnotes at end of table.

Table A-4 Chemical Analysis Results for Borehole 116-H-7 (page 2 of 7)

Analyte	SAMPLE NUMBERS									
	B05WT8		B05WT9		B05WV2		B05WV3		B05WV4	
	top: 1.0 ft bottom: 3.0 ft	Q	top: 8.0 ft bottom: 10.0 ft	Q	top: 9.8 ft bottom: 12.4 ft	Q	top: 14.8 ft bottom: 16.4 ft	Q	top: 19.2 ft bottom: 20.8 ft	Q
Zinc	53.10		56.20	J	83.10	J	44.30	J	40.30	J
Organic Analysis[b]										
1,1,1-Trichloroethane	5	U	5	U	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane	5	U	5	U	5	U	5	U	5	U
1,1,2-Trichloroethane	5	U	5	U	5	U	5	U	5	U
1,1-Dichloroethane	5	U	5	U	5	U	5	U	5	U
1,1-Dichloroethene	5	U	5	U	5	U	5	U	5	U
1,2-Dichloroethane	5	U	5	U	5	U	5	U	5	U
1,2-Dichloroethene	5	U	5	U	5	U	5	U	5	U
1,2-Dichloropropane	5	U	5	U	5	U	5	U	5	U
2-Butanone	11	U	11	U	11	U	11	U	10	U
2-Hexanone	11	U	11	U	11	U	11	U	10	U
4-Methyl-2-pentanone	11	U	11	U	11	U	11	U	10	U
Acetone	11	U	31	U	41	U	36	U	23	U
Benzene	5	U	5	U	5	U	5	U	5	U
Bromodichloromethane	5	U	5	U	5	U	5	U	5	U
Bromoform	5	U	5	U	5	U	5	U	5	U
Bromomethane	11	U	11	U	11	U	11	U	10	U
Carbon disulfide	5	U	5	U	5	U	5	U	5	U
Carbon tetrachloride	5	U	5	U	5	U	5	U	5	U
Chlorobenzene	5	U	5	U	5	U	5	U	5	U
Chloroethane	11	U	11	U	11	U	11	U	10	U
Chloroform	5	U	5	U	5	U	5	U	5	U
Chloromethane	11	U	11	U	11	U	11	U	10	U

Refer to footnotes at end of table.

Table A-4 Chemical Analysis Results for Borehole 116-H-7 (page 3 of 7)

Analyte	SAMPLE NUMBERS									
	B05WT8		B05WT9		B05WV2		B05WV3		B05WV4	
	top: 1.0 ft bottom: 3.0 ft	Q	top: 8.0 ft bottom: 10.0 ft	Q	top: 9.8 ft bottom: 12.4 ft	Q	top: 14.8 ft bottom: 16.4 ft	Q	top: 19.2 ft bottom: 20.8 ft	Q
Dibromochloromethane	5	U	5	U	5	U	5	U	5	U
Ethylbenzene	5	U	5	U	5	U	5	U	5	U
Methylene chloride	11	U	14	U	13	U	22	U	10	U
Styrene	5	U	5	U	5	U	5	U	5	U
Tetrachloroethene	5	U	5	U	5	U	5	U	5	U
Toluene	2	U	49		5	U	3	J	5	U
Trichloroethene	5	U	5	U	5	U	5	U	5	U
Vinyl acetate	11	U	11	U	11	U	11	U	10	U
Vinyl chloride	11	U	11	U	11	U	11	U	10	U
Xylenes (total)	5	U	5	U	5	U	5	U	5	U
cis-1,3-Dichloropropene	5	U	5	U	5	U	5	U	5	U
trans-1,3-Dichloropropene	5	U	5	U	5	U	5	U	5	U
Semivolatile Organic Analysis[b]										
1,2,4-Trichlorobenzene	340	U	350	U	340	U	350	U	330	U
1,2-Dichlorobenzene	340	U	350	U	340	U	350	U	330	U
1,3-Dichlorobenzene	340	U	350	U	340	U	350	U	330	U
1,4-Dichlorobenzene	340	U	350	U	340	U	350	U	330	U
2,4,5-Trichlorophenol	1700	U	1700	U	1700	U	1700	U	1600	U
2,4,6-Trichlorophenol	340	U	350	U	340	U	350	U	330	U
2,4-Dichlorophenol	340	U	350	U	340	U	350	U	330	U
2,4-Dimethylphenol	340	U	350	U	340	U	350	U	330	U
2,4-Dinitrophenol	1700	U	1700	U	1700	U	1700	U	1600	U
2,4-Dinitrotoluene	340	U	350	U	340	U	350	U	330	U
2,6-Dinitrotoluene	340	U	350	U	340	U	350	U	330	U

Refer to footnotes at end of table.

Table A-4 Chemical Analysis Results for Borehole 116-H-7 (page 4 of 7)

Analyte	SAMPLE NUMBERS									
	B05WT8		B05WT9		B05WV2		B05WV3		B05WV4	
	top: 1.0 ft bottom: 3.0 ft	Q	top: 8.0 ft bottom: 10.0 ft	Q	top: 9.8 ft bottom: 12.4 ft	Q	top: 14.8 ft bottom: 16.4 ft	Q	top: 19.2 ft bottom: 20.8 ft	Q
2-Chloronaphthalene	340	U	350	U	340	U	350	U	330	U
2-Chlorophenol	340	U	350	U	340	U	350	U	330	U
Methylnaphthalene	340	U	350	U	340	U	350	U	330	U
2-Methylphenol	340	U	350	U	340	U	350	U	330	U
2-Nitroaniline	1700	U	1700	U	1700	U	1700	U	1600	U
2-Nitrophenol	340	U	350	U	340	U	350	U	330	U
3-Nitroaniline	1700	U	1700	U	1700	U	1700	U	1600	U
3,3-Dichlorbenzidine	690	U	690	U	690	U	700	U	660	U
4,6-Dinitro-2-methyl phenol	1700	U	1700	U	1700	U	1700	U	1600	U
4-Bromophenylphenyl ether	340	U	350	U	340	U	350	U	330	U
4-Chloro-3-methylphenol	340	U	350	U	340	U	350	U	330	U
4-Chlorophenylphenyl ether	340	U	350	U	340	U	350	U	330	U
4-Chloroaniline	340	U	350	U	340	U	350	U	330	U
4-Methylphenol	340	U	350	U	340	U	350	U	330	U
4-Nitroaniline	1700	U	1700	U	1700	U	1700	U	330	U
4-Nitrophenol	1700	U	1700	U	1700	U	1700	U	1600	U
Acenaphthene	340	U	350	U	340	U	350	U	330	U
Acenaphthylene	340	U	350	U	340	U	350	U	330	U
Anthracene	340	U	350	U	340	U	350	U	330	U
Benzo(a)anthracene	340	U	350	U	340	U	350	U	330	U
Benzo(a)pyrene	340	U	350	U	340	U	350	U	330	U
Benzo(b)fluoranthene	340	U	350	U	340	U	350	U	330	U
Benzo(ghi)perylene	340	U	350	U	340	U	350	U	330	U
Benzo(k)fluoranthene	340	U	350	U	340	U	350	U	330	U

Refer to footnotes at end of table.

Table A-4 Chemical Analysis Results for Borehole 116-H-7 (page 5 of 7)

Analyte	SAMPLE NUMBERS									
	B05WT8		B05WT9		B05WV2		B05WV3		B05WV4	
	top: 1.0 ft bottom: 3.0 ft	Q	top: 8.0 ft bottom: 10.0 ft	Q	top: 9.8 ft bottom: 12.4 ft	Q	top: 14.8 ft bottom: 16.4 ft	Q	top: 19.2 ft bottom: 20.8 ft	Q
Benzoic acid	1700	U	1700	U	1700	U	1700	U	330	U
Benzyl alcohol	340	U	350	U	340	U	350	U	330	U
Bis(2-chloroethoxy)methane	340	U	350	U	340	U	350	U	330	U
Bis(2-chloroethyl)ether	340	U	350	U	340	U	350	U	330	U
Bis(2-chloroisopropyl)ether	340	U	350	U	340	U	350	U	330	U
Bis(2-ethylhexyl)phthalate	340	U	350	U	340	U	350	U	330	U
Butylbenzylphthalate	340	U	350	U	340	U	350	U	330	U
Chrysene	340	U	350	U	340	U	350	U	330	U
Di-n-butylphthalate	340	U	350	U	340	U	350	U	330	U
Di-n-octylphthalate	340	U	350	U	340	U	350	U	330	U
Dibenz[a,h]anthracene	340	U	350	U	340	U	350	U	330	U
Dibenzofuran	340	U	350	U	340	U	350	U	330	U
Diethyl phthalate	340	U	350	U	340	U	350	U	330	U
Dimethyl phthalate	340	U	350	U	340	U	350	U	330	U
Fluoranthene	340	U	350	U	340	U	350	U	330	U
Fluorene	340	U	350	U	340	U	350	U	330	U
Hexachlorobenzene	340	U	350	U	340	U	350	U	330	U
Hexachlorobutadiene	340	U	350	U	340	U	350	U	330	U
Hexachlorocyclopentadiene	340	U	350	U	340	U	350	U	330	U
Hexachloroethane	340	U	350	U	340	U	350	U	330	U
Ideno(1,2,3-cd)pyrene	340	U	350	U	340	U	350	U	330	U
Isophorone	340	U	350	U	340	U	350	U	330	U
N-Nitroso-di-n-dipropylamine	340	U	350	U	340	U	350	U	330	U
N-Nitrosodiphenylamine	340	U	350	U	340	U	350	U	1600	U

Refer to footnotes at end of table.

Table A-4 Chemical Analysis Results for Borehole 116-H-7 (page 6 of 7)

Analyte	SAMPLE NUMBERS									
	B05WT8		B05WT9		B05WV2		B05WV3		B05WV4	
	top: 1.0 ft bottom: 3.0 ft	Q	top: 8.0 ft bottom: 10.0 ft	Q	top: 9.8 ft bottom: 12.4 ft	Q	top: 14.8 ft bottom: 16.4 ft	Q	top: 19.2 ft bottom: 20.8 ft	Q
Naphthalene	340	U	350	U	340	U	350	U	330	U
Nitrobenzene	340	U	350	U	340	U	350	U	330	U
Pentachlorophenol	1700	U	1700	U	1700	U	1700	U	1600	U
Phenanthrene	340	U	350	U	340	U	350	U	330	U
Phenol	340	U	350	U	340	U	350	U	330	U
Pyrene	340	U	350	U	340	U	350	U	330	U
Pesticide Analysis[b]										
4,4' - DDD	17	U	17	U	17	U	17	U	16	U
4,4' - DDE	17	U	17	U	17	U	17	U	16	U
4,4' - DDT	17	U	17	U	17	U	17	U	16	U
Aldrin	8	U	8	U	8	U	8	U	8	U
Alpha-BHC	8	U	8	U	8	U	8	U	8	U
Aroclor-1016	84	U	83	U	84	U	86	U	80	U
Aroclor-1221	84	U	83	U	84	U	86	U	80	U
Aroclor-1232	84	U	83	U	84	U	86	U	80	U
Aroclor-1242	84	U	83	U	84	U	86	U	80	U
Aroclor-1248	84	U	83	U	84	U	86	U	80	U
Aroclor-1254	170	U	170	U	170	U	170	U	160	U
Aroclor-1260	170	U	170	U	170	U	170	U	160	U
Beta-BHC	8	U	8	U	8	U	8	U	8	U
Delta-BHC	8	U	8	U	8	U	8	U	8	U
Dieldrin	17	U	17	U	17	U	17	U	16	U
Endosulfan I	8	U	8	U	8	U	8	U	8	U
Endosulfan II	17	U	17	U	17	U	17	U	16	U

Refer to footnotes at end of table.

Table A-4 Chemical Analysis Results for Borehole 116-H-7 (page 7 of 7)

Analyte	SAMPLE NUMBERS									
	B05WT8		B05WT9		B05WV2		B05WV3		B05WV4	
	top: 1.0 ft bottom: 3.0 ft	Q	top: 8.0 ft bottom: 10.0 ft	Q	top: 9.8 ft bottom: 12.4 ft	Q	top: 14.8 ft bottom: 16.4 ft	Q	top: 19.2 ft bottom: 20.8 ft	Q
Endosulfan sulfate	17	U	17	U	17	U	17	U	16	U
Endrin	17	U	17	U	17	U	17	U	16	U
Endrin ketone	17	U	17	U	17	U	17	U	16	U
Gamma-BHC (Lindane)	8	U	8	U	8	U	8	U	8	U
Heptaclor	8	U	8	U	8	U	8	U	8	U
Heptaclor epoxide	8	U	8	U	8	U	8	U	8	U
Methoxyclor	84	U	83	U	84	U	86	U	80	U
Toxaphene	170	U	170	U	170	U	170	U	160	U
alpha-Chlordane	84	U	83	U	84	U	86	U	80	U
gamma-Chlordane	84	U	83	U	84	U	86	U	80	U

[a]Units in mg/kg.
[b]Units in μg/kg.
Q = Laboratory qualifier.
U = Below dection limit; detection limit reported.
J = Estimated value–QC discrepancies occurred.
B = Detected in laboratory blank.
R = Data deemed unusable during data validation due to significant QC deficiency.

Table A-5 Chemical Analysis Results for Borehole 116-H-9 (page 1 of 5)

Analyte	SAMPLE NUMBERS					
	B05WN8[a]		B05WN9		B05WP0	
	top: 3.1 ft bottom: 5.3 ft	Q	top: 17.6 ft bottom: 20.1 ft	Q	top: 21.7 ft bottom: 24.2 ft	Q
Inorganic Analysis[b]						
Aluminum	74400.00		9340.00		5010.00	
Antimony	80.10	U	5.90	U	6.20	U
Arsenic	2.10	U	3.20	U	1.60	U
Barium	672.00		72.50		73.50	
Beryllium	4.70		0.25		0.26	
Cadmium	10.60	U	0.75	U	1.10	U
Calcium	79000.00		6320.00		5150.00	
Chromium	114.00		11.20		8.50	
Cobalt	86.40		13.40		6.90	
Copper	195.00		34.90		13.10	
Cyanide	5.10	U	5.10	U	4.90	U
Iron	184000.00		24200.00		13400.00	
Lead	7.90		4.20		2.60	U
Magnesium	50000.00		6700.00		3640.00	
Manganese	3050.00		280.00		214.00	
Mercury	0.10	U	0.09	U	0.09	U
Nickel	132.00		28.00		8.00	
Potassium	13000.00		600.00		916.00	
Selenium	4.00	U	0.76	U	0.79	U
Silver	12.90	U	0.95	U	0.99	U
Sodium	2010.00		721.00		271.00	
Thallium	0.59	U	0.57	U	0.59	U
Vanadium	389.00		46.70		36.80	
Zinc	430.00		42.20		32.80	
Organic Analysis[c]						
1,1,1-Trichloroethane	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane	5	U	5	U	5	U
1,1,2-Trichloroethane	5	U	5	U	5	U
1,1-Dichloroethane	5	U	5	U	5	U
1,1-Dichloroethene	5	U	5	U	5	U
1,2-Dichloroethane	5	U	5	U	5	U
1,2-Dichloroethene	5	U	5	U	5	U

Refer to footnotes at end of table.

9 3 1 3 0 4 0 5 0 5

Table A-5 Chemical Analysis Results for Borehole 116-H-9 (page 2 of 5)

Analyte	SAMPLE NUMBERS					
	B05WN8[a]		B05WN9		B05WP0	
	top: 3.1 ft bottom: 5.3 ft	Q	top: 17.6 ft bottom: 20.1 ft	Q	top: 21.7 ft bottom: 24.2 ft	Q
1,2-Dichloropropane	5	U	5	U	5	U
2-Butanone	11	U	10	U	10	U
2-Hexanone	11	U	10	U	10	U
4-Methyl-2-pentanone	11	U	10	U	10	U
Acetone	19	U	35	U	20	U
Benzene	5	U	5	U	5	U
Bromodichloromethane	5	U	5	U	5	U
Bromoform	5	U	5	U	5	U
Bromomethane	11	U	10	U	10	U
Carbon disulfide	5	U	5	U	5	U
Carbon tetrachloride	5	U	5	U	5	U
Chlorobenzene	5	U	5	U	5	U
Chloroethane	11	U	10	U	10	U
Chloroform	5	U	5	U	5	U
Chloromethane	11	U	10	U	10	U
Dibromochloromethane	5	U	5	U	5	U
Ethylbenzene	5	U	5	U	5	U
Methylene chloride	14	U	16	U	10	U
Styrene	5	U	5	U	5	U
Tetrachloroethene	5	U	5	U	5	U
Toluene	5	U	3	U	5	U
Trichloroethene	5	U	5	U	5	U
Vinyl acetate	11	U	10	U	10	U
Vinyl chloride	11	U	10	U	10	U
Xylenes (total)	5	U	5	U	5	U
cis-1,3-Dichloropropene	5	U	5	U	5	U
trans-1,3-Dichloropropene	5	U	5	U	5	U
Semivolatile Organic Analysis[c]						
1,2,4-Trichlorobenzene	340	U	330	U	320	U
1,2-Dichlorobenzene	340	U	330	U	320	U
1,3-Dichlorobenzene	340	U	330	U	320	U
1,4-Dichlorobenzene	340	U	330	U	320	U
2,4,5-Trichlorophenol	1700	U	1600	U	1600	U

Refer to footnotes at end of table.

Table A-5 Chemical Analysis Results for Borehole 116-H-9 (page 3 of 5)

Analyte	SAMPLE NUMBERS					
	B05WN8[a]		B05WN9		B05WP0	
	top: 3.1 ft bottom: 5.3 ft	Q	top: 17.6 ft bottom: 20.1 ft	Q	top: 21.7 ft bottom: 24.2 ft	Q
2,4,6-Trichlorophenol	340	U	330	U	320	U
2,4-Dichlorophenol	340	U	330	U	320	U
2,4-Dimethylphenol	340	U	330	U	320	U
2,4-Dinitrophenol	1700	U	1600	U	1600	U
2,4-Dinitrotoluene	340	U	330	U	320	U
2,6-Dinitrotoluene	340	U	330	U	320	U
2-Chloronaphthalene	340	U	330	U	320	U
2-Chlorophenol	340	U	330	U	320	U
2-Methylnaphthalene	340	U	330	U	320	U
2-Methylphenol	340	U	330	U	320	U
2-Nitroaniline	1700	U	1600	U	1600	U
2-Nitrophenol	340	U	330	U	320	U
3-Nitroaniline	1700	U	1600	U	1600	U
3,3-Dichlorbenzidine	690	U	690	U	650	U
4,6-Dinitro-2-methyl phenol	1700	U	1600	U	1600	U
4-Bromophenylphenyl ether	340	U	330	U	320	U
4-Chloro-3-methylphenol	340	U	330	U	320	U
4-Chlorophenylphenyl ether	340	U	330	U	320	U
4-Chloroaniline	340	U	330	U	320	U
4-Methylphenol	340	U	330	U	320	U
4-Nitroaniline	1700	U	330	U	320	U
4-Nitrophenol	1700	U	1600	U	1600	U
Acenaphthene	340	U	330	U	320	U
Acenaphthylene	340	U	330	U	320	U
Anthracene	340	U	330	U	320	U
Benzo(a)anthracene	340	U	330	U	320	U
Benzo(a)pyrene	340	U	330	U	320	U
Benzo(b)fluoranthene	340	U	330	U	320	U
Benzo(ghi)perylene	340	U	330	U	320	U
Benzo(k)fluoranthene	340	U	330	U	320	U
Benzoic acid	1700	U	330	U	320	U
Benzyl alcohol	340	U	330	U	320	U
Bis(2-chloroethoxy)methane	340	U	330	U	320	U

Refer to footnotes at end of table.

9 3 1 3 0 4 0 5 0 7

Table A-5 Chemical Analysis Results for Borehole 116-H-9 (page 4 of 5)

Analyte	SAMPLE NUMBERS					
	B05WN8[a]		B05WN9		B05WP0	
	top: 3.1 ft bottom: 5.3 ft	Q	top: 17.6 ft bottom: 20.1 ft	Q	top: 21.7 ft bottom: 24.2 ft	Q
Bis(2-chloroethyl)ether	340	U	330	U	320	U
Bis(2-chloroisopropyl)ether	340	U	330	U	320	U
Bis(2-ethylhexyl)phthalate	340	U	330	U	320	U
Butylbenzylphthalate	340	U	330	U	320	U
Chrysene	340	U	330	U	320	U
Di-n-butylphthalate	340	U	330	U	320	U
Di-n-octylphthalate	340	U	330	U	320	U
Dibenz[a,h]anthracene	340	U	330	U	320	U
Dibenzofuran	340	U	330	U	320	U
Diethyl phthalate	340	U	330	U	320	U
Dimethyl phthalate	340	U	330	U	320	U
Fluoranthene	340	U	330	U	320	U
Fluorene	340	U	330	U	320	U
Hexachlorobenzene	340	U	330	U	320	U
Hexachlorobutadiene	340	U	330	U	320	U
Hexachlorocyclopentadiene	340	U	330	U	320	U
Hexachloroethane	340	U	330	U	320	U
Ideno(1,2,3-cd)pyrene	340	U	330	U	320	U
Isophorone	340	U	330	U	320	U
N-Nitroso-di-n-dipropylamine	340	U	330	U	320	U
N-Nitrosodiphenylamine	340	U	1600	U	1600	U
Naphthalene	340	U	330	U	320	U
Nitrobenzene	340	U	330	U	320	U
Pentachlorophenol	1700	U	1600	U	1600	U
Phenanthrene	340	U	330	U	320	U
Phenol	340	U	330	U	320	U
Pyrene	340	U	330	U	320	U
Pesticide Analysis[c]						
4,4' - DDD	16	U	16	U	16	U
4,4' - DDE	16	U	16	U	16	U
4,4' - DDT	16	U	16	U	16	U
Aldrin	8	U	8	U	7	U
Alpha-BHC	8	U	8	U	7	U

Refer to footnotes at end of table.

Table A-5 Chemical Analysis Results for Borehole 116-H-9 (page 5 of 5)

Analyte	SAMPLE NUMBERS					
	B05WN8[a]		B05WN9		B05WP0	
	top: 3.1 ft bottom: 5.3 ft	Q	top: 17.6 ft bottom: 20.1 ft	Q	top: 21.7 ft bottom: 24.2 ft	Q
Aroclor-1016	81	U	80	U	78	U
Aroclor-1221	81	U	80	U	78	U
Aroclor-1232	81	U	80	U	78	U
Aroclor-1242	81	U	80	U	78	U
Aroclor-1248	81	U	80	U	78	U
Aroclor-1254	160	U	160	U	160	U
Aroclor-1260	160	U	160	U	160	U
Beta-BHC	8	U	8	U	7	U
Delta-BHC	8	U	8	U	7	U
Dieldrin	16	U	16	U	16	U
Endosulfan I	8	U	8	U	7	U
Endosulfan II	16	U	16	U	16	U
Endosulfan sulfate	16	U	16	U	16	U
Endrin	16	U	16	U	16	U
Endrin ketone	16	U	16	U	16	U
Gamma-BHC (Lindane)	8	U	8	U	7	U
Heptaclor	8	U	8	U	7	U
Heptaclor epoxide	8	U	8	U	7	U
Methoxyclor	81	U	80	U	78	U
Toxaphene	160	U	160	U	160	U
alpha-Chlordane	81	U	80	U	78	U
gamma-Chlordane	81	U	80	U	78	U

[a]Inorganic analysis results are suspect.
[b]Units in mg/kg.
[c]Units in μg/kg.
Q = Laboratory qualifier.
U = Below dection limit; detection limit reported.
J = Estimated value–QC discrepancies occurred.
B = Detected in laboratory blank.

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Table A-6 Radionuclide Analysis Results for Borehole 116-H-1

Radionuclide[a]	Sample Numbers											
	B05WV5		B05WV6		B05WV8		B05WV9		B05WW0		B05WW4	
	top: 10.0 ft bottom: 12.0 ft	Q	top: 13.6 ft bottom: 15.6 ft	Q	top: 15.0 ft bottom: 17.0 ft	Q	top: 16.5 ft bottom: 17.8 ft	Q	top: 19.3 ft bottom: 20.8 ft	Q	top: 24.0 ft bottom: 25.1 ft	Q
U-233/234	NA		0	U	0.53		0.62		NA		NA	
U-235	0.031	U	0	U	0.025	U	0.13	U	0.05	U	0.043	U
U-238	0.61		0	U	0.31		0.23	J	0.39		0.58	
Pu-239/240	0.74		0.58		0.64		0.33		0.063		0.034	J
Am-241	0.2		0.16		0.16		0.068		0	U	0.006	U
Sr-90	1.5	J	1.5	J	6.2		5.5		1.3	J	-0.081	U
Tc-99	0.25	U	0.25	J	0.18	J	0.67		0.21	U	-0.076	U
Co-60	2.5		1.8		2.2		2		0	U	0	U
Cs-137	32		24		23		11		0.25		0	U
Ra-226	NA		0	U	0.78		0.85		0.55		0.4	
Th-228	NA		0.95		0.52		0.44		0.75		0.53	
Th-232	NA		0	U	0	U	0	U	0.89		0.64	
Eu-152	54		36		34		42		0.72		NA	
Eu-154	5.4		3.6		3.6		3.6		0.34		NA	

[a]Units in pCi/g.
Q = Laboratory qualifier.
U = Below detection limit; detection limit reported.
J = Estimated value; QC discrapencies occurred.
NA = Not detected.

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Table A-7 Radionuclide Analysis Results for Borehole 116-H-2

Radionuclide[a]	Sample Numbers					
	B05WW5		B05WW6		B05WW7	
	top: 9.9 ft bottom: 12.1 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q	top: 14.9 ft bottom: 17.2 ft	Q
U-233/234	NA		NA		NA	
U-235	0	U	0	U	0	U
U-238	0.33		0.54		0.5	
Pu-239/240	0	U	0	U	0.006	U
Am-241	0.004	U	0.002	U	-0.033	U
Sr-90	-0.02	U	-0.76	U	-0.24	U
Tc-99	0.14	U	0.084	U	0.42	U
Co-60	0	U	0	U	0	U
Cs-137	0	U	0	U	0	U
Ra-226	0.37		0.47		0.5	
Th-228	0.49		0.5		0.63	
Th-232	0.35		0	U	0	U
Eu-152	NA		NA		NA	
Eu-154	NA		NA		NA	

[a]Units in pCi/g.
Q = Laboratory qualifier.
U = Below detection limit; detection limit reported.
J = Estimated value; QC discrepancies occurred.
NA = Not detected.

Table A-8 Radionuclide Analysis Results for Borehole 116-H-3

Radionuclide[a]	Sample Numbers			
	B05WP1		B05WP5	
	top: 14.5 ft bottom: 16.3 ft	Q	top: 19.6 ft bottom: 21.7 ft	Q
U-233/234	NA		0.35	
U-235	0.016	U	0	U
U-238	0.58		0.44	
Pu-239/240	0.006	U	0	U
Am-241	0.009	U	0.011	U
Sr-90	0.048	U	0.24	U
Tc-99	0.52	U	0.2	U
Co-60	0.38		0.13	
Cs-137	0	U	0	U
Ra-226	0	U	0.45	
Th-228	0.58		0.57	
Th-232	0.44		0.39	
Eu-152	0.54		NA	
Eu-154	NA		NA	

[a]Units in pCi/g.
Q=Laboratory qualifier.
U=Below detection limit; detection limit reported.
J=Estimated value; QC discrepancies occurred.
NA=Not detected.

9 3 1 3 0 4 0 3 1 2

Table A-9 Radionuclide Analysis Results for Borehole 116-H-7

Radionuclide[a]	Sample Numbers									
	B05WT8		B05WT9		B05WV2		B05WV3		B05WV4	
	top: 1.0 ft bottom: 3.0 ft	Q	top: 8.0 ft bottom: 10.0 ft	Q	top: 9.8 ft bottom: 12.4 ft	Q	top: 14.8 ft bottom: 16.4 ft	Q	top: 19.2 ft bottom: 20.8 ft	Q
U-233/234	NA		NA		NA		NA		NA	
U-235	0.023	U	0.013	U	0.38		0.018	U	0.014	U
U-238	0.69		0.47		0.68		0.5		0.53	
Pu-239/240	0.026	J	1.1		1.3		0.073		0.003	U
Am-241	0.011	U	0.54		0.72		0.031	U	0.011	U
Sr-90	-0.15	U	3.2		0.93	J	-0.7	U	1.2	J
Tc-99	0.15	U	0.33	U	0.095	U	0.26	U	0.22	U
Co-60	0	U	14		36		0.68		0	U
Cs-137	0	U	11		35		1.7		0	U
Ra-226	0.29		0	U	0	U	0.65		0.44	
Th-228	0.41		0	U	0	U	0.81		0.46	
Th-232	0.41		0	U	0	U	0	U	0.44	
Eu-152	NA		120		260		4		NA	
Eu-154	NA		19		37		0.5		NA	

[a]Units in pCi/g.
Q = Laboratory qualifier.
U = Below detection limit; detection limit reported.
J = Estimated value; QC discrepancies occurred.
NA = Not detected.

Table A-10 Radionuclide Analysis Results for Borehole 116-H-9

Radionuclides[a]	Sample Numbers					
	B05WN8		B05WN9		B05WP0	
	top: 3.1 ft bottom: 5.3 ft	Q	top: 17.6 ft bottom: 20.1 ft	Q	top: 21.7 ft bottom: 24.2 ft	Q
U-233/234	NA		NA		NA	
U-235	0.029	U	0	U	0.015	U
U-238	0.47		0.19	U	0.45	
Pu-239/240	0.004	U	0.024	U	0.004	U
Am-241	0.023	U	0.01	U	0	U
Sr-90	0.085	U	-0.18	U	-0.16	U
Tc-99	-0.13	U	0.23	U	0.17	U
Co-60	0	U	0	U	0	U
Cs-137	0	U	0.29		0	U
Ra-226	0.64		0.71		0.5	
Th-228	1.2		1.1		0.73	
Th-232	0.75		1.1		0.39	
Eu-152	NA		0.36		NA	
Eu-154	NA		NA		NA	

[a]Units in pCi/g.
Q=Laboratory qualifier.
U=Below detection limit; detection limit reported.
J=Estimated value; QC discrepancies occurred.
NA=Not detected.

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9 3 1 3 0 4 0 5 1 5

APPENDIX B
RESULTS OF LABORATORY ANALYSES FOR LOW-PRIORITY SITES

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Table B-1 Chemical Analysis Results for Septic Tank 1607-H-2 (page 1 of 3)

Analyte	Sample Numbers													
	B00ZM6		B00ZM7		B01605		B01606		B01607		B01608		B01609	
	Sludge	Q	Sludge	Q	Water	Q	Water	Q	Water	Q	Water	Q	Water	Q
Inorganic Analysis[a]														
Aluminum	11600.00		13600.00		10.00	U	43.80		18.90		10.80		10.00	U
Antimony	30.30	U	18.60		11.00	U	11.00	U	11.00	U	14.70		11.00	U
Arsenic	24.10		8.90		4.00	U	4.00	U	4.00	UJ	4.00	U	4.00	U
Barium	1930.00		4260.00		1.00	U	1.20		25.20		25.50		1.00	U
Beryllium	1.80	U	1.70		1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Cadmium	22.50		28.50		1.00	U	1.00	U	1.00	U	1.00	U	1.00	U
Calcium	12200.00		14400.00		7.00	U	181.00		19300.00		20000.00		7.00	U
Chromium	1020.00		2510.00		2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Cobalt	16.60		19.60		2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Copper	534.00		627.00		3.00	U	3.00	U	3.00	U	3.00	U	3.00	U
Iron	29400.00		18800.00		7.00	U	7.00	U	7.00	U	7.00	U	7.00	U
Lead	419.00		499.00		1.00	U	1.50		1.00	U	1.00	U	1.00	U
Magnesium	2940.00		3000.00		13.00	U	13.00	U	222.00		245.00		13.00	U
Manganese	158.00		113.00		1.00	U	1.00	U	1.00	U	1.00		1.00	U
Mercury	34.10	J	37.00	J	0.20	UJ	0.20	UJ	0.20	UJ	0.20	UJ	0.26	J
Nickel	56.40		51.20		4.00	U	4.00	U	4.00	U	4.00	U	4.00	U
Potassium	1030.00		1060.00		42.00	U	42.00	U	45900.00		47000.00		42.00	U
Selenium	7.80	J	4.00	U	4.00	U	4.00	U	4.00	U	4.00	U	4.00	U
Silver	119.00		107.00		2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Sodium	727.00		888.00		22.00	U	143.00		132000.00		134000.00		78.20	
Thallium	3.50		5.40	J	3.00	U	3.00	U	15.00	UJ	15.00	U	3.00	U
Vanadium	47.00		43.40		2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Zinc	4080.00		6160.00		3.00	U	3.00	U	3.00	U	4.30		3.00	U

Refer to footnotes at end of table.

Table B-1 Chemical Analysis Results for Septic Tank 1607-H-2 (page 2 of 3)

Analyte	Sample Numbers													
	B00ZM6		B00ZM7		B01605		B01606		B01607		B01608		B01609	
	Sludge	Q	Sludge	Q	Water	Q	Water	Q	Water	Q	Water	Q	Water	Q
Wet Chemistry Analysis[a]														
Fluoride					0.24		0.24		1.96		0.25		0.24	
Chloride					0.03	U	0.03	U	0.03	U	0.03	U	0.03	U
Nitrite	1.20		1.00	U	0.03	U	0.03	U	0.56		0.56		0.03	U
Nitrate	15.20		5.00		5.00	U	5.00	U	130.00		130.00		5.00	U
Sulfate	4425.00		7115.00											
Organic Analysis[b]														
Chloromethane	91	UJ	45	UJ	10	UJ	10	UJ	10	UJ	10	UJ	10	U
Bromomethane	91	UJ	45	UJ	10	UJ	10	UJ	10	UJ	10	UJ	10	U
Vinyl Chloride	91	UJ	45	UJ	10	UJ	10	UJ	10	UJ	10	UJ	10	U
Chloroethane	91	UJ	45	UJ	10	UJ	10	UJ	10	UJ	10	UJ	10	U
Methylene Chloride	91	UJ	45	UJ	10	UJ	10	UJ	10	UJ	10	UJ	300	J
Acetone	770	UJ	450	UJ	10	UJ	10	UJ	10	UJ	10	UJ	10	U
Carbon Disulfide	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
1,1-Dichloroethene	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
1,1-Dichloroethane	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
1,2-Dichloroethene (total)	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
Chloroform	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
1,2-Dichloroethane	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
2-Butanone	91	UJ	45	UJ	10	UJ	10	UJ	10	UJ	10	UJ	10	U
1,1,1-Trichloroethane	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
Carbon Tetrachloride	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
Bromodichloromethane	91	UJ	45	UJ	10	UJ	10	UJ	10	UJ	10	UJ	10	U
1,2-Dichloropropane	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U

Refer to footnotes at end of table.

Table B-1 Chemical Analysis Results for Septic Tank 1607-H-2 (page 3 of 3)

Analyte	Sample Numbers													
	B00ZM6		B00ZM7		B01605		B01606		B01607		B01608		B01609	
	Sludge	Q	Sludge	Q	Water	Q	Water	Q	Water	Q	Water	Q	Water	Q
cis-1,3-Dichloropropene	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
Trichloroethene	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
Dibromochloromethane	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
1,1,2-Trichloroethane	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
Benzene	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
trans-1,3-Dichloropropene	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
Bromoform	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
4-Methyl-2-pentanone	91	UJ	45	UJ	10	UJ	10	UJ	10	UJ	10	UJ	10	U
2-Hexanone	91	UJ	45	UJ	10	UJ	10	UJ	10	UJ	10	UJ	10	U
Tetrachloroethene	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
1,1,2,2-Tetrachloroethane	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
Toluene	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
Chlorobenzene	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
Ethylbenzene	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
Styrene	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U
Xylene (total)	45	UJ	23	UJ	5	UJ	5	UJ	5	UJ	5	UJ	5	U

[a]Units in mg/kg for sludge; µg/L for water.
[b]Units in µg/kg for sludge; µg/L for water.
Q = Laboratory qualifier.
U = Below detection limit; detection limit reported.
J = Estimated value–QC discrepancies occurred.
B = Detected in laboratory blank.
R = Data deemed unusable due to significant QC deficiency.

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Table B-2 Radionuclide Analysis Results for Septic Tank 1607-H-2

Radionuclide[a]	Sample Numbers													
	B00ZM6		B00ZM7		B01605		B01606		B01607		B01608		B01609	
	Sludge	Q	Sludge	Q	Water	Q	Water	Q	Water	Q	Water	Q	Water	Q
Gross Alpha	15	R	2	R	0	R	2	R	4	R	2	R	0	R
Gross Beta	18	R	21	R	0	R	0	R	21	R	22	R	1	R
Tritium	200	R	200	R	180	R	180	R	224	R	310	R	169	R
Uranium-233/234	3.3	R	5.8	R	0.3	R	0.1	R	1.8	R	1.7	R	0.3	R
Uranium-235	0.17	R	0.28	R	0.2	R	0.1	R	0.1	R	0.2	R	0.1	R
Uranium-238	2.6	R	4.4	R	0.1	R	0.1	R	1.7	R	1.5	R	0.2	R
Plutonium-238	0.07	R	0.05	R	0.2	R	0.1	R	0.1	R	0.1	R	0.1	R
Plutonium-239/240	0.09	R	0.11	R	0.1	R	0.1	R	0.1	R	0.1	R	0.1	R
Plutonium-241	9	R	6	R	7	R	8	R	23	R	9	R	13	R
Americium-241	0.038	R	0.09	R	0.1	R	0.2	R	0.1	R	0.1	R	0.2	R
Nickel-63	7	R	5	R	9	R	9	R	9	R	10	R	10	R
Strontium-90	0.79	R	0.7	R	0.5	R	0.5	R	0.6	R	1.4	R	0.5	R
Technetium-99	0.6	U	0.4	U	11.2	R	12.4	R	12.4	R	13.8	R	13.4	R
Potassium-40	7.027	J	8.053	J	133	J	253	J	174	J	69	J	215	J
Cobalt-60	0.48	J	1.379	J										
Cesium-137	0.871	J	0.745	J	10	J	14	J	11	J	6.3	J	12	J
Radium-226	0.6807	J	1.362	J	24	J	35	J	28	J	21	J	20	J
Thorium-228	0.861	J	0.9115	J	19	J	23	J	22	J	13	J	18	J
Thorium-232	1.429	J	2.041	J	45	J	57	J	53	J	34	J	55	J
Europium-152	0.9524	J	1.122	J										

[a]Units in pCi/g for sludge, pCi/L for water.
Q = Laboratory qualifier.
U = Below detection limit; detection limit reported.
R = Data deemed unusable due to significant QC deficiency.

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Table B-3 Chemical Analysis Results for Septic Tank 1607-H-4 (page 1 of 5)

Analyte	Sample Numbers							
	B07206		B07208		B07207		B07211	
	Surface Soil	Q	Surface Soil	Q	Surface Soil	Q	Surface Soil	Q
Inorganic Analysis[a]								
Aluminum	5240.00		4950.00		3940.00		8240.00	
Antimony	3.20	U	3.20	U	12.10	U	3.30	U
Arsenic	0.94	B	1.50	B	2.00	U	7.80	
Barium	27.30	B	27.60	B	40.40		226.00	
Beryllium	0.14	U	0.14	U	1.00	U	0.18	B
Cadmium	0.29	U	0.29	U	1.00	U	0.31	U
Calcium	2490.00		2460.00		2160.00		8310.00	
Chromium	8.90		9.40		8.20		19.80	
Cobalt	6.90	B	6.50	B	10.10	U	8.40	B
Copper	15.60		15.30		11.30		40.20	
Cyanide	0.50	U	0.49	U	1.00	U	0.52	U
Iron	13800.00		13200.00		10500.00		19800.00	
Lead	3.40		3.50		2.70		50.00	
Magnesium	3730.00		3580.00		2960.00		4440.00	
Manganese	203.00		187.00		157.00		315.00	
Mercury	0.05	U	0.04	U	0.10	U	0.50	
Nickel	8.40		8.30		8.10	U	12.80	
Potassium	605.00	B	546.00	B	1010.00	U	1050.00	
Selenium	0.70	U	0.76	U	1.00	U	0.80	U
Silver	0.94	U	0.93	U	2.00	U	0.98	U
Sodium	139.00	B	118.00	B	1010.00	U	258.00	B
Thallium	0.30	U	0.32	U	2.00	U	0.34	U
Vanadium	39.10		36.00		21.00		37.80	
Zinc	33.60		33.30		25.20		194.00	
Organic Analysis[b]								
1,1,1-Trichloroethane	10	U	10	U	10	U	10	U
1,1,2,2-Tetrachloroethane	10	U	10	U	10	U	10	U
1,1,2-Trichloroethane	10	U	10	U	10	U	10	U
1,1-Dichloroethane	10	U	10	U	10	U	10	U
1,2-Dichloroethane	10	U	10	U	10	U	10	U
1,2-Dichloropropane	10	U	10	U	10	U	10	U
2-Hexanone	10	U	10	U	10	U	10	U
4-Methyl-2-pentanone	10	U	10	U	10	U	10	U

Refer to footnotes at end of table.

Table B-3 Chemical Analysis Results for Septic Tank 1607-H-4 (page 2 of 5)

Analyte	Sample Numbers							
	B07206		B07208		B07207		B07211	
	Surface Soil	Q	Surface Soil	Q	Surface Soil	Q	Surface Soil	Q
Acetone	24	B	17		6	B	23	B
Benzene	10	U	10	U	10	U	10	U
Bromodichloromethane	10	U	10	U	10	U	10	U
Bromoform	10	U	10	U	10	U	10	U
Bromomethane	10	U	10	U	10	U	10	U
Carbon disulfide	10	U	10	U	10	U	2	J
Carbon tetrachloride	10	U	10	U	10	U	10	U
Chlorobenzene	10	U	10	U	10	U	10	U
Chloroethane	10	U	10	U	10	U	10	U
Chloroform	10	U	10	U	10	U	10	U
Chloromethane	10	U	10	U	10	U	10	U
Dibromochloromethane	10	U	10	U	10	U	10	U
Ethylbenzene	10	U	10	U	10	U	10	U
Methylene chloride	10	U	10	U	10	U	6	J
Styrene	10	U	10	U	10	U	10	U
Tetrachloroethene	10	U	10	U	10	U	10	U
Toluene	10	U	10	U	10	U	4	J
Trichloroethene	10	U	10	U	10	U	10	U
Vinyl chloride	10	U	10	U	10	U	10	U
Xylenes (total)	10	U	10	U	10	U	10	U
cis-1,3-Dichloropropene	10	U	10	U	10	U	10	U
trans-1,3-Dichloropropene	10	U	10	U	10	U	10	U
Semivolatile Organic Analysis[b]								
2,4-Dinitrotoluene	330	U	330	U	340	U	680	U
2,6-Dinitrotoluene	330	U	330	U	340	U	680	U
3,3-Dichlorobenzidine	330	U	330	U	340	U	680	U
4,6-Dinitro-2-methylphenol	790	U	800	U	840	U	1600	U
4-Bromophenylphenyl ether	330	U	330	U	340	U	680	U
4-Chlorophenylphenyl ether	330	U	330	U	340	U	680	U
4-Nitroaniline	790	U	800	U	840	U	1600	U
4-Nitrophenol	790	U	800	U	840	U	1600	U
Carbazole	330	U	330	U	340	U	150	J
Anthracene	330	U	330	U	340	U	320	J
Benzo(a)anthracene	330	U	330	U	340	U	1800	

Refer to footnotes at end of table.

Table B-3 Chemical Analysis Results for Septic Tank 1607-H-4 (page 3 of 5)

Analyte	Sample Numbers							
	B07206		B07208		B07207		B07211	
	Surface Soil	Q	Surface Soil	Q	Surface Soil	Q	Surface Soil	Q
Benzo(a)pyrene	330	U	330	U	340	U	940	
Benzo(b)fluoranthene	330	U	330	U	340	U	2400	
Benzo(ghi)perylene	330	U	330	U	340	U	460	J
Benzo(k)fluoranthene	330	U	330	U	340	U	680	U
Bis(2-ethylhexyl)phthalate	330	U	330	U	45	B	680	U
Butylbenzylphthalate	330	U	330	U	340	U	680	U
Chrysene	330	U	330	U	340	U	920	
Di-n-butylphthalate	330	U	330	U	180	B	680	U
Di-n-octylphthalate	330	U	330	U	340	U	680	U
Dibenz[a,h]anthracene	330	U	330	U	340	U	680	U
Dibenzofuran	330	U	330	U	340	U	680	U
Diethyl phthalate	330	U	330	U	340	U	680	U
Fluoranthene	330	U	330	U	340	U	2900	
Fluorene	330	U	330	U	340	U	110	J
Hexachlorobenzene	330	U	330	U	340	U	680	U
Indeno(1,2,3-cd)pyrene	330	U	330	U	340	U	480	J
N-Nitrosodiphenylamine	330	U	330	U	340	U	680	U
Pentachlorophenol	790	U	800	U	33	J	1600	U
Phenanthrene	330	U	330	U	340	U	1600	
Pyrene	330	U	330	U	340	U	2700	
1,2,4-Trichlorobenzene	330	U	330	U	340	U	680	U
1,2-Dichlorobenzene	330	U	330	U	340	U	680	U
1,3-Dichlorobenzene	330	U	330	U	340	U	680	U
1,4-Dichlorobenzene	330	U	330	U	340	U	680	U
2,4,5-Trichlorophenol	790	U	800	U	840	U	1600	U
2,4,6-Trichlorophenol	330	U	330	U	340	U	680	U
2,4-Dichlorophenol	330	U	330	U	340	U	680	U
2,4-Dimethylphenol	330	U	330	U	340	U	680	U
2,4-Dinitrophenol	790	U	800	U	840	U	1600	U
2-Chloronaphthalene	330	U	330	U	340	U	680	U
2-Chlorophenol	330	U	330	U	340	U	680	U
2-Methylnaphthalene	330	U	330	U	340	U	680	U
2-Methylphenol	330	U	330	U	340	U	680	U
2-Nitroaniline	790	U	800	U	840	U	1600	U

Refer to footnotes at end of table.

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Table B-3 Chemical Analysis Results for Septic Tank 1607-H-4 (page 4 of 5)

Analyte	Sample Numbers							
	B07206		B07208		B07207		B07211	
	Surface Soil	Q	Surface Soil	Q	Surface Soil	Q	Surface Soil	Q
2-Nitrophenol	330	U	330	U	340	U	680	U
3-Nitroaniline	790	U	800	U	840	U	1600	U
4-Chloro-3-methylphenol	330	U	330	U	340	U	680	U
4-Chloroaniline	330	U	330	U	340	U	680	U
4-Methylphenol	330	U	330	U	340	U	680	U
Acenaphthene	330	U	330	U	340	U	130	J
Acenaphthylene	330	U	330	U	340	U	680	U
Bis(2-Chloroethoxy)methane	330	U	330	U	340	U	680	U
Bis(2-Chloroethyl)ether	330	U	330	U	340	U	680	U
Dimethyl phthalate	330	U	330	U	340	U	680	U
Hexachlorobutadiene	330	U	330	U	340	U	680	U
Hexachlorocyclopentadiene	330	U	330	U	340	U	680	U
Hexachloroethane	330	U	330	U	340	U	680	U
Isophorone	330	U	330	U	340	U	680	U
N-Nitroso-di-n-dipropylamine	330	U	330	U	340	U	680	U
Naphthalene	330	U	330	U	340	U	680	U
Nitrobenzene	330	U	330	U	340	U	680	U
Phenol	330	U	330	U	220	J	680	U
Pesticide Analysis[b]								
4,4' - DDD	3.3	U	3.2	U	3.4	U	110.0	
4,4' - DDE	3.3	U	3.2	U	3.4	U	12.0	
4,4' - DDT	3.3	U	3.2	U	3.4	U	3.3	U
Aldrin	1.7	U	1.7	U	1.7	U	1.7	U
Alpha-BHC	1.7	U	1.7	U	1.7	U	1.7	U
Aroclor-1016	33.0	U	32.0	U	34.0	U	33.0	U
Aroclor-1221	66.0	U	66.0	U	67.0	U	68.0	U
Aroclor-1232	33.0	U	32.0	U	34.0	U	33.0	U
Aroclor-1242	33.0	U	32.0	U	34.0	U	33.0	U
Aroclor-1248	33.0	U	32.0	U	34.0	U	33.0	U
Aroclor-1254	33.0	U	32.0	U	34.0	U	33.0	U
Aroclor-1260	33.0	U	32.0	U	34.0	U	33.0	U
Beta-BHC	1.7	U	1.7	U	1.7	U	1.7	U
Delta-BHC	1.7	U	1.7	U	1.7	U	1.7	U
Dieldrin	3.3	U	3.2	U	3.4	U	3.3	U

Refer to footnotes at end of table.

9 3 1 3 0 2 4 0 5 2 3

Table B-3 Chemical Analysis Results for Septic Tank 1607-H-4 (page 5 of 5)

Analyte	Sample Numbers							
	B07206		B07208		B07207		B07211	
	Surface Soil	Q	Surface Soil	Q	Surface Soil	Q	Surface Soil	Q
Endosulfan I	1.7	U	1.7	U	1.7	U	1.7	U
Endosulfan II	3.3	U	3.2	U	3.4	U	3.3	U
Endosulfan sulfate	3.3	U	3.2	U	3.4	U	3.3	U
Endrin	3.3	U	3.2	U	3.4	U	3.3	U
Endrin Aldehyde	3.3	U	3.2	U	3.4	U	3.3	U
Endrin ketone	3.3	U	3.2	U	3.4	U	3.3	U
Gamma-BHC (Lindane)	1.7	U	1.7	U	1.7	U	1.7	U
Heptachlor	1.7	U	1.7	U	1.7	U	1.7	U
Heptachlor epoxide	1.7	U	1.7	U	1.7	U	1.7	U
Methoxychlor	17.0	U	17.0	U	17.0	U	17.0	U
Toxaphene	170.0	U	170.0	U	170.0	U	170.0	U
alpha-Chlordane	1.7	U	1.7	U	1.7	U	1.7	U
gamma-Chlordane	1.7	U	1.7	U	1.7	U	18.0	

[a]Units in mg/kg.
[b]Units in μg/kg.
Q = Laboratory qualifier.
U = Below detection limit; detection limit reported.
J = Estimated value–QC discrepancies occurred.
B = Detected in laboratory blank.

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Table B-4 Radionuclide Analysis Results for Septic Tank 1607-H-4

Radionuclide[a]	Sample Numbers					
	B07206		B07208		B07211	
	Surface Soil	Q	Surface Soil	Q	Surface Soil	Q
Gross Alpha	8.8	J	7.6	J	4.7	U
Gross Beta	17		15		17	
Uranium-233/234	0.57		0.41		0.62	
Uranium-235	0.058	U	0.026	U	0	U
Uranium-238	0.48		0.44		0.31	
Plutonium-238	0	U	-0.001	U	0.011	U
Plutonium-239/240	0.005	U	0.003	U	0.006	U
Americium-241	-0.005	U	-0.003	U	-0.004	U
Strontium-90	-0.042	U	0.23	U	0	U
Potassium-40	12		14		8.3	
Cobalt-60	0	U	0	U	0	U
Cesium-137	0	U	0	U	0.67	
Radium-226	0.45		0.44		0.37	
Thorium-228	0.54		0.56		0.40	
Thorium-232	0.51		0.62		0.44	
Europium-152	0	U	0	U	1.2	
Europium-154	0	U	0	U	0	U

[a]Units in pCi/g.
Q = Laboratory qualifier.
U = Below detection limit; detection limit reported.
J = Estimated value–QC discrepancies occurred.

Table B-5 PCB Analysis Results for Electrical Facilities Soil Sample

Analyte[a]	Sample Numbers															
	B018S5		B018S6		B018S7		B018S8		B018S9		B018T0		B018T1		B018T2	
	Soil	Q	Soil	Q	Soil	Q	Soil	Q	Soil	Q	Soil	Q	Soil	Q	Soil	Q
Aroclor-1016	7	U	7	U	7	U	20	U	7	U	7	U	7	U	7	U
Aroclor-1221	7	U	7	U	7	U	39	U	7	U	7	U	7	U	7	U
Aroclor-1232	7	U	7	U	7	U	20	U	7	U	7	U	7	U	7	U
Aroclor-1242	7	U	7	U	7	U	20	U	7	U	7	U	7	U	7	U
Aroclor-1248	7	U	7	U	7	U	20	U	7	U	7	U	7	U	7	U
Aroclor-1254	7	U	7	U	7	J	350		7	U	32	J	7	U	7	U
Aroclor-1260	1200	J	770	J	630	J	20	U	7	U	--	E	7	U	7	U

[a]All values in $\mu g/Kg$
Q = Laboratory qualifier.
U = Below detection limit; detection limit reported.
J = Estimated value–QC discrepancies occurred.
E = Error in analyzing sample.